The Great Trinity Forest Management Plan

Volume 17
Wildlife Management

GREAT TRINITY FOREST

Wildlife Management

Volume 17

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Wildlife Management

Wildlife is an important part of any ecosystem. A wide variety of wildlife species not only indicates a healthy environment but also enrich the visitors' experience. Currently the Great Trinity Forest is dominated by tree species such as elm (*Ulmus* spp) and ash (*Fraxinus* spp.), which do provide cover and food for wildlife. However, there are other bottomland species which provide superior food and cover for a wider range of wildlife species. (This is shown in Table 1 by the low Habitat Suitability Index's (HSI) for five of the managed wildlife species.) To improve wildlife habitat, the overstory trees in certain areas will be killed using herbicides and the area will be replanted with valuable mast producing species. In the short term, this will create openings in the forest where shrubs and saplings will flourish while also creating a multitude of valuable snags used by wildlife. Unfortunately, it generally takes several years for the planted hardwood species to produce mast so any mature hard mast producing species growing in the forest will be preserved for wildlife habitat. And, because only 3,442 acres will be intensively planted and managed, the rest of the forest will remain in its current condition constantly producing food and cover for wildlife. This transformation of the Great Trinity Forest from an undesirable bottomland hardwood forest into a mature forest with excellent wildlife habitat is clearly shown in Table 1 by the high HSI values attained once the forest has matured.

Current Vegetation

At this time the Great Trinity Forest is mainly composed of elm, ash, sugarberry (*Celtis laevigata*), cottonwood (*Populus deltoids* var *deltoids* or *occidentalis*), eastern redcedar (*Juniperus virginiana*) and, to a lesser extent, pecan (*Carya illinoensis*), swamp privet (*Forestiera acuminata*) and black willow (*Salix nigra*). These provide cover in the form of cavities and woody material but many also provide food. In fact, of these species only cottonwood and black willow do not provide food in the form of nuts or fruits. However, they, along with several other species, do provide browse or sap for wildlife species such as white-tailed deer, rabbits and the yellow-bellied sapsucker. Food is also provided in the form of the various insects which attack these tree species. The following is the benefit that each of these species provides for forest wildlife.

Elm: *Ulmus* spp. are attacked by more than 125 insect species which provide ample food for insect eating wildlife species. The twigs and leaves are browsed by deer and rabbits but deer also will strip bark off of saplings or pole-sized trees, especially on slippery elm (*U. rubra*). Fire may damage the tree which will allow heart rot fungi to enter and create cavities. Squirrels eat the flowers, flower buds and fruit while the seeds are eaten by a wide variety of birds and small mammals. Slippery elm, American elm (*U. Americana*) and winged elm (*U. alata*) fruit ripens during in spring; however, cedar elm (*U. crassifolia*) fruit ripens from September to October and this species can have a second flowering and fruiting in October and November. (Burns and Barbara 1990)

Ash: Young trees provide browse for deer and rabbits while the seeds are eaten by a variety of animal and bird species. These seeds are usually produced annually by trees that are 8 to 10 cm (3 to 4 inches) in d.b.h. and 20 to 25 feet tall. The seeds ripen late September or early October and are dropped in the winter. These species also provide food in the form of insects living on the trees including carpenterworm *(Prionoxystus robiniae,)* brownheaded ash sawfly *(Tomostethus multicinctus),* and the ash borer *(Podosesia syringae).* (Burns and Barbara 1990)

Sugarberry: This species produces spherical drupes which are eaten by numerous wildlife species. The fruit is produced on trees that are at least 15 years old but the optimum seed-bearing age is 30 to 70 years old. The fruit ripens in September and October and good seed crops occur in most

years. This species can also be easily damaged by fire and ice, which allows rot-causing fungi to enter and create cavities. These cavities can then be used by a wide variety of wildlife species as den or roosting sites. (Burns and Barbara 1990)

Cottonwood: Young seedlings and saplings of this tree species are browsed by rabbits, deer and domestic stock while beavers will use sapling and pole-size trees for dam construction. Many species of insects, such as the cottonwood leaf beetle (*Chrysomela scripta),* also attack this species, which then provide food for insect eating wildlife species. (Burns and Barbara 1990)

Pecan: Saplings and lower branches of older trees are used as browse by white-tailed deer while many other species use pecans for cover. A wide variety of insects attack the leaves, nuts, twigs, wood and roots of this species. These insects provide food for insect eating wildlife species. Pecan nuts are eaten by many wildlife species such as squirrels, opossums, raccoons and a variety of birds. Pecans may start producing nuts as early as 2 years old but it may take up to 20 years in natural stands. The nuts ripen in September and October and good crops occur every 1 to 3 years. (Burns and Barbara 1990, Moore and Hurteau 2006)

Swamp privet: This species grows in wet areas and produces 8 to 12 mm long drupes during the summer which are eaten by a variety of wildlife species. (Connor 2003)

Eastern redcedar: This is an evergreen species that provides year round cover, roosting and nesting sites for many species, such as chipping sparrow, robin, mockingbird and junco. The twigs and foliage of this species are also used as browse by white-tailed deer. Even more important is the fleshy berry-like fruit which are a vital food source for many wildlife species. These cones are produced every 2 to 3 years, once the tree is 10 years old, and ripen from September to October. (Steven et al 2005)

Willow: This species provides cover for many bird and animal species and it is a source of sap for the yellow-bellied sapsucker. Many insects, such as the forest tent caterpillar *(Malacosoma disstria),* the cottonwood leaf beetle *(Chrysomela scripta)* and the willow-branch borer *(Oberea ferruginea),* attack this species and serve as food for insect eating wildlife species. Fire can easily damage the truck and allow wood rotting fungi to enter, which will create cavities for wildlife species. (Burns and Barbara 1990)

Future Vegetation

Though the forest does currently provide food and cover for some wildlife species, the forest can be improved by planting more desirable mast producing trees. The trees that are going to be planted include bur oak (*Quercus macrocarpa*), pecan, black walnut (*Juglans nigra*) common persimmon (*Diospyros virginiana*), shumard oak (*Q. shumardii*), roughleaf dogwood (*Cornus drummondii*), red mulberry (*Morus rubra*), blackjack oak (*Q. marilandica*), chinkapin (*Q. muehlenbergii*), post oak (*Q. stellata*) and mexican plum (*Prunus mexicana*). All of these species are well known for the excellent food they provide for numerous wildlife species in the form of fruit, acorns and walnuts. The following is the benefits that each of these species provides for the forest wildlife.

Mexican plum: This tree species produces a purple/red fruit that matures from July to September and is eaten by humans as well as many birds and mammals. (Oklahoma Biological Survey 1999).

Blackjack oak: This red oak provides excellent cover and food for wildlife. In fact, its acorns are ranked fourth in preference for the fox squirrel. Its acorns ripen from September to November but they germinate in the spring, which provides a food source throughout the winter. (Carey 1992)

Roughleaf dogwood: Not only does this dogwood species provide excellent cover, it produces fruit in the fall that is eaten by at least 40 bird species. (Gilman and Watson 1993)

Common persimmon: This species is well known for its fruit which falls from September to late winter. The seed germinates in April and May, which means that the seed is available for food all winter. Optimum fruit bearing age is 25 to 50 years old but can start producing fruit as early as 10 years old. Once it starts producing mast, it will produce a good crop every 2 years. Its fruit is eaten by song and game birds, white-tailed deer and small mammals such as raccoons and squirrels. (Burns and Barbara 1990)

Red mulberry: This species produces a fruit that is readily eaten by many species such as opossum, raccoon, fox squirrels and birds. It produces fruit from June to August once it is about 10 years old; however, optimum seedbearing age is 30 to 85 years old. Good crops occur every 2 to 3 years. (Burns and Barbara 1990)

Chinkapin oak: This species' acorn ripens in September and October and germinates soon after falling. The minimum seed bearing age of this species is not known but most oaks start bearing seed at about 20 to 30 years old. The acorn of this species is sweet and palatable and is eaten by a variety of species. (Burns and Barbara 1990)

Bur oak: This species is very drought resistant and produces the largest acorns of all native oaks. The acorns may fall anytime between August and November and will usually germinate soon after. It will start bearing acorns about 35 years old but the optimum age is 75 to 150 years. Good crops occur every 2 to 3 years with no or light crops in between. (Burns and Barbara 1990)

Post oak: This oak species is valuable for wildlife food and cover. It starts bearing acorns when it is about 25 years old and good crops are produced at 2 to 3 year intervals. The acorns fall from September to November and will germinate soon after. The acorns are an important part of the diet of wild turkey, white-tailed deer, squirrels and other rodents and provide high energy food in the fall and winter. (Burns and Barbara 1990)

Shumard oak: The minimum seed bearing age of shumard oak is 25 years old but the optimum seed production occurs at about 50 years old. The crops ripen and fall during September or October and crops are produced every 2 to 3 years. The acorns are an excellent wildlife food that is used by birds, white-tailed deer and squirrels. (Burns and Barbara 1990)

Black walnut: The nut ripens in September or October and falls shortly after the leaves fall. Good seed crops are produced irregularly with about 2 good crops every 5 years. Open grown trees may

produced seeds when 4 to 6 years old but large seed crops do not start to occur until the tree is 20 to 30 years old. The nuts are eaten by many wildlife species but it is also used as a deer browse, and by mice and rabbits which gnaw on the stems of young trees during the winter, and by yellow-bellied sapsuckers which feed on it during late winter or early spring (Burns and Barbara 1990)

Snags

Snags, which are standing dead trees, are usually seen as useless by lumbermen and recreationist. However, these trees are very important to a forest ecosystem. Snags are used by numerous wildlife species such as bats, raptors and song birds, for perching, feeding and nesting sites. In fact, of the nine managed wildlife species in the Great Trinity Forest, only the eastern cottontail and eastern meadowlark will not use snags. As shown in the snag summary, by killing trees with herbicide and leaving them standing to naturally decompose, we are creating an abundance of snags for these species. Once the forest has been replanted, trees will continue to die and create snags naturally but the habitat can always be enhanced by providing artificial nesting or perching structures.

Habitat Suitability Index (HSI) and Habitat Evaluation Procedures (HEP)

The Habitat Evaluation Procedure (HEP) is a "planning and evaluation technique that focuses on the habitat requirements of fish and wildlife species" (USGS National Wetlands Research Center 2007), and was created in 1980 "in response to the need to document the nonmonetary value of fish and wildlife resources" (U.S. Fish and Wildlife Service 1996). HEP values are obtained by multiplying the Habitat Suitability Index (which indicates habitat quality) by the available habitat to created Habitat Units (HU's). The HU's can then be used to evaluate the predicted effects of proposed actions.

The Habitat Suitability Index (HSI) "provides habitat information for evaluating impacts on fish and wildlife habitat resulting from water or land use changes" (USGS National Wetlands Research Center 2007). It accomplishes this by measuring key habitat components ability to supply the life requisites of select species and compares this to optimum habitat conditions. These models assume that the optimal habitat conditions are associated with the highest potential densities of that species. Therefore, HSI becomes an index for the carrying capacity for that species. HSI quantifies habitat suitability on a numerical index from 0.0 (unsuitable) to 1.0 (optimal). This is shown in Table 1 where the current habitat quality in the Great Trinity Forest for 4 of the 5 species evaluated is either unsuitable or extremely low. These low values are due to several factors such as few mast bearing trees, small diameter trees and few snags. However, as time goes on there is a dramatic increase in habitat quality in all 4 species due to the creation of snags and the planting and development of mast producing trees and shrubs. It is important to remember that these models "should be viewed as hypothesis of species-habitat relationships rather than statements of proven cause and effect relationships" (USGS National Wetlands Research Center 2007). These models are guides of habitat relationships and they may need to be modified or tested in certain situations.

Ragweed (*Ambrosia* spp.)

Ragweed is a common annual plant in the United States which generally inhabits disturbed sites. There are six species of ragweed in the southeastern United States such as common ragweed (*Ambrosia artemisiifolia*) which grows 1 - 3 meters tall, flowers from August to November and produces seeds from

September to December. Another common species is giant ragweed (*Ambrosia trifida*) which grows 1 - 6 meters tall, flowers from September to December and produces seeds from October to December.

Unfortunately, 10 to 20% of Americans are allergic to ragweed pollen which causes multiple symptoms such as sneezing, stuffy or runny nose and itchy eyes. Ragweed season generally goes from mid-August to October during which time one plant will release up to 1 billion pollen grains into the air. Despite the allergic reactions these plants cause, they are very beneficial for wildlife. Common ragweed is known to be "among the most important seed and cover-producing plants for Northern bobwhite" (Miller and Miller 2005). The seeds are also used by numerous song and game birds and are a preferred white-tailed deer browse in the spring and summer.

To minimize symptoms one should avoid contact with pollen by avoiding areas with ragweed, limiting time outdoors, keeping windows closed and by taking showers to wash the pollen off skin and hair. One can also start taking allergy medicine right before peak ragweed season and track pollen information in the area at www.aaaai.org/nab. In an area as large as the Great Trinity Forest, it is impossible to eliminate ragweed but it can be controlled in areas which receive a large number of visitors such as campgrounds and along trails and roads by mowing or using herbicide. It will be more difficult and costly to control ragweed in the Habitat Improvement Areas, but soil disturbance in these areas will be kept to a minimum and ragweed is easily overgrown by perennials so the number of ragweed plants in these openings will decrease as the site matures.

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Table 1. The Habitat Suitability Index for 5 of the managed wildlife species in the Great Trinity Forest, Dallas, Texas. These values are based on data produced by Cliff Sunda for Management Unit 2010.

Species	Year										
	2006	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Barred Owl	1.00	1.00	0.20	0.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Carolina Chickadee	0.00	0.50	0.00	0.20	0.10	0.20	0.95	0.92	0.89	0.87	0.87
Fox squirrel*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.28	1.34	1.35	1.38
Hairy woodpecker	0.00	0.04	0.00	0.00	0.00	0.00	0.08	1.23	1.38	1.68	1.75
Raccoon**	0.10	0.50	0.50	0.53	0.58	0.58	0.60	0.80	0.80	0.80	0.80

*Based on the assumption that the percent of shrub crown cover is less than 30%.

** Based on the assumption that the management area is ≤ 0.5 mile to water.

Snag Summary

Projection of the forest's snag component.

To estimate the contribution of snags to forest structure and wildlife habitat, the Forest Vegetation Simulator (FVS) was used to model the snag component of the Great Trinity Forest.

SNAG REPORT

Terms and Methods Defined

Overview

The Forest Vegetation Simulator's (FVS) Fire and Fuels Extension (FFE) was used to model the occurrence and fate of snag trees in the Great Trinity Forest (GTF). The FFE also models each snag's transition from hard to soft and its decay and fall rate. Snag reports were generated at the time that growth and yield models were run. Snags are divided into 6 size classes and two categories: soft and hard. FFE considers soft snags to have %80 the density of hard snags. Snag classes are broken into 5 inch classes and represent the number of trees per acre larger than the particular size class size class. For instance, the first size class column represents all trees greater than 0 inches at Diameter Breast Height (DBH), the second column represents all trees greater than 5" DBH, but not those that are less than 5". It should be noted that throughout this text a "snag" is referring to a standing dead tree. FFE default parameters were used in the projection.

The following assumptions were made for this projection:

- No snags exist at the beginning of the projection.
- The current forest inventory is correct.
- A majority of trees are 30 years old in 2006.
- Site index is 50 foot base age 50 years for white oak.
- The Davy Crocket National Forest was used as the FVS location code for modeling forest growth.

Snag report descriptions.

- Managed Land: Snags in the City of Dallas' management units.
- Mitigation Land: Snags in the mitigation management units.
- Wilderness Land: Snags in all forested acres not to receive active management.
- Following the three general reports, snag reports are then presented by unit.

Managed Land

1,000.0 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	25.7	19.6	5.2	0.0	0.0	0.0	1.6	1.4	0.4	0.0	0.0	0.0
2030	30.8	28.3	10.0	0.6	0.0	0.0	1.4	1.4	0.6	0.1	0.0	0.0
2040	10.2	6.3	4.0	1.4	0.0	0.0	1.2	1.2	0.8	0.4	0.0	0.0
2050	4.6	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.6	0.9	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	13.3	7.5	0.8	0.3	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	20.1	15.0	2.7	0.6	0.3	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	22.9	19.8	5.5	0.9	0.4	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2100	20.0	19.3	8.3	1.8	0.6	0.1	0.3	0.3	0.2	0.1	0.0	0.0
2110	24.4	24.4	13.5	4.2	1.1	0.1	0.4	0.4	0.3	0.1	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Land

235.2 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	58.5	58.2	29.1	3.5	0.0	0.0	1.3	1.3	1.0	0.4	0.0	0.0
2040	5.4	2.2	1.4	0.9	0.0	0.0	1.6	1.6	1.5	0.5	0.0	0.0
2050	4.8	1.4	0.6	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	16.5	4.8	3.5	0.6	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	23.3	7.9	6.0	2.2	0.4	0.0	0.1	0.1	0.1	0.0	0.0	0.0
2080	18.2	12.0	5.6	2.2	0.7	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2090	22.6	17.6	8.3	4.8	1.5	0.3	0.2	0.2	0.2	0.1	0.0	0.0
2100	33.3	30.4	16.0	10.1	4.0	0.9	0.3	0.3	0.3	0.2	0.1	0.0
2110	20.7	20.7	13.2	9.0	4.9	1.1	0.8	0.8	0.7	0.5	0.3	0.1

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Wilderness

3,442.2 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	13.4	7.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	37.5	21.8	5.9	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2040	38.8	19.4	10.2	0.5	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
2050	79.5	35.3	23.1	3.7	0.5	0.0	0.3	0.2	0.1	0.0	0.0	0.0
2060	87.3	39.7	22.9	12.7	1.8	0.0	0.6	0.4	0.3	0.0	0.0	0.0
2070	65.6	29.1	21.0	11.3	2.8	0.6	1.0	0.6	0.5	0.2	0.0	0.0
2080	54.5	20.8	15.1	8.6	4.1	1.7	1.1	0.7	0.6	0.3	0.1	0.0
2090	50.4	15.9	13.1	10.8	5.3	1.5	1.1	0.7	0.6	0.4	0.2	0.1
2100	46.1	13.8	10.2	8.4	4.7	1.8	1.3	0.9	0.8	0.7	0.5	0.1
2110	51.8	14.1	9.2	8.1	5.9	2.1	1.4	1.0	0.9	0.8	0.6	0.1

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2010

41.0 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2011	206.2	160.6	49.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	4.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2030	4.6	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.7	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.7	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	6.2	4.9	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	32.8	21.1	3.3	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	23.1	23.1	7.4	0.9	0.4	0.1	0.3	0.3	0.1	0.0	0.0	0.0
2090	16.9	16.9	7.9	1.2	0.4	0.1	0.3	0.3	0.3	0.1	0.0	0.0
2100	28.5	28.5	17.2	5.5	1.0	0.1	0.3	0.3	0.3	0.1	0.0	0.0
2110	29.0	29.0	19.9	10.5	2.4	0.3	0.6	0.6	0.5	0.2	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2011

39.9 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2012	205.9	160.4	49.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	3.6	0.5	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2030	4.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.7	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	2.9	1.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	34.3	21.9	2.7	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	22.7	22.7	7.2	0.8	0.5	0.0	0.2	0.2	0.1	0.0	0.0	0.0
2090	18.3	18.3	9.2	1.1	0.4	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2100	26.1	26.1	15.8	6.3	1.1	0.1	0.4	0.4	0.4	0.1	0.0	0.0
2110	31.6	31.6	19.5	8.1	2.2	0.2	0.6	0.6	0.5	0.2	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2012

40.9 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2013	205.5	160.2	49.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	3.1	0.5	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.0	0.0
2030	4.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.6	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.8	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	2.0	2.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	34.6	22.0	3.1	0.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	23.7	23.7	6.1	1.1	0.3	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2090	18.6	18.6	8.9	1.3	0.3	0.1	0.4	0.4	0.3	0.0	0.0	0.0
2100	27.0	27.0	15.9	4.4	1.1	0.1	0.4	0.4	0.3	0.1	0.0	0.0
2110	33.5	33.5	17.7	7.3	2.5	0.3	0.6	0.6	0.5	0.2	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2013

41.1 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2014	205.4	160.3	49.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	3.0	0.6	0.2	0.0	0.0	0.0	6.9	6.9	2.1	0.0	0.0	0.0
2030	4.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.6	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.7	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	4.8	2.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	28.9	18.6	2.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	23.6	23.6	5.9	0.7	0.4	0.0	0.2	0.2	0.1	0.0	0.0	0.0
2090	19.1	19.1	8.8	1.1	0.4	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2100	18.0	18.0	11.0	2.2	0.5	0.1	0.3	0.3	0.3	0.1	0.0	0.0
2110	36.0	36.0	19.0	7.6	1.4	0.2	0.4	0.4	0.3	0.1	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2014

41.8 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2015	204.9	160.1	49.7	0.0	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0
2020	14.8	12.8	4.6	0.0	0.0	0.0	15.2	10.0	0.3	0.0	0.0	0.0
2030	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.6	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	4.8	1.7	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	25.6	16.4	1.3	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	24.5	24.3	4.9	0.8	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2090	19.0	19.0	8.2	0.9	0.4	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2100	16.1	16.1	8.4	2.2	0.5	0.1	0.4	0.4	0.3	0.1	0.0	0.0
2110	34.2	34.2	22.4	7.7	1.3	0.1	0.4	0.4	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2015

41.3 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2016	204.9	160.1	49.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	50.8	37.6	6.8	0.0	0.0	0.0	0.6	0.6	0.6	0.0	0.0	0.0
2030	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.6	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	4.8	1.1	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	26.4	16.7	1.4	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	24.7	17.3	5.2	0.9	0.5	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2090	19.1	19.1	8.4	1.0	0.5	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2100	15.6	15.6	8.4	1.8	0.6	0.1	0.4	0.4	0.3	0.1	0.0	0.0
2110	34.7	34.7	21.7	8.4	1.6	0.2	0.4	0.4	0.3	0.1	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2016

41.2 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2017	204.8	160.1	49.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	71.9	52.7	8.9	0.0	0.0	0.0	2.3	2.3	2.3	0.0	0.0	0.0
2030	4.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2040	4.6	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.7	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	4.8	1.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	21.7	13.7	1.2	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	26.2	19.2	4.3	1.0	0.4	0.0	0.1	0.1	0.1	0.0	0.0	0.0
2090	21.8	21.8	8.9	1.2	0.4	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2100	14.5	14.5	7.9	2.2	0.7	0.0	0.4	0.4	0.3	0.1	0.0	0.0
2110	35.3	35.3	20.9	10.1	2.1	0.2	0.3	0.3	0.3	0.1	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2017

40.9 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2018	204.8	160.0	49.7	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2020	100.8	75.6	19.0	0.0	0.0	0.0	14.1	12.6	5.1	0.0	0.0	0.0
2030	4.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2040	4.6	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.7	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	4.8	0.5	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	19.1	13.5	1.1	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	27.9	19.0	3.7	0.8	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	20.9	20.9	8.0	1.3	0.4	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2100	16.0	16.0	8.9	1.8	0.5	0.1	0.4	0.4	0.3	0.1	0.0	0.0
2110	35.1	35.1	20.3	7.8	1.6	0.2	0.4	0.4	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2018

39.6 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2019	204.8	167.7	49.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	159.8	128.7	36.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	4.5	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2040	4.6	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.7	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	4.8	0.5	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	21.1	14.1	1.1	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	26.2	19.3	4.1	0.8	0.5	0.1	0.1	0.1	0.1	0.0	0.0	0.0
2090	21.1	21.1	8.3	1.4	0.5	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2100	14.7	14.7	7.8	1.6	0.5	0.1	0.4	0.4	0.3	0.1	0.0	0.0
2110	31.7	31.7	20.6	5.7	1.7	0.1	0.4	0.4	0.3	0.1	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2019

39.6 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	204.2	159.5	49.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	4.5	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.7	0.4	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2060	4.8	2.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2070	13.3	7.9	0.5	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	30.1	19.8	3.2	0.9	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0
2090	21.4	21.4	7.5	0.9	0.6	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2100	15.8	15.8	7.5	1.6	0.6	0.1	0.4	0.4	0.3	0.1	0.1	0.0
2110	30.4	30.4	17.6	5.8	1.4	0.2	0.3	0.3	0.3	0.1	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2020

40.0 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2021	204.8	204.6	84.0	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	4.1	0.2	0.1	0.0	0.0	0.0	0.6	0.6	0.5	0.0	0.0	0.0
2040	4.6	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2050	4.7	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.3	0.2	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2070	8.6	5.0	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2080	30.2	19.4	2.3	0.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2090	20.7	20.7	5.3	0.8	0.6	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2100	17.4	17.4	7.9	1.1	0.5	0.1	0.3	0.3	0.2	0.1	0.0	0.0
2110	24.6	24.6	13.3	3.3	0.9	0.2	0.4	0.4	0.3	0.1	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2021

39.5 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.0	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2022	204.9	204.9	80.4	8.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2030	3.7	0.6	0.2	0.0	0.0	0.0	0.7	0.7	0.6	0.0	0.0	0.0
2040	4.6	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2050	4.6	0.3	0.3	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.8	0.3	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	1.9	1.8	0.2	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	29.5	18.0	2.0	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2090	24.2	24.2	5.1	0.9	0.5	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2100	17.1	17.1	7.6	1.0	0.4	0.1	0.3	0.3	0.2	0.1	0.0	0.0
2110	18.9	18.9	10.7	1.6	0.5	0.1	0.4	0.4	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2022

40.4 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2023	204.6	204.6	84.0	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	3.5	0.3	0.1	0.0	0.0	0.0	1.6	1.6	1.6	0.0	0.0	0.0
2040	4.5	0.4	0.3	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2050	4.7	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.3	0.2	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	2.2	0.8	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
2080	31.4	21.5	2.5	0.7	0.3	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	23.1	22.0	5.6	1.0	0.4	0.1	0.1	0.1	0.1	0.0	0.0	0.0
2100	17.9	17.9	7.3	1.3	0.6	0.1	0.4	0.3	0.3	0.1	0.0	0.0
2110	22.9	22.9	13.2	2.7	1.1	0.1	0.4	0.4	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2023

40.5 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2024	205.0	205.0	84.1	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	6.3	3.7	3.2	0.0	0.0	0.0	9.0	9.0	4.1	0.0	0.0	0.0
2040	4.5	0.4	0.3	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2050	4.7	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.3	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.9	3.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	28.0	17.6	1.8	0.7	0.3	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	22.9	22.9	5.1	0.8	0.5	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2100	18.8	18.8	8.0	1.0	0.5	0.1	0.3	0.3	0.2	0.1	0.0	0.0
2110	17.4	17.4	9.0	2.6	0.6	0.1	0.4	0.4	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2024

40.1 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.4	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	205.6	205.6	84.3	15.7	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2030	25.2	23.1	13.0	0.0	0.0	0.0	10.3	10.3	0.4	0.2	0.0	0.0
2040	4.5	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2050	4.6	0.4	0.3	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.8	1.1	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	24.0	16.1	1.4	0.5	0.3	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	24.9	24.9	4.8	0.8	0.6	0.1	0.1	0.1	0.1	0.0	0.0	0.0
2100	18.9	18.9	6.5	1.3	0.5	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2110	15.1	15.1	8.0	2.3	0.4	0.1	0.4	0.4	0.3	0.1	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2025

29.6 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2026	205.7	205.7	84.3	8.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2030	55.7	53.9	18.7	0.1	0.0	0.0	1.0	1.0	1.0	0.3	0.0	0.0
2040	4.5	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0
2050	4.6	0.4	0.3	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.8	1.4	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	26.0	16.4	1.6	0.7	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2090	25.1	25.1	5.3	0.7	0.5	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2100	19.4	19.4	8.2	1.2	0.5	0.1	0.3	0.3	0.2	0.1	0.0	0.0
2110	19.6	19.6	11.2	2.3	0.8	0.1	0.4	0.4	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2026

28.9 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2027	206.1	206.1	84.4	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	76.1	74.9	24.4	0.0	0.0	0.0	5.0	5.0	5.0	2.0	0.0	0.0
2040	4.5	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.2	0.0	0.0	0.0
2050	4.6	0.3	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.8	0.5	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	24.1	16.1	1.4	0.5	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	25.2	25.0	4.7	1.1	0.4	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2100	19.1	19.1	6.9	1.0	0.4	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2110	15.7	15.7	9.2	2.1	0.5	0.1	0.3	0.3	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2027

30.1 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2028	206.3	206.3	84.4	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	110.2	109.6	43.8	4.1	0.0	0.0	11.0	11.0	4.1	0.0	0.0	0.0
2040	4.5	0.2	0.1	0.0	0.0	0.0	0.4	0.4	0.3	0.0	0.0	0.0
2050	4.6	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.3	0.3	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.8	2.4	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	20.6	13.0	0.7	0.4	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	23.7	16.6	3.9	0.7	0.5	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	19.0	19.0	6.4	1.0	0.5	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2110	15.5	15.5	8.2	1.0	0.5	0.1	0.4	0.4	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2028

29.4 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2029	206.7	206.7	84.5	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	164.1	163.7	66.2	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.5	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.4	0.0	0.0	0.0
2050	4.6	0.4	0.3	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.7	0.6	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	12.0	8.6	0.5	0.3	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	27.9	19.3	3.8	0.7	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	20.9	20.9	6.3	1.2	0.4	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2110	16.7	16.7	8.1	2.1	0.4	0.1	0.4	0.4	0.2	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2029

31.1 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	207.1	207.1	84.6	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.5	0.2	0.1	0.0	0.0	0.0	0.6	0.6	0.5	0.0	0.0	0.0
2050	4.6	0.3	0.3	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.7	0.3	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	13.7	9.5	0.5	0.4	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	28.3	18.9	3.7	0.8	0.5	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	20.5	20.5	6.5	0.8	0.5	0.1	0.3	0.3	0.2	0.0	0.0	0.0
2110	16.0	16.0	7.7	1.5	0.5	0.1	0.3	0.3	0.2	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2030

30.3 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2031	199.3	199.3	111.3	45.9	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.0	0.5	0.3	0.1	0.0	0.0	1.5	1.4	1.3	0.8	0.0	0.0
2050	4.5	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
2060	4.6	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.8	0.4	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	7.2	4.4	0.3	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	28.4	19.4	2.9	0.6	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	21.3	21.3	5.4	1.0	0.6	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2110	17.8	17.8	8.1	1.6	0.5	0.1	0.2	0.2	0.2	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2031

30.7 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2032	189.0	189.0	108.7	45.9	1.7	0.0	2.8	2.8	0.7	0.0	0.0	0.0
2040	3.7	0.2	0.2	0.1	0.1	0.0	1.9	1.9	1.8	1.2	0.0	0.0
2050	4.5	0.3	0.3	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	4.7	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.7	0.3	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	6.7	4.5	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	28.9	17.4	2.5	0.7	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	22.1	22.1	6.8	1.0	0.5	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2110	16.0	16.0	7.0	1.0	0.4	0.1	0.4	0.4	0.3	0.1	0.1	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2032

29.7 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2033	184.5	184.5	107.2	45.9	1.7	0.0	0.3	0.3	0.3	0.0	0.0	0.0
2040	4.2	1.4	1.2	1.0	0.1	0.0	4.2	4.2	4.1	2.5	0.0	0.0
2050	4.5	0.2	0.1	0.1	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
2060	4.6	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.7	0.3	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	2.2	2.2	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	29.2	18.3	1.9	0.6	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	22.7	22.7	5.9	0.7	0.5	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2110	18.3	18.3	7.7	0.8	0.5	0.1	0.3	0.3	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2033

31.5 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.4	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.8	36.8	9.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2034	181.1	181.1	113.9	32.6	3.9	0.0	0.1	0.1	0.1	0.0	0.0	0.0
2040	11.5	8.9	8.8	2.2	0.0	0.0	7.9	7.9	5.1	0.0	0.0	0.0
2050	4.5	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
2060	4.6	0.3	0.3	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	4.7	0.3	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	4.8	1.9	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	26.3	16.1	1.3	0.6	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	22.7	22.5	5.5	0.7	0.5	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2110	18.6	18.6	8.0	0.9	0.4	0.1	0.4	0.4	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2034

40.2 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2035	175.7	175.7	106.3	45.9	1.7	0.0	2.1	2.1	0.0	0.0	0.0	0.0
2040	29.4	27.5	21.2	7.8	0.1	0.0	6.3	6.3	0.6	0.4	0.1	0.0
2050	4.5	0.2	0.1	0.1	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0
2060	4.6	0.2	0.2	0.1	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
2070	4.7	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	4.8	3.1	0.2	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	27.1	18.1	1.5	0.7	0.4	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	23.9	17.5	5.3	0.7	0.4	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2110	18.0	18.0	6.8	0.9	0.4	0.1	0.4	0.4	0.3	0.1	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2035

39.5 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2036	173.4	173.4	105.5	45.9	1.7	0.0	1.3	1.3	0.4	0.0	0.0	0.0
2040	51.1	49.6	29.2	10.0	0.2	0.0	1.8	1.8	1.7	1.3	0.4	0.0
2050	4.5	0.2	0.1	0.1	0.0	0.0	0.3	0.3	0.1	0.0	0.0	0.0
2060	4.6	0.2	0.2	0.1	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0
2070	4.7	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	4.8	3.4	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	23.3	14.5	1.3	0.5	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	24.3	18.5	5.3	0.7	0.4	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2110	18.9	18.9	7.9	1.4	0.4	0.1	0.3	0.3	0.2	0.0	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Management Unit 2036

41.2 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2037	173.3	173.3	105.4	45.9	1.7	0.0	0.1	0.1	0.1	0.0	0.0	0.0
2040	67.7	66.4	37.5	12.6	0.6	0.0	7.1	7.1	7.0	6.0	0.2	0.0
2050	4.5	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.3	0.2	0.0	0.0
2060	4.6	0.2	0.2	0.1	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
2070	4.7	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	4.8	1.9	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2090	21.9	14.0	0.8	0.5	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0
2100	24.3	17.6	5.2	0.6	0.4	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2110	18.4	18.4	7.7	0.5	0.5	0.1	0.3	0.3	0.2	0.0	0.0	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Unit 2025

23.0 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2026	119.4	119.4	76.5	13.8	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2030	35.8	34.4	19.7	0.0	0.0	0.0	0.8	0.8	0.8	0.5	0.0	0.0
2040	4.9	1.0	0.2	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0
2050	4.9	1.6	0.7	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	26.9	8.5	6.2	1.0	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	23.0	12.4	6.2	2.5	0.4	0.0	0.1	0.1	0.1	0.0	0.0	0.0
2080	16.3	12.3	5.9	2.5	0.8	0.1	0.2	0.2	0.1	0.1	0.0	0.0
2090	32.4	24.9	13.3	7.4	2.6	0.6	0.2	0.2	0.2	0.1	0.0	0.0
2100	24.9	24.9	15.4	9.7	4.1	1.0	0.5	0.5	0.4	0.2	0.1	0.0
2110	17.1	17.1	12.8	8.0	4.6	1.2	0.9	0.9	0.8	0.6	0.4	0.1

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Unit 2026

28.1 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2027	121.3	121.3	76.6	13.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	47.3	46.6	25.5	0.0	0.0	0.0	4.3	4.3	4.2	2.9	0.0	0.0
2040	4.8	0.9	0.4	0.1	0.0	0.0	0.3	0.3	0.2	0.0	0.0	0.0
2050	4.9	1.3	0.6	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	23.1	7.4	5.3	0.9	0.3	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	21.9	8.0	6.0	2.2	0.4	0.0	0.1	0.1	0.1	0.0	0.0	0.0
2080	18.0	13.8	5.9	2.1	0.7	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2090	25.8	20.4	10.7	6.4	1.7	0.3	0.2	0.2	0.2	0.1	0.0	0.0
2100	29.9	29.9	16.0	9.9	4.0	1.1	0.4	0.4	0.3	0.2	0.1	0.0
2110	20.8	20.8	13.7	10.1	4.8	1.1	0.7	0.7	0.6	0.4	0.2	0.1

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Unit 2027

28.2 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2028	122.7	122.7	76.7	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	69.6	68.9	42.1	6.5	0.0	0.0	5.5	5.5	3.4	0.0	0.0	0.0
2040	4.8	1.4	0.2	0.1	0.0	0.0	0.4	0.4	0.3	0.0	0.0	0.0
2050	4.8	1.8	0.8	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	19.2	5.6	3.5	0.7	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	22.4	7.5	5.8	2.2	0.5	0.1	0.1	0.1	0.1	0.0	0.0	0.0
2080	19.0	14.9	5.7	2.1	0.8	0.1	0.1	0.1	0.1	0.0	0.0	0.0
2090	26.2	20.2	9.9	5.3	2.0	0.1	0.2	0.2	0.2	0.1	0.0	0.0
2100	33.3	33.2	17.1	10.4	3.9	1.0	0.4	0.4	0.3	0.2	0.1	0.0
2110	19.1	19.1	12.3	9.1	4.7	0.9	0.8	0.8	0.7	0.4	0.3	0.1

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Unit 2028

25.9 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2029	124.5	124.5	76.6	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	100.3	100.0	61.1	10.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.7	0.8	0.2	0.0	0.0	0.0	0.5	0.5	0.4	0.0	0.0	0.0
2050	4.8	1.2	0.5	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	24.0	7.3	5.4	1.1	0.3	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	20.8	7.2	6.0	2.2	0.6	0.0	0.1	0.1	0.1	0.0	0.0	0.0
2080	17.0	12.9	5.6	2.4	0.8	0.1	0.2	0.2	0.1	0.1	0.0	0.0
2090	24.2	19.1	8.9	5.1	1.9	0.6	0.2	0.2	0.2	0.1	0.0	0.0
2100	33.0	33.0	15.2	9.1	3.4	0.9	0.3	0.3	0.2	0.2	0.1	0.0
2110	19.8	19.8	12.6	8.7	5.3	1.2	0.7	0.7	0.6	0.4	0.2	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Unit 2029

25.9 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	126.2	126.2	76.5	13.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.7	1.3	0.3	0.1	0.0	0.0	0.6	0.6	0.5	0.0	0.0	0.0
2050	4.7	1.9	0.8	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	15.0	3.6	2.6	0.4	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	23.1	7.7	5.8	2.3	0.4	0.1	0.1	0.1	0.1	0.0	0.0	0.0
2080	20.0	12.3	6.4	2.6	0.7	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2090	20.3	16.1	7.1	4.3	1.2	0.3	0.2	0.2	0.2	0.1	0.0	0.0
2100	33.8	27.0	16.2	10.7	4.1	0.7	0.3	0.3	0.2	0.2	0.1	0.0
2110	20.5	20.5	13.6	8.5	4.7	1.2	0.7	0.7	0.7	0.5	0.3	0.1

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Unit 2030

26.6 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2031	118.9	118.9	94.1	39.4	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2040	4.2	1.6	0.3	0.1	0.0	0.0	1.5	1.5	1.4	0.9	0.1	0.0
2050	4.7	0.7	0.4	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	6.1	1.8	1.1	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	26.3	8.5	5.6	2.4	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	19.2	11.4	5.6	2.2	0.7	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2090	17.8	14.0	6.0	3.1	1.0	0.1	0.2	0.2	0.1	0.1	0.0	0.0
2100	36.6	36.6	17.0	8.2	4.5	0.9	0.3	0.3	0.2	0.1	0.0	0.0
2110	21.8	21.8	14.0	10.5	5.5	1.0	0.7	0.7	0.6	0.4	0.3	0.1

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Unit 2031

23.6 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2032	109.4	109.4	91.8	39.4	1.8	0.0	2.8	2.8	0.7	0.0	0.0	0.0
2040	3.9	0.6	0.3	0.2	0.1	0.0	2.0	2.0	1.8	1.2	0.0	0.0
2050	4.7	2.0	0.9	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2060	16.0	4.3	3.2	0.5	0.2	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	23.6	7.0	5.8	2.1	0.5	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	17.3	10.3	5.0	1.9	0.7	0.2	0.2	0.2	0.1	0.1	0.0	0.0
2090	23.5	17.8	8.3	4.6	1.5	0.4	0.2	0.2	0.2	0.1	0.0	0.0
2100	28.9	27.2	15.3	11.4	4.5	1.4	0.3	0.3	0.3	0.2	0.1	0.1
2110	24.9	24.9	13.6	8.1	4.2	1.4	0.8	0.8	0.8	0.7	0.5	0.3

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Unit 2032

26.1 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2033	105.8	105.8	89.3	39.4	1.8	0.0	0.3	0.3	0.3	0.0	0.0	0.0
2040	4.3	2.5	1.4	1.0	0.1	0.0	4.5	4.5	4.4	2.6	0.0	0.0
2050	4.7	0.8	0.6	0.2	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
2060	8.6	2.7	2.0	0.3	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	24.8	6.6	6.0	1.3	0.5	0.0	0.1	0.1	0.1	0.0	0.0	0.0
2080	18.7	10.7	5.6	2.1	0.5	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2090	18.4	14.1	5.8	3.8	0.9	0.1	0.2	0.2	0.1	0.0	0.0	0.0
2100	40.3	31.8	17.3	13.0	4.1	0.5	0.2	0.2	0.2	0.1	0.0	0.0
2110	24.0	24.0	13.8	8.3	5.4	1.4	0.9	0.9	0.8	0.6	0.4	0.0

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Mitigation Unit 2033

27.8 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	1.6	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	36.3	36.3	8.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2034	103.4	103.4	88.5	39.4	1.8	0.0	0.1	0.1	0.1	0.0	0.0	0.0
2040	11.6	9.4	8.9	5.9	0.1	0.0	4.7	4.7	4.1	0.0	0.0	0.0
2050	4.6	1.3	0.6	0.2	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
2060	10.6	2.6	2.1	0.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2070	24.0	7.1	6.6	2.2	0.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2080	18.2	9.3	4.9	1.8	0.6	0.2	0.2	0.2	0.1	0.0	0.0	0.0
2090	16.4	12.6	5.3	3.2	1.0	0.2	0.2	0.2	0.1	0.0	0.0	0.0
2100	37.7	29.1	14.6	9.0	3.7	0.9	0.3	0.3	0.2	0.1	0.1	0.0
2110	18.6	18.6	12.0	9.3	5.0	0.9	0.8	0.8	0.7	0.5	0.3	0.1

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Wilderness

3,442.2 acres

	HARD SNAGS / ACRE						SOFT SNAGS / ACRE					
DBH:	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**	**>=00"**	**>=05"**	**>=10"**	**>=15"**	**>=20"**	**>=25"**
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2010	2.5	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2020	13.4	7.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2030	37.5	21.8	5.9	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
2040	38.8	19.4	10.2	0.5	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
2050	79.5	35.3	23.1	3.7	0.5	0.0	0.3	0.2	0.1	0.0	0.0	0.0
2060	87.3	39.7	22.9	12.7	1.8	0.0	0.6	0.4	0.3	0.0	0.0	0.0
2070	65.6	29.1	21.0	11.3	2.8	0.6	1.0	0.6	0.5	0.2	0.0	0.0
2080	54.5	20.8	15.1	8.6	4.1	1.7	1.1	0.7	0.6	0.3	0.1	0.0
2090	50.4	15.9	13.1	10.8	5.3	1.5	1.1	0.7	0.6	0.4	0.2	0.1
2100	46.1	13.8	10.2	8.4	4.7	1.8	1.3	0.9	0.8	0.7	0.5	0.1
2110	51.8	14.1	9.2	8.1	5.9	2.1	1.4	1.0	0.9	0.8	0.6	0.1

*Per acre figures.
*See attachment for snag descriptions.
*DBH - Diameter at Breast Height (4.5 ft above the groundline)

Great Trinity Forest Management Plan

Wildlife Management

Importance of Disturbance in Habitat Management

NRCS Natural Resources Conservation Service

WILDLIFE HABITAT COUNCIL℠ © 1988 WHC

Importance of Disturbance in Habitat Management

October 2006 *Fish and Wildlife Habitat Management Leaflet* *Number 37*

Introduction

Any event that disrupts an ecosystem or plant or wildlife population structure and changes its resources, substrates, or physical environment is called a disturbance. Disturbances are natural components of virtually all of the world's ecosystems and can include fires, floods, droughts, storms, herbivory, and disease outbreaks. Disturbances are critically important for maintaining healthy and productive ecosystem functions. For example, periodic disturbances are essential for early successional plants and animals, overall biotic diversity, enhancing the capacity of ecosystems to produce clean air and water, and allowing nutrient cycling to occur.

Disturbances interact in a complex manner with climate and soils to produce and maintain a plant community that is unique to that site. In a healthy ecosystem, the plant community is in a state of dynamic equilibrium, and there is variability in its species composition and successional stages following disturbance. This variability is desirable because such habitats can accommodate a diverse wildlife community adapted to different plant species and successional stages.

Fully functioning ecosystems have a natural resistance and resilience to disturbances. Resistance refers to the ecosystem's ability to retain its plant and animal communities during and after a disturbance. Resilience refers to the magnitude of disturbance an ecosystem can withstand and regain its original function after the disturbance. As an ecosystem is degraded, its resistance and resilience to disturbance weaken. In these cases, a disturbance can push an ecosystem past a certain threshold. Once that threshold is reached, ecosystem processes change, resulting in changes in the plant and animal communities. As these changes occur, the ecosystem is in a transition from its original state to a new state.

The purpose of this leaflet is to provide landowners with an improved understanding of natural disturbances and their ecological importance. Three examples of disturbance-adapted systems are used to demonstrate the importance of disturbance on the landscape. Disturbance management options are discussed, with suggestions for incorporating disturbance into management plans.

Wes Burger, Mississippi State University
Oak savannahs maintained by periodic fire

Fire-adapted systems

Fire has historically been an integral factor in maintaining native prairies, shrublands, and forests across North America. While fire frequency and severity vary by region and ecosystem type, all fires are influenced by the plant community and climate of a site. In turn, the severity and frequency of a fire influences the plant community that will recolonize a site and the wildlife species that will inhabit it during the successional stages following the fire.

The flora and fauna in native prairies, shrublands, and forests have lived with periodic fire for thousands of years. Many plant species have specific adaptations that allow them to continue to survive in a post-fire environment. Cottonwoods and oaks exhibit epicormic sprouting, which means that new branches resprout if old ones are burned. Other trees, such as willows, have the ability to resprout from their roots after a fire. Some trees, such as the ponderosa pine,

have thick bark, which protects them from fire. Many plants actually depend on fire to complete their life cycles. For example, many pine trees have cones that will not open until heated by fire; blueberries exhibit fire-enhanced flowering and fruit production.

Fire releases nutrients and uncovers bare soil. The blackened, bare soil warms quickly, which stimulates soil microbial activity, nutrient cycling, and plant growth. In forests, fire opens up part of the canopy to sunlight, which allows sun-loving plant species to recolonize the site. In prairies, fire can remove dead vegetation that hinders new growth, reduce invasive plants, encourage native species, and create wildlife habitat.

Following fires, plant communities go through successional changes. Many native wildlife species and popular game species, such as bobwhite quail, white-tailed deer, and wild turkey, are dependent on periodic fire to create and maintain suitable habitat. Surface fires can stimulate the growth of herbaceous foods for deer, elk, moose, and hares, and can enhance berry production for black bears and other wildlife. Small mammal populations generally increase in response to new vegetation growth, providing a food source for carnivores. Fire can also reduce internal and external parasites on wildlife.

Fire suppression has been widespread throughout North America since European settlement. Fire suppression causes fuels to accumulate and can result in high-intensity, more destructive fires. Many native plant and animal species find it difficult to adapt to fire suppression. Fire intolerant species are able to invade and displace native species in areas protected from fire. In the Pacific Northwest, increased disease and insect outbreaks appear to be related to fire suppression. However, the benefits of wildfire are becoming better known and fire suppression has given rise to managed fires in many areas.

Herbivory-adapted systems

Herbivory is an important disturbance in many rangeland ecosystems. Before European settlement, bison, elk, prairie dogs, and other herbivorous wildlife grazed the North American rangelands. Today, livestock have replaced native herbivores in many rangeland ecosystems. So, past and present herbivores exert a strong influence on a site's plant community.

Underbrush in various successional stages after fire at Tall Timbers Research Station in Florida

Steve Dinsmore

Steve Dinsmore

Steve Dinsmore

Woody plants, for example, cannot establish themselves in areas that are moderately or heavily grazed. Instead of woody plants, grasses and forbs make up most of the plant community in rangeland ecosystems. Herbivores influence ecosystem properties such as nutrient cycling and productivity by compacting soils and adding organic material to them.

Native rangeland plants have adapted to grazing by developing extensive root systems or an ability to resprout quickly. In turn, many wildlife species have adapted to grassland plant communities and are highly dependent on rangeland ecosystems for their habitat needs. Rangeland plant communities provide food, escape, nesting, and brood-rearing cover for many mammals, birds, and reptiles. For example, the bunching nature of native grasses provides excellent nesting habitat for ground nesting birds, such as the northern bobwhite quail. Rangeland grasses and forbs support a wide variety of insects, which serve as food for many grassland bird species.

Rangeland ecosystems are adapted to a certain level of grazing; however, overgrazing can be severely detrimental to these ecosystems. If a site is overgrazed, a threshold is reached and ecosystem processes may change. The subsequent loss of vegetation, redistribution of nutrients, and dispersal of exotic plant species can increase erosion, degrade water quality, and alter the hydrology, fire regime, and plant and animal community of a site. Conversely, if grazing were completely removed from rangeland ecosystems, the plant community would go through a number of successional stages, leading to a dominance of woody plants. Woody encroachment in rangelands reduces their attractiveness for grassland-dependent wildlife species.

U.S. Fish and Wildlife Service

North American bison

Flood-adapted systems

The interface between water and land can be subject to daily, seasonal, and long-term changes. Plants found within this dynamic zone must be tolerant of short- to long-term inundation, have sufficient structure to withstand the physical force of moving water, or be capable of rapidly colonizing flood-prone areas between events.

In river and stream ecosystems, floods move water and sediment through the channel and onto the flood plain. High water flows maintain ecosystem productivity and diversity by removing fine sediments that would otherwise fill the interstitial spaces in productive gravel habitats. Floods bring leafy and woody material into the channel, which creates structure and provides detrital foods for aquatic species. Many temporary habitats, such as river bars and riffle-pool sequences, are formed and maintained by high flows.

Animals associated with areas subject to flooding have adapted to varying flow regimes, including seasonal flooding and droughts, and long-term, more intense flood events. The timing of floods is important because the life cycles of many aquatic and riparian species are timed to either avoid or exploit floods and/or droughts. For example, the seed release of riparian trees such as willows and cottonwoods is synchronized with the timing of spring-flood recession to maximize dispersal efficiency. Native fish in desert streams avoid being affected by flash floods by sensing higher flow speeds and moving to sheltered areas within the stream. Stoneflies and other aquatic insects enter their diapause stage (a period during which growth or development is suspended and physiological activity is diminished) during the drought season. Several species of fish exhibit seasonal movement to escape drought or post-flood spawning. Adaptations such as these allow plants and animals to persist in seemingly harsh floods and droughts.

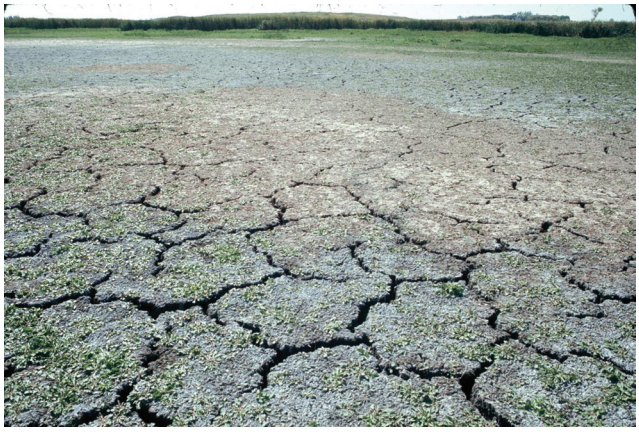
The natural flow regimes of river and stream ecosystems have been important in the evolution of the plants and animals therein. However, these natural flow regimes have been severely altered by the use of rivers for transportation, waste disposal, and hydroelectricity, intensive agriculture, flood-control projects, and other human activities. In the United States, only 2 percent of rivers remain in their natural, unmodified condition. The natural functions of large river-flood plain ecosystems have practically disappeared, principally because of human efforts to contain flooding. The alteration of flow regimes by human activity has resulted in species extirpations, fishery closures, ground water depletion, declines in water quality and availability, invasions by nonna-

Cycle of drying (a and b) and reflooding (c) for a pothole in central Minnesota

(a)

Bill Hohman, NRCS

(b)



Bill Hohman, NRCS

(c)

Bill Hohman, NRCS

tive species, and more frequent and intense flooding. However, many river restoration projects are increasingly attempting to return to a more natural flow regime.

Many of the important and highly productive depressional wetlands (prairie potholes) of the upper Midwest have been altered or destroyed due to increased agricultural and commercial development. As a result, only an estimated 40 to 50 percent of the region's original prairie pothole wetlands remain today. More than 78 percent of the remaining wetlands are smaller than one acre in size. These potholes, which seasonally flood with snowmelt and rain, are home to more than 50 percent of North American migratory waterfowl, with many species dependent on the potholes for breeding and feeding.

Disturbance management

When managing ecological sites, it is important to recognize the historical disturbance regime of the site, their importance, and how they continue to influence the ecosystem. The goal of disturbance management should be to restore ecosystem processes (e.g. energy flow, nutrient cycling, or water cycling) to support sustainable use of the land. When management actions are focused on restoring these processes, the outcome will be an ecosystem in sustained, dynamic equilibrium, with natural interactions among disturbances, soils, and the plant and animal community.

Prescribed burning

From a biological and ecological perspective, the only known substitute for wildfires is prescribed burning. Prescribed burning is an inexpensive way to restore ecosystems and landscapes to their historical levels of biological diversity and productivity. Prescribed burning is a necessary management tool for maintaining wildlife habitat in forestlands, shrublands, and grasslands, including successional habitat for some endangered or threatened species such as the lesser and greater prairie-chickens. Using prescribed burning, landowners can suppress nonnative or invasive species, improve forage production and palatability, improve timber production by reducing logging debris and leaf litter, control diseases and parasites in livestock and wildlife, reduce the risk of wildfires, and enhance ecosystem productivity and biodiversity.

To be safe and effective, prescribed burning must be planned carefully. Burn plans will vary greatly, based on climate and weather, vegetation type and desired response, topography, proximity to homes or utilities, and management goals. Consultation with fire management specialists is highly recommended (and

is often required by law); they can help landowners develop a customized burn plan and ensure that landowners are operating within state and local laws. Local NRCS or Conservation District offices can offer assistance in developing a prescribed burn management plan to meet specific objectives.

Burns are generally not conducted every year. The frequency of prescribed burns varies among forestlands, grasslands, and shrublands, depending on the historical fire regimes of the ecological site. Within grassland systems, frequency of burning increases with annual moisture from 2 to 4 years in tallgrass prairies to over 10 years in shortgrass prairies. The frequency of burns also depends on management goals. To control sprouting woody plants such as oak, elm, mesquite, osage orange, blackberry, or sagebrush, burning every 2 years is necessary. To control nonsprouting woody plants, such as eastern red cedar or Ashe's juniper, burning every 5 to 10 years is sufficient.

The burn season varies depending on management goals. Some prefer to burn as late as possible in the spring, when warm-season grasses are initiating growth. However, waiting until late spring can result in destruction of ground nesting bird and mammal nests, so late winter or early spring is often better. However, summer or fall burns may be needed for specific vegetation management problems. Many prescribed burns are conducted during cool, moist conditions to reduce the chance of the fire spreading out of control. Landowners should not burn during a drought, or if there is a forecasted frontal passage or wind shift within 12 hours. The 60:40 rule states that burns should be conducted when the air temperature is less than 60 degrees Fahrenheit, the relative humidity is greater than 40 percent, and the wind speed is 5 to 15 miles per hour, measured at 6 feet above the ground.

Firebreaks are used to contain the fire within the boundary of the burn unit and to assist with reducing fuel along the boundary. Firebreaks vary in type and can include mowed, disked, plowed, or dozed areas, roads, or bodies of water. The best firebreak method will be determined by the characteristics specific to the land area that is to be burned. In general, the width of the firebreak on the downwind side of the fire should be 10 times the height of flammable vegetation. The firebreak should be prepared at least 6 months ahead of the burning date.

Grazing

Rangeland ecologists consider herbivory to be a key natural disturbance in the evolution of rangeland ecosystems. While the numbers of large herbivorous wildlife have decreased substantially in the last two centuries, this natural disturbance can be replicated using livestock as the primary grassland grazers. In the absence of livestock or other herbivores, haying and/or mowing can be used to simulate the effects of grazing.

NRCS

Prescribed burning

When planning a grazing program, landowners should determine the carrying capacity of the land, that is, the amount of forage that can be grazed before degrading the ecosystem, losing soil to erosion, or losing biodiversity. If livestock graze at a rate higher than the carrying capacity, then production of desirable forage species will decline, livestock production will decline, and the necessity for supplemental feed and weed control will increase.

Planned grazing systems provide opportunities to optimize harvest efficiency, as well as periodic rest to allow plants to recover from grazing. A rotational grazing system, allowing plants a periodic rest from grazing during the growing season, is most beneficial to rangeland vegetation. Two, three, or four pasture systems allowing a rest for plants in the early growing season (May, June) or the late growing season (August, September) are improvements over continuous grazing. If enough land is available, the same herd of livestock could rotate through eight or more paddocks, although fewer paddocks will work. As the number of paddocks increases, the total rest for each paddock increases.

Patch burning/rotational grazing without fencing

In many ecosystems, natural disturbances interact with each other. Historically, rangeland ecosystems have been shaped by two major natural disturbances: fire and grazing. This type of interactive disturbance is re-created with a process called patch burning, also known as rotational grazing without fencing. Patch burning systems vary the season, frequency, and severity of fires, as well as the size and location of graz-

NRCS

Rancher practices rotational grazing

ing areas, resulting in an uneven distribution of grazing and fire that is similar to what occurred before European settlement. Patch burning re-creates the natural disturbance pattern on the landscape, increasing biodiversity and wildlife habitat. This management tool can also improve livestock production by increasing the diversity of forage species that livestock consume.

Patch burning uses prescribed fire, rather than fences, to control livestock herbivory. When using patch burning, spatially discrete fires are applied to a portion of total grazing area each year. Though they have access to the entire area, livestock will focus their grazing on recently burned patches due to the high-quality regrowth after fire. New portions of the pasture are burned periodically, and grazing animals shift to more recently burned patches. As grazing shifts, successional processes lead to changes in the plant community, which will eventually return to the pre-burn state, ready to be burned again. Patch burning creates a landscape that is always changing, but always includes heavily disturbed communities, moderately disturbed communities, and undisturbed communities. Ideal patch size and fire-return intervals depend on management goals and the amount of time required for patches to recover. For example, in North American tallgrass prairies, a landowner could burn one-third of a pasture each year (half of the third in the summer and half in the spring), which allows an interval between burns of 3 years.

Restoring natural flow regimes

Every aquatic system has a unique natural flow regime that is characterized by flow quantity, timing, and variability. Variability can take place over hours, days, seasons, years, or longer, and it is this variability that is critical to healthy aquatic ecosystem functions and biodiversity. When managing aquatic ecosystems, such as wetlands or rivers and their flood plains, the most important management goal should be to reestablish natural flow regimes. This may involve removing dams and spillways, reducing irrigation, or safeguarding against upstream development and land uses that alter runoff and sediment in the waterway.

The first step in reestablishing a natural flow regime is to determine what that flow regime actually is. Once the natural flow regime has been defined, management actions to restore it can take a number of forms. Some systems may need a restoration of low flows, while others may require a return to historical timing, magnitude, and duration of peak flows. Unfortunately, it is not always possible to define a system's natural flow regime, due to human alterations of the system or a lack of historical data. If this is the case, landowners should consult with natural resource professionals to design the most appropriate flow regime management plan based on the site's climate, hydrology, and plant and animal community.

Landowner assistance

Landowners may require additional information (about permits, regulations, historical fire and/or water regimes, local best management practices) before undertaking a disturbance management plan. Landowners may also need financial assistance to manage disturbance on their properties. There are a number of governmental agencies and other organizations willing to provide assistance to landowners wishing to manage disturbance. Landowners are encouraged to begin their disturbance management activities by contacting these organizations. State and/

Bill Hohman, NRCS

Grasses resprout quickly after prescribed burning

or local contacts for a number of relevant government agencies can be found by visiting the Web sites listed in table 1 or by consulting the local telephone directory. Table 2 lists programs that can provide technical and/or financial assistance for disturbance management practices.

Conclusion

Until recently, land managers have not recognized the value of natural disturbances and have often suppressed these disturbances. However, natural disturbance such as fires, floods, and herbivory are critical in maintaining valuable ecosystem functions and creating and restoring wildlife habitat. With assistance from conservation and governmental organizations, landowners can learn to recognize natural disturbances and re-create them on their properties.

Table 1 Organizations providing assistance for disturbance management

Organization	Web site
Farm Service Agency	http://www.fsa.usda.gov/edso/statedefault.htm
Natural Resources Conservation Service	http://offices.sc.egov.usda.gov/locator/app
State Fish and Wildlife Departments	http://www.lib.washington.edu/fish/fandg/fandglist.html
U.S. Fish and Wildlife Service	http://www.fws.gov/offices/directory/listofficemap.html
Wildlife Habitat Council	http://www.wildlifehc.org

Table 2 Assistance programs for disturbance management

Program	Description	Land eligibility	Opportunities for disturbance management	Contact
Conservation Reserve Program (CRP)	Up to 50% cost-share for establishing permanent cover and conservation practices, and annual rental payments for land enrolled in 10- to 15-yr contracts. 50% cost-share for management activities	Highly erodible land, wetland, and certain other lands with cropping history, stream-side areas in pasture land	Annual rental payments may include an additional amount up to $5/a/yr as an incentive to perform certain maintenance obligations, including disturbance management activities	NRCS or FSA State or local office
Environmental Quality Incentives Program (EQIP)	Cost-share and incentive payments for conservation practices in accordance with 1- to 10-yr contracts	Cropland, range, grazing land, and other agricultural land in need of conservation	Incentive payments may be provided for up to 3 years to encourage producers to carry out management practices, including disturbance management practices, that may not otherwise be carried out	NRCS State or local office
Grassland Reserve Program (GRP)	Financial incentives, technical assistance, and cost-share for enhancement and restoration of grasslands in permanent or 30-yr easements or rental agreements	Restored, improved or natural grassland, rangeland, pastureland, shrubland, and certain other lands	Participants must follow a site-specific grassland resources conservation plan, which can include disturbance management practices for the sustainability of forage health and habitat enhancement for declining populations of grassland dependant wildlife	NRCS State or local office
Partners for Fish and Wildlife Program (PFW)	Up to 100% financial and technical assistance to restore wildlife habitat under a minimum 10-yr cooperative agreement	Most degraded fish and/or wildlife habitat	Restoration projects may include restoring wetland hydrology or performing prescribed burning to restore natural disturbance regimes	U.S. Fish and Wildlife Service local office
Waterways for Wildlife	Technical and program development assistance to coalesce habitat efforts of corporations and private landowners to meet common watershed level goals	Private lands	Can provide State-specific advice and/or contacts for prescribed burning, managed grazing, restoration of flow regimes, or other disturbance management practices	Wildlife Habitat Council
Wetlands Reserve Program (WRP)	Technical and financial assistance to address wetland, wildlife habitat, soil, water, and related natural resource concerns in an environmentally beneficial and cost-effective manner; 75% cost-share for wetland restoration under 10-yr contracts and 30-yr easements; 100% cost-share on restoration under permanent easements	Previously degraded wetland and adjacent upland buffer, with limited amount of natural wetland and existing or restorable riparian areas	Can provide technical and financial assistance for disturbance management, provided these activities are consistent with the protection and enhancement of the wetland	NRCS State or local office
Wildlife at Work	Technical assistance on developing habitat projects into programs that allow companies to involve employees and the community	Corporate lands	Can provide State-specific advice and/or contacts for prescribed burning, managed grazing, restoration of flow regimes, or other disturbance management practices	Wildlife Habitat Council
Wildlife Habitat Incentives Program (WHIP)	Technical assistance on developing habitat projects into programs that allow companies to involve employees and the community	High-priority fish and wildlife habitats	Technical assistance is provided to help the participant maintain wildlife habitat, which may include disturbance management activities	NRCS State or local office

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The Natural Resources Conservation Service provides leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment.

NRCS Natural Resources Conservation Service

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The mission of the Wildlife Habitat Council is to increase the amount of quality wildlife habitat on corporate, private, and public land. WHC engages corporations, public agencies, and private, nonprofit organizations on a voluntary basis as one team for the recovery, development, and preservation of wildlife habitat worldwide.

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Great Trinity Forest Management Plan

Wildlife Management

Managing Forests for Fish and Wildlife

NRCS Natural Resources Conservation Service
Wildlife Habitat Management Institute

WILDLIFE HABITAT COUNCIL

Managing Forests for Fish and Wildlife

December 2002 *Fish and Wildlife Habitat Management Leaflet* *Number 18*

U.S. Forest Service, Southern Research Station

Introduction

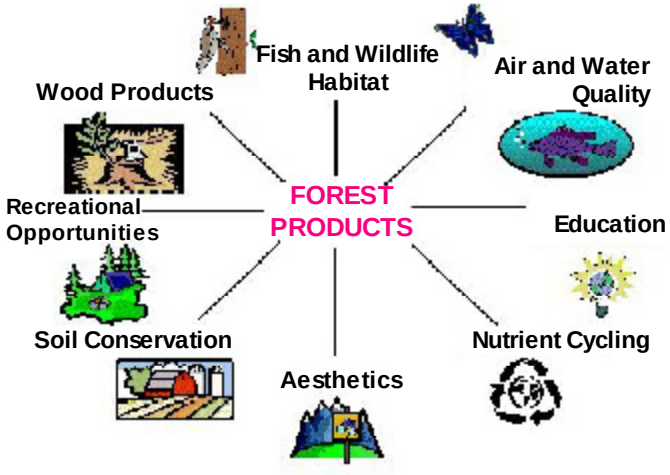
Forests in North America provide a wide variety of important natural resource functions. Although commercial forests may be best known for production of pulp, lumber, and other wood products, they also supply valuable fish and wildlife habitat, recreational opportunities, water quality protection, and other natural resource benefits. In approximately two-thirds of the forest land (land that is at least 10% tree-covered) in the United States, harvest of wood products plays an integral role in how these lands are managed. Sustainable forest management applies biological, economic, and social principles to forest regeneration, management, and conservation to meet the specific goals of landowners or managers.

Much of the forest land in the western U.S. is managed by public agencies, whereas most eastern forests are privately owned or under a combination of private/ public ownership. National forests cover only 19% of forested land in the United States. Non-industrial private landowners own 59% of the forested land in the U.S., making private lands management critically important to the welfare of the fish and wildlife communities associated with forested landscapes.

Forested areas can be managed with a wide variety of objectives, ranging from allowing natural processes to dictate long-term condition without active management of any kind, to maximizing production of wood products on the shortest rotations possible. The primary purpose of this document is to show how fish and wildlife habitat management can be effectively integrated into the management of forestlands that are subject to periodic timber harvest activities. For forestlands that are not managed for production of timber or other forest products, many of the principles in this leaflet also apply.

Succession of Forest Vegetation

In order to meet both timber production and wildlife management goals, landowners and managers need to understand how forest vegetation responds following timber management, or silvicultural prescriptions, or other disturbances. Forest vegetation typically progresses from one plant community to another over time. This forest succession can be described in four stages:



Forests produce a variety of tangible and intangible "products."

1) **Stand initiation**
   - Begins when grasses, forbs, tree seedlings, and shrubs become established in an open space created by natural (flood, tornado, fire, etc.) or artificial (timber harvest, land clearing) disturbances.

2) **Stem exclusion**
   - Sapling and pole-size trees compete for light, growing space, and nutrients.

3) **Understory reinitiation**
   - Many trees die due to overcrowding, disease, insect blights, or other causes.
   - New vacancies allow young plants to grow in understory gaps.
   - Saw-timber and mature forest structure are characteristic of this stage.

4) **Old-growth**
   - Old-growth forests generally contain large and overmature trees, snags and downed logs, and a developed but patchy understory.

Regeneration occurs when disturbance creates new space, and forest succession begins again.

USDA, NRCS

Forested wetlands provide food and cover for many species of wildlife.

Wildlife habitat conditions shift in response to changes in stand age, structure, size, and species composition. As a result, the assemblage of wildlife species inhabiting the forest typically shifts as the stand moves through each successional stage. Birds and other wildlife frequently play an important role in the dispersal of heavy-seeded and fleshy-fruited tree species, contributing to the re-establishment of trees in disturbed areas.

U.S. Forest Service

Only five weeks after the Fish Day Fire in Croatan National Forest, stand initiation began with ferns and other herbaceous vegetation.

Forest Wildlife Habitat Requirements

Forest structure affects habitat quality for many wildlife species. Tree density, canopy height, percent canopy closure, and the number of standing and fallen dead trees are some key structural features that affect habitat quality. Each wildlife species responds differently to changes in forest structure. Whereas general habitat requirements are discussed in this leaflet, specific habitat management practices for particular wildlife species may be obtained from other sources (see Hoover and Wills 1984, DeGraaf et al. 1992, USDA Forester Service 2001).

Some wildlife species are dependent on a particular forest type or successional stage. Kirtland's warbler is an extreme example of a habitat specialist, inhabiting

only extensive stands of jack pine (a fire-dependent species) six to 20 feet tall with low ground cover. These habitat conditions occur where frequent fire keeps the forest in early successional stages. The fire also releases jack pine seeds from mature cones, which allows regeneration of new trees. The warblers nest only in young trees and abandon stands that exceed a certain height.

Food

Wildlife food availability depends on the forest successional stage, season, local climate, and other factors. The stand initiation stage produces seeds and soft mast (berries and fleshy fruits) that are important wildlife foods. Tree seedlings and shrubs such as sumac, juniper, blueberry, hazelnut, elderberry and blackberry, and herbaceous forbs, legumes, and grasses provide food for songbirds and small mammals. The buds, twigs, and leaves of woody plants are browsed by deer, elk, moose, rabbits, hares and grouse, and also provide food for the insect prey of birds, bats and other wildlife.

As the forest progresses through successional stages, wildlife responds to the variety of food types available. Birds and mammals associated with stem exclusion, understory reinitiation, and old-growth stages use both hard mast (nuts and seeds) and soft mast of aspen, cedar, birch, cherry, oak, hickory, maple, pine, and beech trees.

C. Rewa

Vibernums and other fruit-producing shrubs are important wildlife food sources in early successional forests.

The rose-breasted grosbeak is found in open deciduous woodlands and forest edges of the northeastern and mid-western United States.

Food quantity often varies seasonally, and careful forest management can help ensure its availability year-round. For example, thinning that preserves mast-producing trees and shrubs can help sustain songbirds, deer, black bear, wild turkey, and small mammals through the winter months. Landowners and managers should understand the seasonal changes in food availability for the wildlife species of concern.

Cover

Cover refers to physical features that provide animals with shelter from weather, resting places, or concealment from predators. Wildlife uses a variety of cover types depending on season and local climate. Grass-forb vegetation in the stand initiation stage provides ground cover for game birds such as ruffed grouse and woodcock, and for small mammals like voles, mice, and shrews. Many wildlife species benefit from canopy cover. In northern regions, closed, dense canopies of conifers in the understory provide thermal cover for deer (“deeryards”) and other species during winter months.

Snags (standing dead trees) supply foraging sites for woodpeckers and cavities for nesting and resting birds and denning mammals. Fifty-five species of cavity nesting birds in North America use snags, as do nearly half of North America’s 45 bat species. Invertebrates in dead wood are a rich food source. Bats roost in cavities and under the sloughing bark. Bald eagles, goshawks, spotted owls, pine martens, flying squirrels,

tree voles, red-backed voles, and some bat species prefer cover provided by old-growth woodlands. Dead trees, limbs, and litter on the forest floor provide cover and invertebrate foods for woodpeckers and other wildlife.

Water

Wildlife water requirements vary by species. Water is obtained from plant and animal foods consumed, as well as from free water in ponds, lakes, streams, and wetlands.

Timber Harvest Management

Even-aged and uneven-aged forest management are two common silvicultural systems used to produce timber. Harvest and regeneration methods define each approach. In even-aged stands, most trees belong to one age class. Uneven-aged stands have trees of three or more age classes that are mixed, or in small groups. Combinations of even- and uneven-aged systems can be used in an area to enhance wildlife habitat and timber production. Table 1 presents basic characteristics of timber harvest management systems.

One potential result of timber harvest and regeneration practices is a high level of human activity, including construction and frequent use of logging roads and skid trails. Comprehensive timberland management includes measures to limit disturbance, soil erosion, and discharge of sediments and pollutants into waterways.

U.S. Forest Service

Snags are standing dead or dying trees that provide nesting sites for cavity nesting species and roosting and foraging sites for raptors, bats, and other wildlife.

Nonpoint source pollution degrades stream water quality, impacting aquatic life. In 1981, the Forestry Nonpoint Source Pollution Technical Task Force developed Best Management Practices, or BMPs, to minimize nonpoint source pollution, such as sedimentation and pollution of waterways caused by timber harvest and other land use activities. BMPs were recently revised to include considerations for nonpoint source pollution abatement in wetlands. Forest management BMPs include:

- Permanent and temporary access roads should follow land contours and minimum grade

Table 1. Characteristics of even-aged and uneven-aged harvest methods.

	Even-aged	Uneven-aged
Harvest method	Clearcut, shelterwood,and seed-tree.	Single-tree and group selection.
Tree type	Shade-intolerant.	Shade-tolerant.
Stand appearance	Uniform tree height within stands.	Variation in tree height. If group selection used on groups larger than 0.4 hectares, appears similar to even-aged stands.
Forest appearance	Patchwork of stands at various ages.	Uniformly mixed tree sizes.
Wildlife use	Species adapted to early and mid-successional stages and mature forest conditions, depending on stand age.	Species adapted to mature forests as well as early and mid-successional conditions.

guidelines.

- Water control structures should be installed on roads with highly erosive soils.
- Landowners should limit the number, width, and length of access roads, especially at stream crossings.
- Road construction should take place under dry conditions
- Dips, water bars, and water turnouts should be installed on roads to provide proper surface drainage on roadways.
- Hay bales, rocks, or silt fences should be strategically placed to help prevent sedimentation.
- Wildlife-friendly vegetation should be planted to stabilize exposed soil and supply wildlife food and cover.

In general, landowner compliance with voluntary BMPs is high. BMP specifications for timber harvest and road construction vary from state to state. Some states enforce BMPs while others rely on voluntary compliance. Landowners should contact their state forest management agencies for specific information on local BMPs.

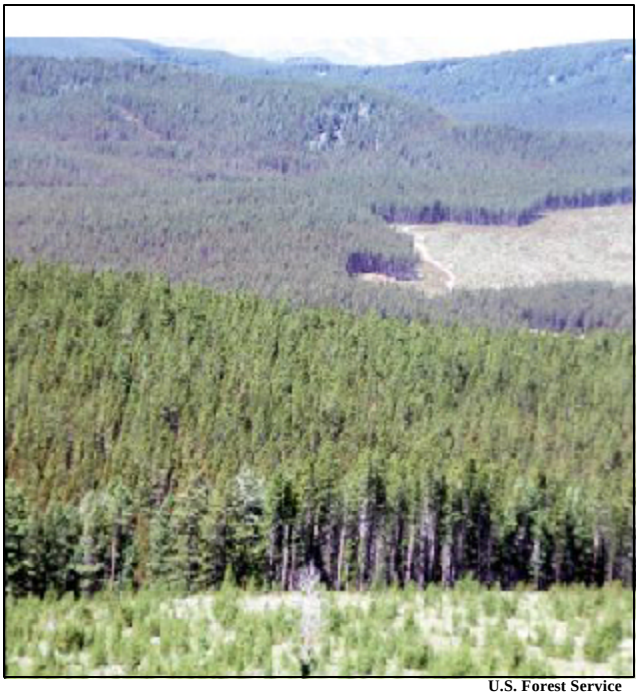
Even-aged management

Under even-aged management systems, most of the trees within the stand are approximately the same age. Small stands of different age classes can form a diverse assemblage of wildlife habitats. Even-aged timber stand management often begins with the complete, or nearly complete, removal of existing timber. Clearcutting removes all marketable trees, dramatically changing the composition of wildlife in the area. Usually, mature forest flora and fauna are replaced by early successional species. Small clearcuts (1 to 15 acres) are generally more beneficial to wildlife than larger clearcuts. The flush of herbaceous growth in clearcut areas lasts for several years and provides big game animals such as white-tailed deer, elk, and moose with nutritious browse, and early successional birds and small mammals with food and cover. The shrub layer succeeds the grasses and forbs and supports "thicket" species like the yellow-breasted chat, willow flycatcher, mourning warbler, and many small mammals. Herbaceous growth and shrubs also provide rich sources of food for lepidopteran larvae and other insects that are preyed on by foraging bats. The size,

Southern Research Station, U.S. Forest Service

The shelterwood cut in this southern mixed forest leaves mature trees on-site to produce seed and maintain some mature habitat structure for woodpeckers and other wildlife.

Moose forage on lush vegetation in clearcut areas.



U.S. Forest Service

Even-aged timber harvests in Deer Lodge National Forest.

U.S. Forest Service

Eastern even-aged pine monocultures typically provide limited wildlife habitat quality due to the lack of plant diversity.

shape, and location of clearcuts affects the wildlife habitat quality (see discussion on edge habitat below) and the species associated with clearcut and surrounding areas. Clearcuts with irregularly shaped boundaries have more edge than clearcuts with linear boundaries. Snags, den trees, and mast-producing trees left standing can add wildlife habitat value to clearcut areas.

Both shelterwood and seed-tree cuts leave some mature trees on-site as seed sources to help establish new stands. These treatments help conserve some mature forest structure required by forest birds like nuthatches and woodpeckers. Nuts and seeds produced by the mature trees also provide a source of wildlife food during the fall and winter months. Forests that contain several successional stages of even-aged stands can provide quality wildlife habitat.

Plantations are stands of trees that are established by planting or artificial seeding. Although single species plantations seem dependable timber producers, they can require intensive management at considerable expense. Insect blights, disease, high winds, and other natural disturbances can destroy susceptible trees. Conifers such as ponderosa pine, red pine, loblolly pine, slash pine, and longleaf pine are often used in plantations because they are fire-resistant and produce marketable timber in short rotations.

Tree species with serotinous cones (species like lodgepole, jack, and sand pine) usually regenerate successfully following burning of clearcut areas. Serotinous cones remain tightly closed until extremely high temperatures, or fire, causes the resin to melt and the cones to open, releasing the seeds. The open ground created in burned areas provides suitable sites for seeds to germinate.

The Swainson's thrush nests in low-growing shrubs or just above the ground in conifers, especially in damp areas, including riparian buffer zones excluded from timber harvest.

Even-aged harvest and regeneration practices:

Clearcut.—Removal of all trees in a stand; reserve trees may be left to accomplish management objectives other than regeneration.

Shelterwood cut.—Removal of most trees in a stand, but leaving enough trees to provide shade for the regenerating age class; trees can be cut in groups, strips, or in a uniform manner to reduce competition for regeneration.

Seed-tree cut.—Removing all trees except for a small number of widely distributed trees for seed production; seed trees usually removed after regeneration is established.

In even-aged systems, the rotation is the period between regeneration establishment and final cutting.

Uneven-aged harvest and regeneration practices:

Single-tree selection cut.—Individual trees of all size classes removed more or less uniformly throughout the stand to increase growth of remaining trees and provide space for regeneration.

Group selection cut.—Small groups of trees removed for regeneration of new age classes; width of cut rarely exceeds twice the height of the mature trees.

In uneven-aged systems, the cutting cycle is the interval between partial harvests.

Uneven-aged management

Under uneven-aged systems the age of the trees within the stand varies greatly. Unevenaged forests can produce quality timber while providing largely continuous canopy cover. Single-tree and group selection cuts maintain mixed age classes within one stand. The high percentage of canopy closure (often 70% or greater) can limit herbaceous ground cover, and wildlife species associated with those vegetation types. Although mid-story levels may develop, brushy ground cover required by some wildlife species can be limited or altogether missing. Some wildlife species benefit from the continuous forest cover associated with uneven-aged systems (e.g., some forest interior birds), but others do not.

The single-tree selection method removes designated trees from one or more age classes every five to 30 years, depending on stand density and growth rates. The harvest of individual trees at periodic intervals creates space for adjacent tree crowns to expand. Single-tree and group selection methods create small canopy gaps, which are similar to gaps formed by natural forest disturbances. Group selection treatments remove groups of trees from one or more age classes. Moderately shade-intolerant species can benefit from this harvesting method because larger openings are created. In the Midwest, forest interior birds like the hooded warbler and Kentucky warbler take advantage of canopy gaps for food and cover.

Improving Fish and Wildlife Habitat with Forest Management Practices

Successful forest management for wildlife requires an understanding of how specific timber management treatments affect the targeted fish and wildlife species. Characteristics of effective management strategies include:

- A thorough inventory and description of forest management areas, including vegetation species composition and age structure.
- An understanding of how the managed area fits

into the surrounding landscape.

- Clearly defined timber management objectives for the management area.
- Clearly defined fish and wildlife management objectives for the management area, such as managing target species or increasing biodiversity.
- A thorough evaluation of the quality and quantity of habitat available for the targeted species.
- Continuous evaluation and modification of timber stand treatments and other management practices.

Regeneration

Regeneration establishes new growth in an open space created by natural or artificial disturbance. Stands can be regenerated artificially using mechanical treatments, prescribed burning, herbicide applications and planting tree seeds, seedlings or cuttings. Stands can also be regenerated by relying on germination of existing seeds and sprouting of stumps. Regeneration of native trees and shrubs provide food and cover for many wildlife species.

Thinning

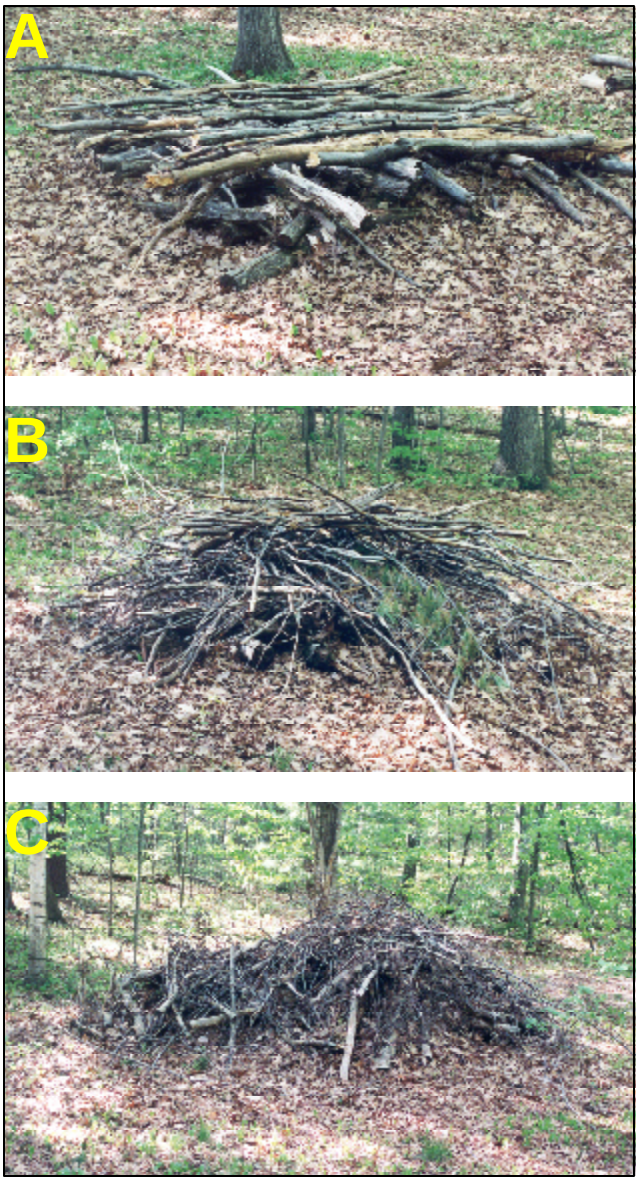
Thinning removes weak or suppressed trees and opens growing space for the remaining healthy trees. Periodic thinning treatments help reduce the risk of insect infestations, disease, and catastrophic fires. The timing and intensity of thinning regimes is as important as selecting which trees to remove. Thinning works best as part of a comprehensive forest management plan. There are four common methods used to select individual trees for thinning:

- **Low thinning** removes trees from lower crown levels to enhance upper crown level growth; soft mast, seeds, and grasses typically increase after low thinning.
- **Crown thinning** removes trees from the mid- to upper crown classes to favor growth of larger trees.
- **Selection thinning** harvests trees from upper crown levels and promotes growth in lower canopies of uneven-aged stands.
- **Free thinning** removes trees with no preference to crown level, but cutting patterns are used to improve growth.

Thinning can improve wildlife habitat by stimulating new growth in the understory and improving mast production by overstory trees, and by increasing flight space under the canopy for foraging bats and forest raptors.

Brush piles

Small mammals, amphibians, reptiles and other wildlife of the forest floor use brush piles for escape, resting and nesting cover. Effective brush piles are built on a base of coarse materials so openings are available at ground level for wildlife movement. A few piles of



C. Rewa

Brush piles should be constructed with heavy material at the base (A) with increasingly finer material on top (B and C) to provide cover for small mammals, reptiles and other wildlife.

large rocks at least 12 inches wide and 2 feet tall, and several crisscrossed logs at least 6 feet long and 6 inches in diameter make good brush pile bases. Stumps can also make good bases. Progressively smaller limbs and brush are piled onto the base until the brush pile is about 6 feet tall. Living brush piles can be made by partially cutting small trees near the base and pushing them to the ground using the bark left intact at the base as a hinge. The partial severing of the tree allows it to remain alive, providing dense live foliage near the ground.

Prescribed fire

Fire is a natural disturbance element of many native ecosystems. However, fire suppression efforts have largely eliminated the regular occurrence of fire from many forested areas. Prescribed fire can be an economically and ecologically beneficial forest management tool when applied properly. Prescribed burning is conducted to achieve specific management goals such as increasing timber production, eliminating undesirable vegetation, improving wildlife habitat, or reducing fire hazards. Fire type, frequency, and intensity are three important factors to consider when planning a prescribed burn. Most prescribed fires are carried out under cool, moist conditions to reduce the chance of wildfire. With careful planning and consultation with the proper authorities, prescribed fire can be an indispensable element of forest management for wildlife.

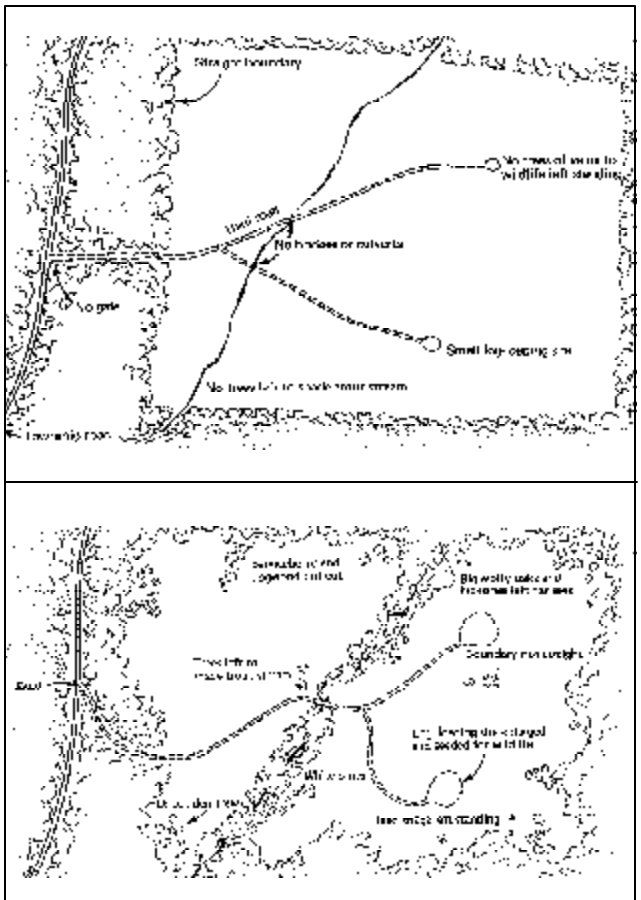
Southern Research Station, U.S. Forest Service

Prescribed burns that simulate natural fire regimes can stimulate new herbaceous growth that benefits deer, turkeys, and other wildlife.

Studies show that most wildlife escapes direct mortality from fire. For many wildlife species, habitat quality is improved by fire, especially for species adapted to early successional vegetation. Surface fires stimulate new herbaceous growth used by deer, elk, moose and other herbivores, and enhance production of berries used by black bears, songbirds and other wildlife. Small mammal populations generally increase in response to new vegetation growth, providing a food source for carnivores. Studies have shown that populations of wild turkeys, northern bobwhites and Bachman's sparrows increased after prescribed fires in forests of the southeastern United States.

Edge habitat

Edge is the boundary where two different plant communities meet. There is generally diverse



Top: Clearcut timber harvest without considerations for wildlife. Bottom: Clearcut timber harvest that takes into account the needs of wildlife associated with edge habitats. From Hassinger et al. (1981).

vegetation associated with edge habitats, where some animals take advantage of the close proximity of different forest successional stages for food and cover. In the past, forest wildlife managers have tried to produce the maximum amount of edge to increase habitat for game species. However, edge does not benefit all wildlife. Many populations of forest interior birds are declining due to fragmentation of forested habitats into smaller patches and the increasing amount of edge and the associated effects of predation and nest parasitism (see section on forest interior birds below). Forest interior species typically avoid edge habitats and require large tracts of contiguous forest. Wildlife species adapted to edge conditions readily outcompete forest interior species for resources along forest margins.

Creation of edges has the following general effects on forest wildlife:

- Habitat quality for **edge-generalist species** (those species whose fitness is enhanced near edge habitats) is improved.
- Habitat quality for **area-sensitive species** (those species requiring large blocks of contiguous forest) is reduced.
- Habitat quality for **edge-sensitive species** (those forest species whose survival and reproductive capacity is reduced near edges) is reduced.

Clearcuts often create abrupt edges, and cutting patterns determine the amount of edge habitat created.

C. Rewa

The dam-building activities of beavers can result in productive habitat for invertebrates, fish, bats, and waterfowl.

Corridor Functions and Benefits:

Wildlife habitat

- connect habitat remnants to increase habitat area for plants and animals
- increase opportunities for emigrating and immigrating wildlife, such as increasing travel lanes for migrating or juvenile animals
- may serve as home range for corridor "dwellers" such as insects, amphibians, reptiles, small mammals, and birds
- increase foraging opportunities and cover for some wildlife species

Other environmental functions

- reduce flooding
- reduce soil erosion and stabilize stream banks
- improve water quality and quantity
- help improve air quality

Social and economic functions

- recreational and educational opportunities
- aesthetics
- introduced corridors can help increase crop yields and quality, decrease energy consumption, and increase property values

Circular cuts produce the least amount of edge. Landowners and managers can increase edge by elongating circles or creating several smaller circles. Irregularly shaped cuts containing islands of residual trees significantly increase edge, whereas straight linear cuts minimize edge.

Managers should be aware of the effect of edges on target wildlife species and plan clearcut sizes and shapes accordingly.

Forest fragmentation

Forest fragmentation is a process in which contiguous forested landscapes are broken up into smaller islands of forest. Forest fragmentation is a major concern because noncontiguous forest cover can negatively impact some wildlife populations. Besides forest interior birds, many wide-ranging carnivores (e.g., bobcat, lynx, black bear, fisher, wolverine) need large blocs of contiguous forest habitat. Adverse affects of forest fragmentation include:

- Increased predation and nest parasitism on forest

interior birds.
- Abandonment of otherwise suitable habitat by area-sensitive species due to close proximity of forest edges.
- Increased interspecific competition.
- Overall habitat loss.

Single-tree and small group selection cuts help preserve areas of contiguous forest by imitating natural forest disturbance processes. Clearcuts and large group selection cuts should be avoided in areas managed for area-sensitive species.

Maintenance or establishment of forested corridors linking forest habitat patches can mitigate the effects of fragmentation to some extent. As forest fragmentation and urban sprawl increase, corridors become increasingly important habitat elements for many species of forest wildlife. Natural corridors include strips of woody riparian vegetation along waterways, and artificial corridors include windbreaks, shelterbelts, and other plantings.

Vernal pools

Vernal pools, also called ephemeral or snowmelt pools, in forest lands of the eastern U.S. are shallow depressions on the forest floor that fill with water when groundwater levels are high, particularly in the spring. Some herbaceous wetlands in California are also known as vernal pools, however, the focus here is on the vernal pools in forested areas. There are several common characteristics of woodland vernal pools: 1) generally occur on ancient soils, usually with an impermeable hardpan, claypan, or volcanic basalt base/ substrate, 2) ground is covered by shallow water for variable periods of time from winter through spring, and pools are typically dry summer through fall, and 3) lack fish populations, which reduces the threat of predation for amphibians and other animals that breed exclusively in the pools. During drought years, water may be absent year-round.

K. Cook

Woodland vernal pools provide important spring breeding habitat for wood frogs, salamanders and other amphibians.

These unique habitats provide a safe haven for some specialized breeding populations of amphibians and invertebrates and food and cover for migrating birds and other wildlife. Many species that inhabit vernal pools are adapted to harsh conditions. High nutrient levels produced by decaying organic material support rapid development of amphibian larvae and other organisms before pools dry up. Animals that breed exclusively in vernal pools and require those habitats for survival are called vernal pool obligate species. The wood frog, a terrestrial amphibian, breeds only in vernal pools as do several species of mole salamanders (including the spotted salamander, blue-spotted salamander, Jefferson salamander, marbled salamander, and others). Other species that use vernal pools in

Conserving vernal pools *includes managing adjacent upland habitat. In forested areas, the loss of surrounding trees and vegetation around vernal pools reduces shade, increases water temperatures, and increases evaporation causing the pools to dry up more quickly. Natural, undisturbed buffers approximately 300 yards wide around pools should help protect animal movements to and from the pools. Forested corridors connecting pools should be preserved, and debris or fill should not be dumped into vernal pools. Roads can be lethal barriers for animals trying to reach vernal pools. Drainage containing road salt, roadside pesticides, and other chemicals can have negative effects on vernal pool habitats. Habitat alterations that must take place should be carried out from November through March to minimize disturbance to breeding and resident animals. Classified as temporary wetlands in many states, landowners and managers should check with their state natural resources agencies for state and federal laws pertaining to vernal pools and associated plants and animals.*

conjunction with permanent aquatic habitats include the spring peeper, green frog, American toad, Fowler's toad, four-toed salamander, red-spotted newt, spotted turtle, painted turtle, snapping turtle, water scorpions, diving beetle larvae, whirligig beetle larvae, dobsonfly larvae, damselfly larvae, fingernail clam, amphibious snails, and others.

Vernal pools are easily overlooked when dry, and are often unknowingly destroyed by land use and management activities. Depressions on the forest floor with dark gray, mottled soils and damp, blackened leaf litter are indicators of vernal pools. The area may also have a strong smell of decomposing organic matter or sulfur. The bases of trees may exhibit watermarks. State wildlife agencies may have lists of possible vernal pool sites.

Riparian zones

Riparian zones are terrestrial areas adjacent to and influenced by perennial or intermittent bodies of water. Riparian zones provide transition areas between terrestrial and aquatic ecosystems, which create unique and highly valuable fish and wildlife habitats. Riparian vegetation provides essential nesting habitat for songbirds, and foraging habitat for songbirds and bats, especially in arid western environments. Forested riparian zones adjacent to streams and rivers provide a variety of important ecological functions, including the following:

Raccoons inhabit wooded areas near streams, lakes, and marshes. Preserving vegetation in riparian zones provides habitat for fish, amphibians, and other wildlife while filtering pollutants and reducing stormwater runoff.

C. Rewa

Riparian vegetation provides shade and a source of organic matter and large wood to stream ecosystems.

- **Stream shading**: Many fish species, especially salmonids and other "cold water" species, cannot tolerate elevated water temperatures. Riparian areas that are heavily vegetated can moderate stream temperatures by shading the stream in summer and providing a buffer from extreme cold in winter.

- **Large wood**: Riparian forests are a source of large wood, which when it falls into the stream, provides structural complexity to stream channels. In-stream wood often results in the development of pools which can slow down stream flow and provide fish refuge from high velocity water, hiding cover and over-wintering habitat. Also, in-stream wood increases the retention time of smaller organic detritus by capturing leaves and twigs in branches and roots. This allows more time for aquatic invertebrates to break down the detritus, supporting the food chain that sustains fish and other vertebrate species. In-stream wood is also habitat to some aquatic insects.

- **Organic matter input**: In upland streams that are shaded by streamside forests, as much as 75 percent of the organic food base is supplied by dissolved organic compounds or detritus such as fruit, limbs, leaves and insects that fall from the riparian canopy. Benthic detritivores, the stream bottom bacteria, fungi and invertebrates that feed on the detritus, form the basis of the aquatic food chain.

C. Rewa

Wolf trees typically have broad, spreading crowns with many natural cavities used by wildlife.

They pass on this energy when they are consumed by larger benthic fauna and eventually by fish.

- **Minimize sediment input**: Riparian ground vegetation acts as a very efficient filtration system by removing sediment and other suspended solids, as well as sediment bound nutrients and pesticides from surface runoff. This function is critical for maintaining good water quality.

- **Nutrient assimilation**: Riparian areas function as a sink when nutrients are taken up by plants and stored in plant tissues. In wetter areas, nutrients in leaf litter may be stored for long periods as peat. Also, sediments filtered out by vegetation remain in the riparian sink to become incorporated into the riparian soils.

Maintaining the integrity of riparian zones in managed forests is a critical aspect of good forest stewardship and integral to providing high quality fish and wildlife habitat. Disturbance of riparian areas during timber harvest operations or other activities should be minimized to the extent possible. The width of non-harvested buffer zones adjacent to streams depends on the stream order, sensitivity of the target species to disturbance, streamside slopes and stream gradient, and many other factors. Managers should consult with local wildlife and natural resource professionals for guidelines concerning the proper width of riparian buffer areas that should be left undisturbed. For all practical purposes, the wider the undisturbed buffer zone, the greater the fish and wildlife habitat benefits that will be maintained.

Cavity-Nesting Wildlife

Some wildlife species depend on tree cavities for nesting. Although this leaflet does not describe requirements for each individual species, general habitat needs are addressed. Primary cavity-nesters, such as members of the woodpecker family, create cavities by drilling holes in dead trees and branches. Many passerine (perching) birds and owls, a few species of waterfowl, and some mammals, including several species of bats, are secondary cavity-nesters, relying on natural cavities formed by fungus, knots, and insects or cavities abandoned by primary excavators for nesting or hiding. Tables 2 and 3 provide lists of North American cavity nesting mammals and birds.

Competition is high for natural cavities, especially where mature forest stands are removed. Landowners and managers can install artificial nesting structures to increase the availability of suitable nesting sites for cavity-nesting wildlife (see Fish and Wildlife Habitat Management leaflet No. 20, *Artificial Nesting Structures*).

Snags and den trees

Snags and den trees are important to many species of wildlife, especially cavity-nesters. Dead branches are used for perching and roosting, while the decaying wood provides a rich invertebrate food source. Sloughing bark on snags provides maternity sites for 17 of North America's 45 bat species. Naturally occurring snags should be left standing wherever possible. Girdling live trees is sometimes used to create snags. To do this, a 3- to 4-inch band of bark is removed from the circumference of a live tree trunk, which kills the tree without felling it. Where safety permits, as many snags as possible should be preserved during timber harvest and thinning. Because snags are

Table 2. Some cavity-nesting mammals in North American forests.

Yellow-pine chipmunk	Common red-backed vole
Northern flying squirrel	Yellow-necked field mouse
Red squirrel	Ermine
Bushy-tailed woodrat	Big brown bat
Deer mouse	Raccoon

an ephemeral resource, green and dying trees should also be left as future replacements for snags lost naturally. To prevent loss to wind throw, snags can be left in clumps, or in locations less susceptible to prevailing winds.

General recommendations for maintaining snags in most timber stands to benefit wildlife include:

- One snag/acre larger than 20-inch dbh for use by larger woodpeckers and owls.
- Four snags/acre between 10- and 20-inch dbh for small mammals such as flying squirrels and smaller raptors such as American kestrels.
- Two snags/acre between 6- and 10-inch dbh for smaller birds such as chickadees and nuthatches.

Den trees, sometimes referred to a "wolf" trees, frequently contain weather-tight cavities used by wildlife for nesting, food storage, and escape cover. Good den trees do not have broken-off tops, which expose wildlife to the weather. Like snags, den trees (or a few large, potential den trees) should be preserved during timber harvest or thinning practices.

Waterfowl, owls, and woodpeckers

Some species of waterfowl, such as the wood duck, nest in cavities in wooded areas near water. Aquatic vegetation and invertebrates provide food for adults and young. Mast-producing trees (especially oaks) are important adult food sources as well. Natural cavities in snags and stumps or cavities abandoned by large woodpeckers are used for nesting. Vegetated buffer zones around streams and wetlands help protect aquatic foraging areas. For more information on wood duck habitat requirements, see Fish and Wildlife Habitat Management Leaflet No. 1, *Wood Duck*.

Most cavity-nesting owls inhabit mature mixed-conifer or deciduous forests near riparian areas. Individuals of some species use several different cavities within their territories. The spotted owl and flammulated owl are both area-sensitive species, and prefer large tracts

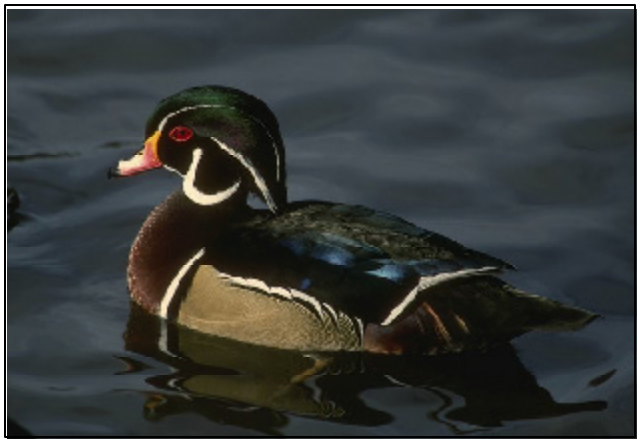
Table 3. Common names of cavity-nesting birds in forests of North America.

Primary (excavator)	Secondary (nonexcavator)	Secondary (nonexcavator)
Northern flicker	Brown-crested flycatcher	Barrow's goldeneye
Pileated woodpecker	Dusky-capped flycatcher	Common goldeneye
Red-bellied woodpecker	Great-crested flycatcher	Bufflehead
Gila woodpecker	Ash-throated flycatcher	Common merganser
Red-headed woodpecker	Violet-green swallow	Hooded merganser
Acorn woodpecker	Mountain chickadee	Black-bellied whistling duck
Lewis' woodpecker	Tufted titmouse	Wood duck
Yellow-bellied sapsucker	Oak titmouse	Barn owl
Williamson's sapsucker	Juniper titmouse	Barred owl
Hairy woodpecker	Bridled titmouse	Spotted owl
Downy woodpecker	White-breasted nuthatch	Western screech owl
Ladder-backed woodpecker	Red-breasted nuthatch	Eastern screech owl
Nuttall's woodpecker	Brown-headed nuthatch	Whiskered screech owl
Strickland's woodpecker	Pygmy nuthatch	Flammulated owl
White-headed woodpecker	Brown creeper	Elf owl
Black-backed woodpecker	House wren	Ferruginous pygmy owl
Three-toed woodpecker	Winter wren	Northern pygmy owl
Black-capped chickadee*	Carolina wren	Northern saw-whet owl
Carolina chickadee*	Bewick's wren	Boreal owl
Boreal chickadee*	Eastern bluebird	Northern hawk owl
Chestnut-backed chickadee*	Western bluebird	Prothonotary warbler
	Mountain bluebird	Lucy's warbler
	Tree swallow	American kestrel
		Purple martin

**Also nests as secondary cavity nester.*

of mature coniferous forests. On long rotations, even-aged systems can provide suitable habitat for many owl species. Owls prey on small mammals and birds found in early succession vegetation adjacent to mature forests, and in mature forest canopy gaps.

Woodpeckers (family Picidae: woodpeckers, flickers, and sapsuckers) rely on snags and mature trees found in deciduous and coniferous forests for food and cover. Most species prefer moist environments or riparian habitats, which promote wood decay and prolific insect populations. On a landscape level, mosaics of different age classes created by even-aged management practices can enhance woodpecker habitat quality if snags and mature trees are preserved. Some area-sensitive species, like the red-cockaded woodpecker that inhabits mature pine forests in the southeast, do not inhabit heavily logged areas. Prescribed burning can improve habitat quality for species that rely on fire-tolerant pines, such as Lewis' woodpecker and black-backed woodpecker.



Wood ducks use cavities in trees for nesting, but will also readily accept nest boxes.

Woodpeckers may occupy several different cavities simultaneously for several years, increasing the importance of snag quality and availability. Woodpeckers are year-round residents, or move short distances in the winter to find food. Some woodpeckers use storage sites, called granaries, to

Table 4. Habitat characteristics and management recommendations for some forest interior birds of North America.

Species	Nest location	Feeding location	Min. forest size*	Management recommendation
Yellow-throated vireo	C	C	250	selective cutting to maintain partially open canopy.
Red-eyed vireo	C	C	50	harvest techniques that retain at least 70% canopy closure.
Northern Parula	C	C	250	retain 60-70% canopy closure and increase shrubs.
Black-and-white warbler	G	M	750	maintain early successional forest.
American redstart	U	M	80	maintain closed canopy and thin understory trees.
Prothonotary warbler	S	G	250	maintain old-growth stands with dead/dying trees.
Worm-eating warbler	G	G	750	maintain dense understory and low tree basal area.
Louisiana waterthrush	G	G	250	maintain wooded streambanks and thick undergrowth.
Ovenbird	G	G	250	maintain closed canopy and open understory.
Barred owl	S	OU	250	maintain large areas on 150-yr. or longer rotations.
Whip-poor-will	G	O	300	pole-sized even-aged stands, retain decaying trees.
Hairy woodpecker	S	T	10	retain decaying and healthy trees during timber harvest.
Pileated woodpecker	T	T	125	retain dead/decaying trees, 150 yr. or greater rotations.
Acadian flycatcher	S	LC	80	maintain tall closed canopy; thin understory trees.
Kentucky warbler	U	G	80	dense understory with well-developed ground cover.
Hooded warbler	U	U	80	maintain canopy closure and dense shrub layer.
Scarlet tanager	C	C	25	maintain pole-size stands, well-developed canopy.
Red-shouldered hawk	C	O	250	maintain mature forest at 140 to 400 trees/acre.

* Minimum forest size in acres. (Compiled from Bushman and Therres 1988.)

C = canopy, G = ground, U = understory, S = snag, M = mid-story, SH = shrub, T = trunk, LC = lower canopy, O = open areas, OU = open understory.

cache surplus mast. Trees in the center of a bird's territory are often used as granaries. Woodpeckers play an important role by reducing the number of tree disease-causing insects found under mature tree bark. Most woodpeckers eat the larvae and adults of wood-boring beetles, ants, flies, caterpillars, and other insects. Some drill holes and forage under bark for insects, while others feed on the wing. Flickers eat invertebrates from the forest floor or fallen logs. Sapsuckers drill small holes in live trees and feed on insects that become trapped in the oozing sap. This resource partitioning allows several different species to inhabit the same area.

Forest interior birds

Management for forest interior birds focuses on maintaining large tracts of contiguous forest in different age and structural classes. Table 4 provides a list of forest interior birds with general habitat management recommendations. Forested landscapes managed on even-aged systems can support viable populations of forest interior species, providing advantages of both early succession and late succession habitats. Harvest management strategies should avoid forest fragmentation and minimize edge. In areas where snags are scarce (<1/acre), landowners can provide nest boxes for cavity-nesting species.

USDI, USGS

Brown-headed cowbirds are more likely to parasitize nests of forest birds in edge habitats than in forest interior regions. Here, two cowbird eggs in this wood thrush nest will hatch before the others, favoring the cowbird chicks.

Habitat loss caused by fragmentation is the major cause of reduced forest interior bird populations. This includes deforestation of the winter habitats of neotropical migrants. In areas of agricultural and urban development, forest interior species are forced to compete with other birds that are better adapted to forest edges and early successional vegetation. During the nesting season, from late April through early August, landowners and managers should minimize disturbance. Individual treatments will depend on forest types, local bird species, and the objectives of the landowner or manager.

Nest parasitism

Nest parasites are birds that lay their eggs in the nests of other species. After hatching, the parasite young typically pushes the other eggs and nestlings out of the nest and is then raised by its "foster" parents. Nest parasitism, particularly in edge habitats, threatens the reproductive success of many forest birds. The brown-headed cowbird, the most common nest parasite, benefits from increased edge created by timber harvest, agriculture, and urban development. Cowbirds prefer early successional vegetation. In landscapes with tall, continuous forest cover, cowbird numbers are generally low. If preliminary monitoring shows that forest interior birds are declining because of nest parasitism by cowbirds, then forest management should include cowbird control measures. However, perhaps the most effective means of controlling the effects of nest parasitism is by limiting forest fragmentation.

Nest predation

Increased nest predation is another consequence of forest fragmentation. Blue jays, American crows, common grackles, squirrels, mice, snakes, and domestic pets are frequent nest predators in edge habitats. Studies show that predation rates for nesting birds in large, forested tracts (managed or unmanaged) are significantly lower than for forest birds that are forced to nest in edge areas.

Blue jays are common nest predators in edge habitats.

Bats

Many North American bats roost in dead and dying trees, especially beneath loose bark, in cavities, decaying hollows, and lightning strike crevices. Others roost exclusively in the foliage of living trees. Bats also use old stumps or downed logs. All of these roosts are required for rearing young, as migratory stopover sites, and occasionally for hibernation. Bats typically select the largest snags and live trees available. Snags in the early stages of decay, with much of their bark remaining, appear to be the most important. Roost trees often receive increased sun exposure, either by extending above the canopy or because they are located in small forest openings, along forest edges, or in more open stands. In landscapes with steeper topography and cold-air drainage, some evidence suggests that upland and ridge top roosts may be used more frequently than roosts in drainage bottoms. Most species move frequently between several roosts during the course of a season, often within a relatively small area. Bats may return to the same roost or group of roosts in subsequent years. Maternity roosts are usually located close to water, as lactating females require frequent access to drinking water.

In the eastern United States, the northern myotis and the endangered Indiana bat rely on exfoliating bark for maternity sites; so do the long-eared myotis and long-legged myotis in the West. Other species, such as the big-brown bat, silver-haired bat, and pallid bat, seem to prefer cavities. In bottomland hardwood forests of the southeastern United States, the Rafinesque's big-eared bat and southeastern myotis form maternity colonies in the hollow trunks of gum, tupelo, and beech trees with basal cavities. Red bats and hoary bats roost primarily in the foliage of deciduous and coniferous trees, while Seminole and northern yellow bats are often found in clumps of Spanish moss.

Bats feed on a variety of night-flying insects, including many forest pests. Bats forage along forest edges, over riparian areas, along forest roads and trails, and in natural forest gaps or small harvest-created openings. Feeding strategies vary greatly among forest-dwelling species, with some foraging around ground-level shrubs while others prefer subcanopy, canopy, or above-canopy locations.

Because snags are an ephemeral resource, and roost switching appears to be essential for most species, forests should be managed where possible to maintain consistent roost availability over time. As many dead, damaged, and dying trees and defective (cull) live trees

Bat Conservation International

Nearly half of North American bat species use forsted habitats for foraging, roosting and maternity sites in tree cavities on under sloughing bark.

should be left as safety and silvicultural objectives permit. Retain less-decayed snags in favor of more-decayed snags, large diameter snags in favor of small diameter snags, and snags with greater bark cover in favor of snags with little bark cover. Leaving small groups of green trees around snags, or groups of snags, can help protect them from wind throw. Leave as many hardwoods as possible that have natural or woodpecker-excavated cavities. In intensively managed forests, snags can be maintained in stream side management zones, the habitat matrix separating managed stands, forested corridors, and other less intensively managed habitats. Where possible, maintain well-distributed, variable-sized patches of mature and old-growth forest through extended harvest rotations. Thinning overstocked stands can improve foraging habitat by increasing flight space beneath the canopy.

Forest Classification

The U.S. Forest Service has developed a system to classify forests in the United States. Seven broad forest regions were designated based on geography and major forest types. In this leaflet, the continental U.S. is divided into eastern and western forest types by the 100th meridian. Dominant vegetation of the major forest types in eastern and western forest type groups are listed in Tables 9 and 11, respectively.

Forests of the eastern United States are primarily deciduous or mixed conifer-deciduous forests, while the western U.S. has mostly coniferous forests. The basic progression of vegetation ranges from evergreen, needle-leaved trees in the far north to deciduous, broad-leaved trees to mixed deciduous and evergreen broad-leaved trees in the deep south. Combinations of broad- and needle-leaved trees are widespread.

Each forest region has unique fish and wildlife species that depend on native forest vegetation types. The type of on-site vegetation depends on climate, geology and soil, fire, competing vegetation, and human influence (land-use development and timber management). The tables on the following pages describe flora and fauna characteristic of eastern and western forest types and management recommendations based on forest wildlife objectives. These tables are intended to guide local decision-making for managing forests for wildlife.

Table 5. Some common mammals of eastern forests.

Virginia opossum	Short-tailed shrew
Big brown bat	Beaver
Little brown bat	Gray squirrel
Eastern mole	Long-tailed weasel
Eastern chipmunk	Mink
Northern and southern flying squirrels	River otter
	Red fox
Red squirrel	Gray fox
Deer mouse	White-tailed deer
White-footed mouse	Black bear
Striped skunk	Bobcat
Raccoon	

Table 6. Some common birds of eastern forests.

Red-tailed hawk	Broad-winged hawk
Ruffed grouse	Whip-poor-will
Great horned owl	Ruby-throated hummingbird
Eastern screech owl	Great crested flycatcher
Common flicker	Eastern wood-pewee
Pileated woodpecker	Wood thrush
Downy woodpecker	Red-eyed vireo
Hairy woodpecker	Ovenbird
American crow	Blue jay
Brown creeper	White-breasted nuthatch
Northern cardinal	

Table 7. Some common mammals of western forests.

Elk	Mountain lion
White-tailed deer	Coyote
Mule deer	Black bear
Long-eared myotis	Grizzly bear
Collared peccary	

Table 8. Some common western forest birds.

Williamson's sapsucker	Band-tailed pigeon
Western tanager	Pine siskin
Townsend's solitaire	Blue grouse
Mountain chickadee	Yellow-rumped warbler
Hairy woodpecker	Dark-eyed junco
Steller's jay	White-crowned sparrow

Table 9. Indicator plant species for eastern forest type groups.

Forest group	Trees	Shrubs	Herbaceous
White-red-jack pine	White spruce, black spruce, balsam fir, paper birch, red pine, white pine, jack pine, Fraser fir, eastern hemlock, and aspens.	Mountain maple, green alder, mountain ash, mountain holly, low-bush blueberry, elder-berry.	Red baneberry, nodding trillium, bunchberry, Canada mayflower, creeping wintergreen.
Loblolly-shortleaf pine	Shortleaf pine, loblolly pine, various oak and hickory species.	Saw-palmetto, southern bayberry, odorless bay-berry, winged sumac.	Little bluestem grass, yellow stargrass, wire-grass, Spanish moss, colicroot.
Longleaf-slash pine	Longleaf pine, slash pine loblolly pine, shortleaf pine red oak, blackjack oak, water water oak.	flowering dogwood, gall-berry, yaupon, bayberry shining sumac, blueberry huckleberry	blustem grasses, panic grasses, wiregrass
Oak-pine	Pitch pine, Virginia pine, various oak species, eastern red cedar.	Bearberry, huckleberries, inkberry, broom crow-berry, lowbush blue-berry.	Blazing-star, butterfly-weed, pinesap, poverty grass, rough hawkweed, wild lupine.
Oak-hickory	Various oak spp., various hickory spp., flowering dogwood, sassafras, hop-hornbeam.	Mountain laurel, high-bush blueberry, lowbush blueberry, mapleleaf viburnum.	Wintergreen, spotted pipissisewa, wild sas-parilla, violet wood-sorrel.
Oak-gum-cypress	Black gum, water tupelo, sweetgum, red maple, swamp hickory, eastern sycamore, oaks.	Swamp-privet, spicebush, buttonbush, hobblebush, swamp dogwood, wild-raisin.	Spanish moss, virgin's bower, heartleaf ampelopsis, wild grapes.
Elm-ash-cottonwood	Eastern cottonwood, black willow, American elm, slip-pery elm, green ash, black ash, eastern sycamore, river birch.	American elder, moon-seed, river grape, poison-ivy, trumpet-creeper, peppervine.	Green dragon, sweet flag, ostrich fern, wood nettle, American black currant, jewel-weed.
Maple-beech-birch	Yellow birch, sugar maple, American beech, eastern hemlock, red pine, pin cherry.	Striped maple, hobble-bush, nannyberry, mountain laurel.	Painted trillium, gold-thread, hairy beard-tongue, common wood-sorrel.

Dot Paul, USDA NRCS

Table 10. Indicator wildlife species of eastern forest type groups.

Forest group*	Birds	Mammals
White-red-jack pine forest Table 10A	Gray jay, common raven, boreal chickadee, white-winged crossbill, red-winged crosbill, pine grosbeak, evening grosbeak, pine siskin, red-breasted nuthatch, winter wren, ruby-crowned kinglet, black-backed woodpecker, northern three-toed woodpecker, blackburnian warbler, Cape May warbler, Wilson's warbler, Swainson's thrush.	Moose, red squirrel, beaver, porcupine, snowshoe hare, lynx, marten, fisher.
Loblolly-shortleaf pine forest Table 10B	Brown-headed nuthatch, pine warbler, yellow-throated warbler, northern parula, red-cockaded woodpecker, red-headed woodpecker, Bachman's sparrow, wild turkey, northern bobwhite, loggerhead shrike, painted bunting, eastern bluebird, black vulture.	Virginia opossum, white-tailed deer, gray fox.
Longleaf-slash pine Table 10C	Brown-headed nuthatch, pine warbler, chipping sparrow Bachman's sparrow, red-cockaded woodpecker, tufted titmouse, blue grossbeak, northern bobwhite, American kestrel, wild turkey.	fox squirrel, pocket gopher, southern flying squirrel, Florida mouse, white-tailed deer.
Oak-pine forest Table 10D	Pine warbler, prairie warbler, rufous-sided towhee, chipping sparrow, great horned owl, common flicker, brown thrasher, northern bobwhite.	Gray squirrel, eastern chipmunk.
Oak-hickory forest Table 10E	Blue jay, wild turkey, scarlet tanager (north), summer tanager (south), rose-breasted grosbeak.	Gray squirrel, fox squirrel, northern and southern flying squirrel, Indiana bat.
Oak-gum-cypress forest Table 10F	Prothonotary warbler, northern parula, herons and egrets, barred owl, wood duck, wood stork, white ibis, limpkin (deep south only), pileated woodpecker, Acadian flycatcher.	Marsh rabbit, raccoon, Rafinesque's big-eared bat, southeastern myotis.
Elm-ash-cottonwood forest Table 10G	Belted kingfisher, bank swallow, spotted sandpiper, green heron, wood duck, yellow-throated vireo, blue-gray gnatcatcher.	Mink, river otter.
Maple-beech-birch forest Table 10H	White-throated sparrow, northern junco, purple finch, northern waterthrush, mourning warbler, Canada warbler, black-throated warbler, blue-throated warbler, green-throated warbler, American redstart, blue-headed vireo, cedar waxwing.	Red-backed vole, snowshoe hare, red squirrel, pocupine, white-tailed deer, nothern long-eared bat.

* Forest group and wildlife management recommendations table number (see following pages).

C. Rewa

Dan Sudia CVIOG/GeorgiaInfo

The brown thrasher is commonly found in oak-pine forests.

Eastern forests

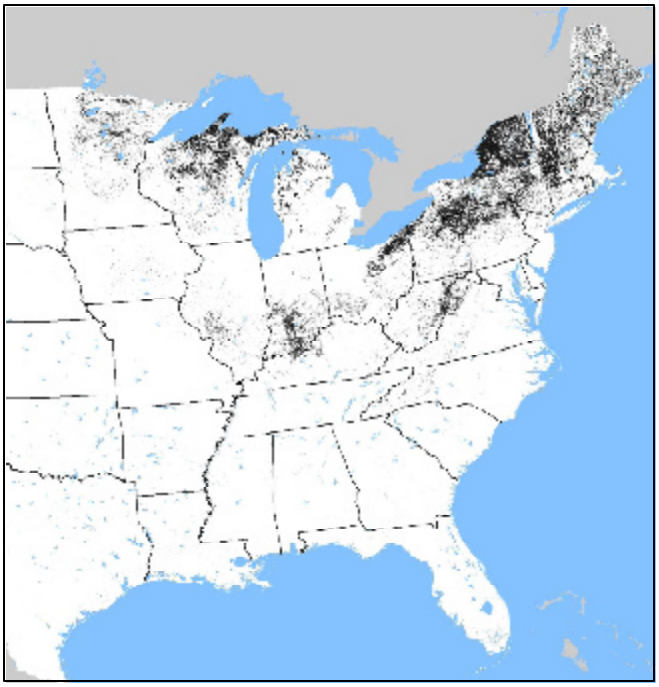
Table 10A. Eastern white-red-jack pine forests: general habitat management recommendations by wildlife management objective.

Wildife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Gray jay, boreal chickadee, white-winged crossbill, red crossbill, pine grosbeak, pine siskin, ruby-crowned kinglet, moose, red squirrel, beaver, snowshoe hare, porcupine	For even-aged management, use high-density shelter-wood cuts, in short cycles (5-10yrs) and use prescribed burns to simulate herbaceous growth to benefit deer, ruffed grouse, and other wildlife.
		For uneven-aged management, practice group selection cuts up to one acre if maintaining some hardwoods.
		Preserve existing snags to provide at least 2-4 large snags (>12-inch dbh) per acre of forest.
		Maintain no-harvest buffer zones along streams to protect riparian and in-stream aquatic habitats.
Forest interior birds	Blackburnian warbler, red-breasted nuthatch	In highly fragmented landscapes, maintain large blocks of contiguous forest.
		In mostly forested landscapes, minimize fragmentation effects by conducting uneven-aged timber management practices.
		If clearcutting, minimize the amount of edge by keeping clearcut openings as close to a circular shape as possible.
Early successional species	Wilson's warbler, Swainson's warbler	Use even-aged management practices to provide patches of brushy habitat.
		If uneven-aged practices must be used, apply group selection cuts to create openings 1-2 acres in size.
		Leave snags and stubs with cavities for cavity nesters.
Late successional species	Black-backed woodpecker, northern three-toed woodpecker	Both black-backed and northern three-toed woodpeckers prefer spruce-fir stands with burned-over areas.
		Maintain no less than 10 percent of the stand in old-growth to ensure availability of snags and den trees.
Specific rare, threatened and endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide specific habitat conditions required by the identified species.

This boreal forest is an evergreen, needle-leaved forest consisting of white-red-jack pine and spruce-fir forest type groups. Red spruce and Fraser fir dominate the Appalachian extension of the boreal forest and replace white spruce and balsam fir, which are often harvested for lumber, pulpwood, and commercial Christmas trees.

Deanna Dawson

Immature blackburnian warbler.

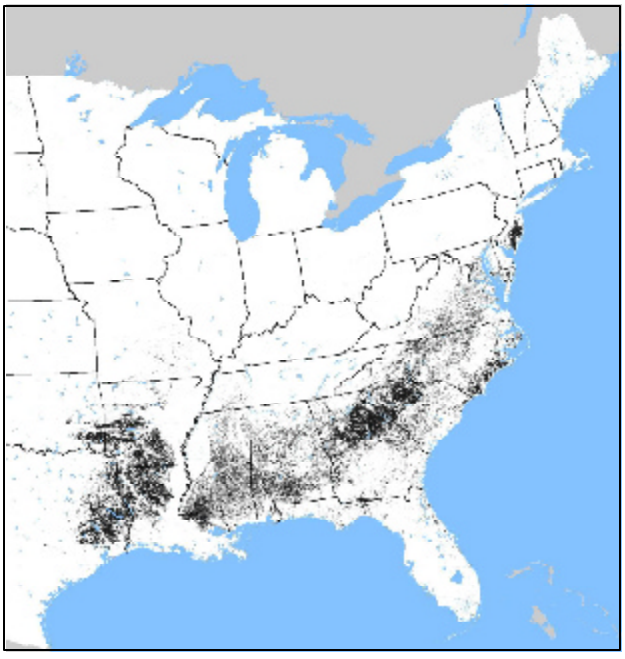


Eastern red-white-jack pine forests

Table 10B. Loblolly-shortleaf pine forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Brown-headed nuthatch, pine warbler, yellow-throated warbler, northern parula, red-headed woodpecker, wild turkey, northern bobwhite, painted bunting, opossum, white-tailed deer, gray fox	For even-aged management, provide several timber age classes in close proximity.
		For uneven-aged mangement, provide a variety of dominant tree species and encourage development of overstory, mid-story, and understory vegetation.
		Retain mast-producing trees (oaks, hickory, walnut).
		Preserve existing snags to provide at least 2-4 large snags (>12-inch dbh) per acre.
		Maintain no less than 10 percent of stand in old-growth.
		Maintain no-harvest buffer zones along riparian areas.
Forest interior birds	Brown-headed nuthatch, red-cockaded woodpecker, Bachman's sparrow, Kentucky warbler, worm-eating warbler.	In fragmented landscapes, maintain large blocks of forest.
		Minimize effects of fragmentation by conducting uneven-aged timber management practices.
		Minimize the amount of edge created by clearcuts by keeping openings as close to a circular shape as possible.
Early successional species	Bewick's wren, painted bunting, prairie warbler, northern bobwhite	Use even-aged management practices and provide patches of brushy habitat.
		If uneven-aged practices must be used, apply group selection cuts to create openings of 1-2 acres in size.
		Leave snags with natural and excavated cavities for wildlife.
Late successional species	Yellow-throated vireo, Acadian flycatcher, wood thrush, Swainson's warbler, Louisiana waterthursh.	Maintain no-harvest sanctuaries of old-growth.
		Maximize stand rotation length and maintain at least 50 percent of the forested area as mature stands (>100 yrs old).
		Position long-rotation stands around contiguous and mature forest reserves; do not remove standing snags or downed logs.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species web site and individual state listings.	Provide habitat conditions specific to the needs of identified species.

Eastern loblolly-shortleaf pine forests



U.S. Forest Service, Southern Research

Mixed loblolly pine forest.

Table 10C. Longleaf-slash pine forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Brown-headed nuthatch, pine warbler, yellow-throated warbler, northern parula, red-headed woodpecker, wild turkey, northern bobwhite, painted bunting, opossum, white-tailed deer, gray fox	For even-aged management, provide several timber age classes in close proximity.
		For uneven-aged mangement, provide a variety of dominant tree species and encourage development of overstory, mid-story, and understory vegetation.
		Retain mast-producing trees (oaks, hickory, walnut).
		Preserve existing snags to provide at least 2-4 large snags (>12-inch dbh) per acre.
		Maintain no less than 10 percent of stand in old-growth.
		Maintain no-harvest buffer zones along riparian areas.
Forest interior birds	Brown-headed nuthatch, red-cockaded woodpecker, Bachman's sparrow.	In fragmented landscapes, maintain large blocks of forest.
		Use prescribed fire to manage understory and encourage long-leaf pine regeneration.
		Minimize the amount of edge created by clearcuts by keeping openings as close to a circular shape as possible.
Early successional species	Bewick's wren, painted bunting, prairie warbler, norhtern bobwhite	Use even-aged management practices and provide patches of brushy habitat.
		If uneven-aged practices must be used, apply group selection cuts to create openings of 1-2 acres in size.
		Leave snags with natural and excavated cavities for wildlife.
Late successional species	Yellow-throated vireo, Acadian flycatcher, wood thrush, Swainson's warbler, Louisiana waterthrush.	Maintain no-harvest sanctuaries of old-growth.
		Maximize stand rotation length and maintain at least 50 percent of the forested area as mature stands (>100 yrs old).
		Position long-rotation stands around contiguous and mature forest reserves; do not remove standing snags or downed logs.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species web site and individual state listings.	Provide habitat conditions specific to the needs of identified species

J. and K. Hollingsworth

The endangered red-cockaded woodpecker nests in mature stands of southern pines with open understories.

Eastern longleaf-slash pine forests

Table 10D. Eastern oak-pine forests: general habitat management recommendations by wildlife habitat management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Pine warbler, rufous-sided, towhee, chipping sparrow, common flicker, brown thrasher, northern bobwhite, wild turkey gray squirrel, eastern chipmunk, white-tailed deer	Oak-pine forest types regenerate best under even-aged management practices such as moderate, dense shelterwood cuts and small clearcuts.
		Retain pines to serve as escape, thermal, and roosting cover.
		Preserve existing standing snags to provide 2 to 4 large snags (>12-inch dbh) per acre of forest.
		Maintain no less than 10 percent of old-growth stands to ensure availability of natural snags and den trees.
		Maintain no-harvest buffer zones along streams to protect riparian and in -stream aquatic habitats.
Forest interior birds	Brown-headed nuthatch, wood thrush, worm-eating warbler, Kentucky warbler, cerulean warbler, Canada warbler	Maintain large blocks of contiguous forest with varied vegetation structure.
		Minimize the amount of edge produced by clearcuts by keeping openings as close to circular shape as possible.
Early successional species	Eastern bluebird, loggerhead shrike, blue-winged warbler, golden winged warbler, Tennessee warbler, meadow vole, long-tailed weasel, meadow jumping mouse	Use even-aged management practices to provide patches of brushy habitat.
		If uneven-aged management practices must be used, apply group selection to create openings 1 to 2 acres in size.
		Leave snags and stubs with cavities in openings for cavity nesting species.
Late successional species	Great blue heron, osprey, bald eagle, red-headed woodpecker red-bellied woodpecker	Maintain no-harvest sanctuaries of old-growth forest.
		Maximize rotation length in timber stands managed for harvest, and maintain at least 50 percent of the forested area as mature stands (>100 years old).
		While conducting intermediate thinnings of oak, maintain hardwood snag and den trees as well as hard mast-producing trees.
Specific rare, threatened or endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions specific to the needs of identified species.

Southern Research Station, U.S. Forest Service

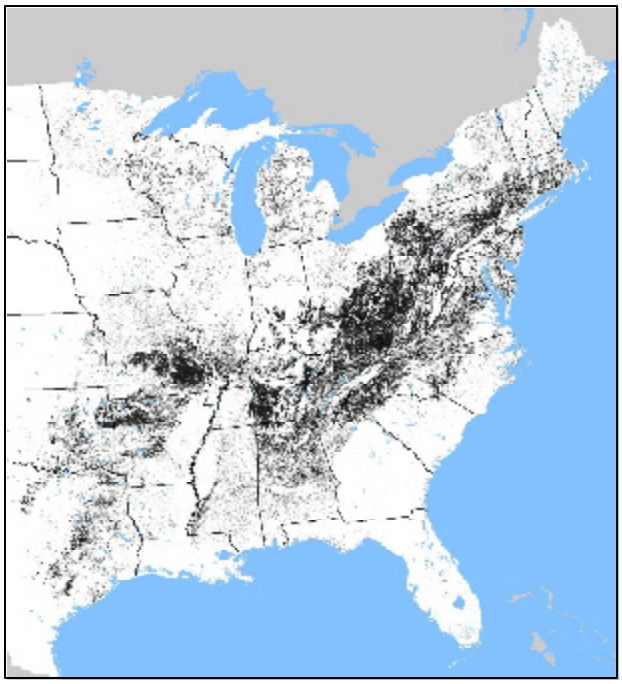
The eastern mixed oak-pine forest supports a unique mix of flora and fauna in each successional stage. Oaks and hickories are common hard mast-producing species found in the mixed forest type. Nuts are an important food source for many wildlife species, including wood ducks and tree squirrels.

Table 10E. Oak-hickory forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Management recommendations
Forest wildlife species diversity	Blue jay, wild turkey, scarlet tanager, rose-breasted grosbeak, ruffed grouse, blue-winged warbler, gray squirrel, fox squirrel, northern and southern flying squirrels, little brown bat	For even-aged management, provide several timber stand age classes in close proximity.
		For uneven-aged management, provide a variety of dominant tree species and encourage development of overstory, mid-story, and understory vegetation.
		Preserve existing snags to provide approximately 2 to 4 large snags (>12-inch dbh) per acre of forest.
		Maintain no less than 10 percent of the stand in old-growth to ensure availability of snags and den trees.
		Maintain no-harvest buffer zones along streams to protect riparian and in-stream aquatic habitats.
Early successional species	Brown thrasher, prairie warbler, yellow-breasted chat, indigo bunting, rufous-sided towhee, blue-winged warbler	Use even-aged management practices and promote disturbance (such as prescribed burns) to open canopy and allow light to reach the forest floor to increase advanced oak regeneration and herbaceous growth.
Forest interior birds	Cerulean warbler, wood thrush, ovenbird, red-eyed vireo, worm-eating warbler, Kentucky warbler, Acadian flycatcher, yellow-billed cuckoo	In highly fragmented landscapes, maintain large blocks of contiguous forested habitat and establish forested corridors to link forest patches.
		In forested landscapes, minimize fragmentation effects by conducting uneven-aged timber management.
		Minimize the amount of edge created in clearcuts by keeping openings in the forest as close to circular in shape as possible.
Late successional species	Cerulean warbler, pileated woodpecker, Rafinesque's big-eared bat	Identify and restore the largest tracts of old-growth and mature forest.
		Don't remove snags or downed logs from stand; maintain large gum and cypress trees with basal cavities.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions specific to the needs of the identified species.

Lynn Betts

The oak-hickory forest is the largest eastern deciduous forest type group and produces hard mast (acorns and hickory nuts) eaten by turkeys and other wildlife. Oak and hickory species mix with other forest types, and are replaced by American elm, sweetgum, tuliptree, and red maple on mesic sites. Sugar maple invades disturbed sites where fire is suppressed and climatic extremes are limited. American chestnut may be found in the understory.



Eastern oak-hickory forests

Table 10F. Eastern oak-gum-cypress forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	White-tailed deer, Carolina chickadee, black bear, wild turkey, American alligator, cotton-mouth, tufted titmouse	For even-aged management, provide several timber age classes in close proximity.
		For uneven-aged management, provide a variety of dominant tree species and encourage development of overstory, mid-story, and understory vegetation.
		Preserve existing snags to provide 2 to 4 large snags (>12-inch dbh) per acre of forest.
		Maintain no less than 5 percent of the stand in old-growth to ensure availability of snags and den trees.
Forest interior birds	Summer tanager, Kentucky warbler, Swainson's warbler, red-shouldered hawk, Acadian flycatcher	In highly fragmented landscapes, maintain large blocks of contiguous forested habitat.
		In mostly forested landscapes, minimize fragmentation effects by conducting uneven-aged timber management practices.
		Minimize the amount of edge by keeping clearcut openings as close to circular shape as possible.
Late-successional species	Pileated woodpecker, barred owl, cerulean warbler, red-eyed vireo	Maintain no-harvest sanctuaries of old-growth forest.
		Maximize rotation length in timber stands and maintain at least 50 percent of the forested area as mature stands (>100 years of age).
		Position long-rotation stands around contiguous and no-harvest forest reserves.
		Maintain no-harvest areas at least 300 feet wide along riparian areas.
		Do not remove snags or downed logs from stand.
Early-successional species	Yellow-breasted chat, Indigo bunting, painted bunting, white-eyed vireo, orchard oriole	Use even-aged management to provide patches of brushy habitat.
		If uneven-aged techniques must be used, apply group selection to create openings 1 to 2 acres in size.
		Leave snags and stubs with cavities for quality nesting sites in open areas for cavity-nesting species.
Specific rare, endangered, or threatened species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions specific to the needs of the identified species.

Southern mixed bottomland hardwood swamp is another name for the oak-gum-cypress forest. Although there are several different combinations of indicator flora, tupelos are usually found in most swamp forests. Dense understories, vines, and the presence of water-resistant oaks are also good indicators.

Table 10G. Eastern elm-ash-cottonwood forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	House wren, great-crested flycatcher, indigo bunting, Kentucky warbler, blue-gray gnatcatcher, common yellow-throat, yellow warbler, mink, river otter, northern and southern flying squirrels	Maintain continuous SMZs, at least 100 feet in width along all streams and rivers in forest-dominated ecoregions.
		Avoid unnecessary alterations of hydrology (dams, levees, channelization) to maintain natural meandering and oxbow sloughs, which provide diverse habitat for wildlife.
Forest interior birds	American redstart, prothonotary warbler, Acadian flycatcher, eastern wood-peewee, yellow-throated vireo	Restore large floodplain forests along major rivers, remove dams and levees where possible to restore natural habitat diversity.
Late successional species	Cerulean warbler, pileated woodpecker, red-shouldered hawk, bald eagle	Retain and restore large floodplain tree species such as cottonwood, sycamore, and swamp white oaks to provide tall tree species.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions specific to the identified species.

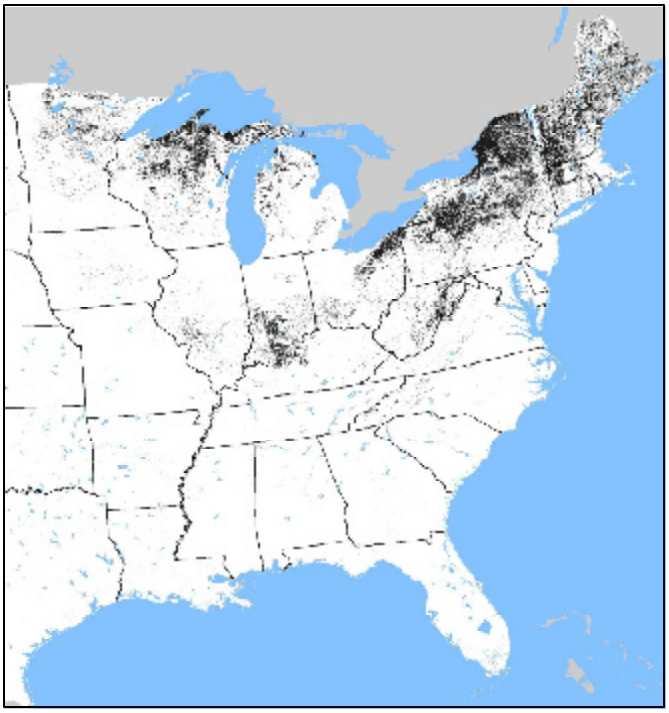
The eastern elm-ash-cottonwood forest group is also referred to as the northern floodplain forest. Spring floods are common after winter snow and ice melts. Floodplains are also fertile from the nutrient-laden sediment deposits, and promote quick tree growth. Cottonwoods and ashes are more abundant in the midwest, while sycamores and maples are more common in northeastern floodplain forests.

Eastern elm-ash-cottonwood forests

Table 10H. Eastern maple-beech-birch forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat management recommendations
Forest wildlife species diversity	White-tailed deer, chipmunk, ruffed grouse, black-capped chickadee	For even-aged management, provide several timber age classes in close proximity.
		For uneven-aged management, provide a variety of dominant tree species and encourage development of overstory, mid-story, and understory vegetation.
		Preserve existing snags, at least 2-4 large snags (>12-inch dbh) per acre of forest.
		Maintain no less than 5 percent of the stand in old-growth to ensure availability of natural snags and den trees.
		Maintain no-harvest buffer zone along streams to protect riparian and in-stream habitats.
Forest interior birds	Scarlet tanager, eastern wood-pewee, black-throated blue warbler, Canada warbler, ovenbird, goshawk	In fragmented landscapes, maintain large blocks of contiguous forest habitat and establish plantings to link forest patches.
		In forested landscapes, minimize fragmentation effects by conducting uneven-aged management practices.
		If clearcutting, minimize the amount of edge by keeping openings as close to circular shape as possible.
Late successional species	Pileated woodpecker, barred owl, fisher	Maximize no-harvest areas of old-growth forest whenever possible.
		Maximize rotation length in timber stands managed for harvest, and maintain at least 50 percent in mature forests (>100 years old).
		Establish long rotation stands around contiguous or no-harvest old-growth forest reserves.
		Do not remove standing snags or downed logs from the stand.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions specific to the indentified species.

Eastern maple-beech-birch forests



Northern hardwood forest is another name for the maple-beech-birch forest group, and includes aspen species as well. The northern hardwood forest is transitional, frequently containing plant species of both the boreal red-white-jack pine forest to the north and the oak-hickory forest to the south.

Greg Lasley CVIOG/GeorgiaInfo

The ruffed grouse is a common inhabitant of early-successional nothern hardwood forests.

Table 11. Indicator plant species in western forest type groups.

Forest group	Trees	Shrubs	Herbaceous
Douglas-fir	Douglas-fir, western hemlock bigleaf maple, tanoak, silver fir, western cedar, ponderosa pine.	Salal, Oregon grape, devil's club, various gooseberries, thimbleberry, Nootka rose, vine maple.	Hooker's fairy bell, calypso orchid, twinflower, bunchberry, pipissisewa.
Hemlock-sitka spruce (temperate rain forest)	Sitka spruce, western hemlock, western redcedar, red alder Douglas-fir, grand fir, silver fir, white fir, western larch, bigleaf maple.	Vine maple, devil's club, salmonberry, Pacific rhododendron, ocean spray, Pacific red elderberry, salal.	Western sword fern, twinflower, vanilla leaf, trail plant, beadlily, deer fern, licorice fern, single sugar scoop.
Ponderosa pine	Ponderosa pine, quaking aspen, lodgepole pine, Douglas-fir gambel oak, Rocky Mountain juniper.	Antelopebrush, mountain-mahogany, desert buckbrush, snowbush, wax currant, common juniper.	Curlycup gumplant, various paintbrushes, blanketflower, miner's candle, wild geranium.
Lodgepole pine	Lodgepole pine, quaking aspen, Douglas-fir, western white pine, whitebark pine, Engelmann spruce.	Snowbrush, kinnikinnick, grouse whortleberry, red elderberry, Canada buffaloberry.	Heartleaf arnica, Wyoming paintbrush, pinedrops, red fireweed, pipissewa, common yarrow.
Spruce-fir	Engelmann spruce (white spruce in far north), subalpine fir (balsam fir in far north), blue spruce, white fir, lodgepole pine.	Grouse whortleberry, myrtle blueberry, tundra dwarf birch, Canada buffaloberry, Colorado currant.	Jacob's ladder, explorer's gentian, broadleaf arnica, pipissewa, monkshood, twinflower, starflower.
Redwood	Redwood, western hemlock, Douglas-fir, bigleaf maple sugar pine, California bay, Pacific madrone.	Pacific rhododendron, western azalea, evergreen huckleberry, salal, salmonberry.	Redwood sorrel, single sugar scoop, western trillium, redwood violet.
Pinyon-juniper	Two-needle pinyon, Utah juniper, Rocky Mountain juniper, gambel oak, oneseed juniper.	Big sagebrush, alderleaf cercocarpus, curlleaf cercocarpus, bitterbrush, desert buckbrush.	Sego lily, Indian paintbrush, scarlet globemallow, various lupines, golden aster, wild zinnia.
Aspen	Quaking aspen, lodgepole pine, Douglas-fir, blue spruce, subalpine fir, white fir.	Roundleaf snowberry, Rocky Mountain maple, common chokeberry, common juniper, ninebark.	Colorado columbine, showy daisy, red fireweed, showy loco, common lupine,sego lily.

Wendell Gilgert

Western forests

Table 12. Indicator wildlife species of western forest groups.

Forest type*	Reptiles and amphibians	Birds	Mammals
Douglas-fir Table 12A	Pacific giant salamander, northwestern salamander, western toad, and Ensatina.	Spotted owl, Vaux's swift, white-winged crossbill, winter wren, great horned owl.	Red tree vole, northern flying squirrel, Townsend chipmunk, mountain beaver.
Hemlock-Sitka spruce Table 12B	Pacific tree frog, Ensatina, western red-backed salamander, dunn sala-mander, Oregon slender salamander.	Winter wren, Townsend's warbler, chestnut-backed chickadee, pileated woodpecker, varied thrush, spruce grouse.	Townsend chipmunk, yellow pine chipmunk, red squirrel, western gray squirrel, marten, bobcat.
Ponderosa pine Table 12C	Fence lizard, many-lined skink, woodhouse toad, sage-brush lizard.	Hepatic tanager, western bluebird, pygmy nuthatch, band-tailed pigeon, Steller's jay.	Tassel-eared squirrel, golden-mantled squirrel, Colorado chipmunk, porcupine.
Lodgepole pine Table 12D	Pacific giant salamander, western toad, Pacific tree-frog, northern leopard frog, western skink.	White-breasted nuthatch, blue grouse, western wood-pewee, Steller's jay, red crossbill, and others.	Red (pine) squirrel, marten, hoary bat, least chipmunk, snow-shoe hare, and others.
Spruce-fir Table 12E	Ensatina, western red-backed salamander, western toad, northern leopard frog, Pacific treefrog, common garter snake.	Gray jay, ruby-crowned kinglet, red-breasted nut-hatch, black-backed wood-pecker, golden-crowned kinglet.	Snowshoe hare, red (pine) squirrel, red fox, mountain vole, lynx, bighorn sheep, longtail weasel.
Redwood Table 12F	Northern alligator lizard, western whiptail, rubber boa, western skink, western racer.	Anna's hummingbird, Wilson's warbler, western screech-owl, rufous hummingbird, northern flicker.	Western gray squirrel, deer mouse, Sonoma chipmunk, raccoon.
Pinyon-juniper Table 12G	Collared lizard, eastern fence lizard, bullsnake, short-horned lizard, western rattlesnake.	Bushtit, pinyon jay, plain tit-mouse, black-chinned hummingbird, rock wren, canyon towhee.	Blacktail jackrabbit, ringtail, Colorado chipmunk, pallid bat, gray fox.
Aspen Table 12H	Smooth green snake, boreal toad, western terrestrial garden snake.	Violet-green swallow, mountain bluebird, red-naped sapsucker, broad-tailed hummingbird.	Beaver, porcupine, masked shrew, dusky shrew, long-legged myotis.

* Forest group and wildlife management recommendations table number (see following pages)

Snowshoe hare.

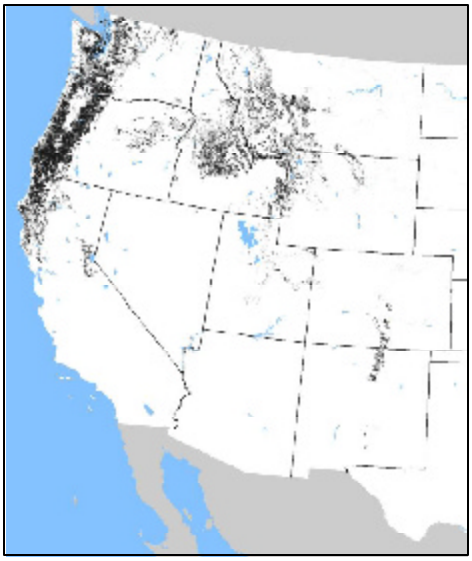
Table 12A. Western Douglas-fir forests: general recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Spotted owl, Vaux's swift, white-winged crossbill, winter wren, great horned owl, red tree vole, northern flying squirrel, chickaree (Douglas squirrel), Townsend chipmunk, porcupine, black bear, mountain beaver, mule deer	For even-aged management, clearcut in small blocks or strips 10-40 acres in size, and provide several timber stand age classes in close proximity; prescribed burns to reduce slash and favor Douglas fir regeneration, leave some slash for wildlife cover.
		For uneven-aged management, provide a variety of dominant tree species and encourage development of overstory, mid-story, and understory vegetation (if western larch desirable).
		Maintain at least 10 percent of stand in old-growth to ensure availability of natural snags and den trees; preserve soft mast species.
		Preserve existing snags to provide approximately 2-4 large snags (>12-inch dbh) per acre of forest.
		Maintain no-harvest buffer zones along streams to protect riparian and in-stream aquatic habitats.
Forest interior birds	Ruby-crowned kinglet, hermit thrush, western wood-pewee, mountain chickadee, hermit warbler, Townsend's warbler, pine siskin, blue grouse, evening grosbeak	In fragmented landscapes, maintain large blocks of contiguous habitat.
		Minimize effects of fragmentation by conducting uneven-aged timber management practices.
		Minimize the amount of edge created by clearcuts by keeping openings in the forest as close to a circular shape as possible.
Late successional species	Spotted owl, hermit warbler, red-breasted nuthatch, brown creeper	Maintain no-harvest sanctuaries of old-growth forest.
		Maximize rotation length in timber stands managed for harvest, and maintain at least 50 percent of the forested area as mature stands (>100 yrs old).
		Position long-rotation stands around contiguous and no-harvest old-growth reserves; do not remove standing snags or downed logs.
		Maintain no-harvest areas at least 300 feet wide along riparian areas.
Specific rare, threatened, or endangered species		Provide habitat conditions specific to the needs of the indentified species.

Douglas-fir forests are found throughout the Pacific Northwest and are present in nearly all but the highest elevations. Douglas-firs often occupy drier sites than those of the hemlock-spruce forest.

CVIOG/GeorgiaInfo

Black bear.



Western Douglas-fir forests

Table 12B. Western hemlock-sitka spruce forests: general habitat management recommendations by wildlife management objectives.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Winter wren, Townsend's warbler, chestnut-backed chickadee, pileated woodpecker, varied thrush, spruce grouse, Townsend's chipmunk, yellow pine chipmunk, red squirrel, western gray squirrel, marten, bobcat	For even-aged management, provide several timber age classes in close proximity.
		For uneven-aged management, provide a variety of dominant tree species and encourage development of overstory, mid-story, and understory vegetation.
		Preserve existing standing snags to provide approximately 2-4 large snags (>12-inch dbh) per acre of forest.
		Maintain no less than 10 percent of the stand in old-growth to ensure availability of snags and den trees.
		Maintain no-harvest buffer zomes along streams to protect riparian and in-stream aquatic habitats.
Forest interior birds	Ruffed grouse, blue grouse fox sparrow, western wood-pewee, Hammond's flycatcher olive-sided flycatcher, golden-crowned kinglet	In fragmented landscapes, maintain large blocks of contiguous forest habitat.
		Minimize effects of fragmentation by conducting uneven timber management practices.
		Minimize the amount of edge created keeping clearcut openings as close to circular shape as possible.
Late successional species	Pileated woodpecker, spotted owl, red-breasted sapsucker, hairy woodpecker, brown creeper, red-breasted nuthatch, hermit warbler	Maintain no-harvest sanctuaries of old-growth forest.
		Maximize rotation length in timber stands managed for harvest, and maintain at least 50 percent of the forested area as mature stands (>100 years of age).
		Position long-rotation stands around contiguous and no-harvest mature forest reserves.
		Maintain no-harvest areas at least 300 feet wide along riparian areas.
		Do not remove snags or downed logs from stands.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions specific to the needs of the identified species.

Western hemlock-sitka spruce forests

The hemlock-spruce forest is also called the temperate rain forest. Due to the ample rainfall, trees in the hemlock-spruce forest can reach 200 feet and live almost 1,000 years. The oldest forests are also called old-growth forests and many mosses, lichens, and other epiphytes grow on tree branches and the forest floor.

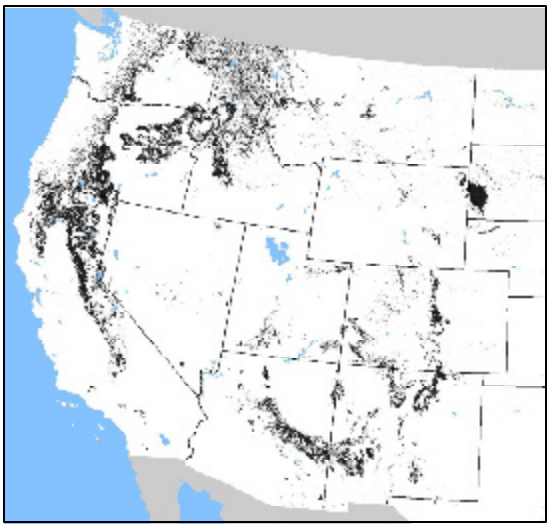
Richard Baetsen USFWS

The spruce grouse prefers mature, old growth coniferous forests.

Table 12C. Western ponderosa pine forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Hepatic tanager, western bluebird, pygmy nuthatch, band-tailed pigeon, Steller's jay, dark-eyed junco tassel-eared squirrel, golden-mantled squirrel, least chip-munk, black bear, coyote, elk, mule deer	For even-aged management, provide several timber age classes in close proximity.
		For uneven-aged management, provide a variety of dominant tree species and encourage development of overstory, mid-story, and understory vegetation.
		Preserve existing snags to provide approximately 2-4 large snags (>12-inch dbh) per acre of forest.
		Maintain no less than 10 percent of the stand in old-growth to ensure availability of snags and den trees.
		Maintain no-harvest buffer zones along streams to protect riparian and in-stream aquatic habitats.
Forest interior birds	Red-breasted nuthatch, white-breasted nuthatch, brown creeper, Grace's warbler, yellow-rumped warbler	In highly fragmented lanscapes, maintain large blocks of contiguous forest.
		Use uneven-aged timber harvest practices to minimize the effects of forest fragmentation.
		Minimize the amount of edge by keeping clearcut openings as close to a circular shape as possible.
Late successional species	White-headed woodpecker, flammulated owl, Lewis's woodpecker, black-backed woodpecker	Practice frequent, low-intensity prescribed burns to maintain park-like structure dominated by very large trees (primarily ponderosa pine).
		Maintain no-harvest sactuaries of old-growth.
		Maximize rotation length in timber stands managed for harvest, and maintain at least 50 percent of the forested area as mature stands (>100 years old).
		Position long-rotation stands next to contiguous and no-harvest mature forest reserves.
		Maintain no-harvest areas at least 300 feet wide along riparian areas.
		Do not remove snags or downed logs from stands.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species Hompeage and individual state listing.	Provide habitat conditions that meet the needs of the identified species.

Ponderosa pine forests are found throughout the southern and central Rocky Mountains. Ponderosa pine is the most widely distributed pine species in the west. At lower elevations and south-facing slopes, Rocky Mountain juniper mixes with ponderosa pine forests. At higher elevations, shrub cover is dense and quaking aspen and lodgepole pine mix with ponderosa pine.

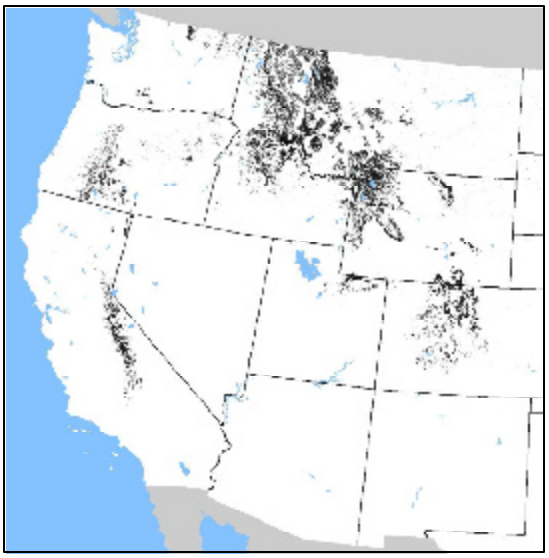


Western ponderosa pine forests

Table 12D. Western lodgepole pine forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Blue grouse, western wood-pewee, white-breasted nuthatch, Steller's jay, red cross-bill, pine grosbeak, calliope hummingbird, red squirrel, marten, least chipmunk, southern red-backed vole, elk	For even-aged management, provide several timber age classes in close proximity; clearcut overmature stands in blocks up to 40 acres in size.
		Keep clearcut blocks or strips less than 200-300 feet wide wide and separate cut areas by untreated strips 100-400 feet wide.
		Retain inclusions of Douglas-fir, spruce-fir, ponderosa pine, and aspen; prescribed burns promote seed dispersal.
		Preserve existing standing snags to provide approximately 2-4 large snags (>12-inch dbh) per acre of forest.
		Maintain at least 10 percent of the stand in old-growth to ensure availability of natural snags and den trees.
		Maintain no-harvest buffer zones along streams to protect riparian and in-stream aquatic habitats.
Forest interior birds	Northern saw-whet owl, sharp-shinned hawk, Cassin's finch, ruby-crowned kinglet, hermit thrush, Clark's nutcracker	In highly fragmented landscapes, maintain large blocks of contiguous forest.
		Preserve snags and downed logs in forest stands.
Late successional species	Black-backed woodpecker, three-toed woodpecker, red-breasted nuthatch, brown creeper	Maintain no-harvest sanctuaries of old-growth forest.
		Maximize rotation length in timber stands managed for harvest, and maintain at least 50 percent of the forested area as mature stands (>100 years old).
		Position long-rotation stands around contiguous and no-harvest mature forest reserves.
		Maintain no-harvest areas at least 300 feet wide along riparian areas.
		Do not remove snags or downed logs from stands.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions that meet the specific needs of the identified species.

Western lodgepole pine forests



Lodgepole pines can occur in pure, even-aged stands and often show signs of previous fires around trunks. Many bark gleaning birds use lodgepole pines for food sources, especially nuthatches and woodpeckers. Mountain chickadees, yellow-rumped warblers, and western wood-pewee take advantage of the ample insect populations of lodgepole stands. The black-backed, three-toed, and Lewis' woodpeckers all prefer the habitat of recently burned lodgepole pine forests. Pine martens and red squirrels (also called pine squirrels) are common lodgepole pine forest inhabitants.

John and Karen Hollingsworth

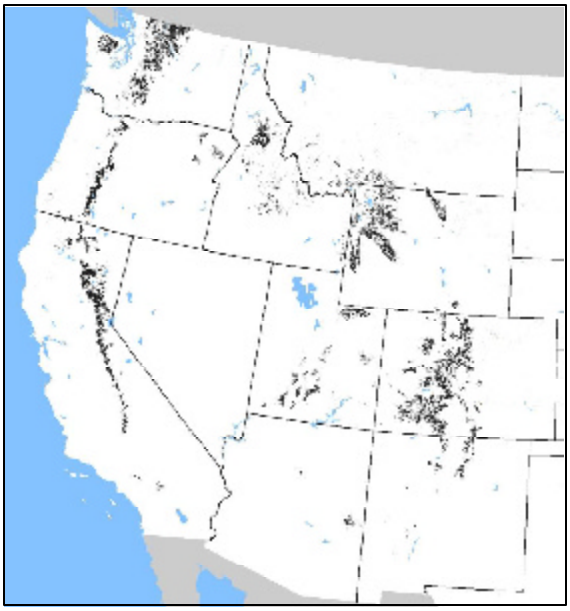
Pine marten

Table 12E. Western spruce-fir forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Gray jay, hermit thrush, red-breasted nuthatch, yellow-rumped warbler, northern goshawk, hairy woodpecker, snowshow hare, red (pine) squirrel, porcupine, lynx, bobcat, mule deer, bighorn sheep	For even-aged management, provide several timber age classes in close proximity.
		For uneven-aged management, provide a variety of dominant tree species and encourage development of overtsory, mid-story, and understory vegetation.
		Preserve existing snags to provide approximately 2-4 large snags per acre of forest.
		Maintain no less than 10 percent of the stand in old-growth to ensure availability of snags and den trees.
		Maintain no-harvest buffer zones along streams to protect riparian and in-stream aquatic habitats.
		Spruce seem to establish more quickly on sites newly opened up by fire.
Forest interior birds	Boreal owl, northern saw-whet owl, ruby-crowned kinglet, golden-crowned kinglet	In highly fragmented landscapes, maintain large blocks of contiguous forest.
		Use uneven-aged timber harvest practices to minimize the effects of forest fragmentation.
		Minimize the amount of edge by keeping clearcut openings as close to a circular shape as possible.
Late sucessional species	Pine siskin, red crossbill, black-backed woodpecker, three-toed woodpecker, brown creeper, Clark's nutcracker	Maintain no-harvest sanctuaries of old-growth.
		Maximize rotation length in timber stands managed for harvest, and maintain at least 50 percent of the forested area as mature stands (>100 years old).
		Position long-rotation stands next to contiguous and no-harvest mature forest reserves.
		Maintain no-harvest areas at least 300 feet wide along riparian areas.
		Do not remove snags or downed logs from stands.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Homepage and individual state listing.	Provide habitat conditions that meet the needs of the indentified species.

Al and Betty Schneider, *Southwest Colorado Wildflowers, Ferns, and Trees*

Engelmann spruce.

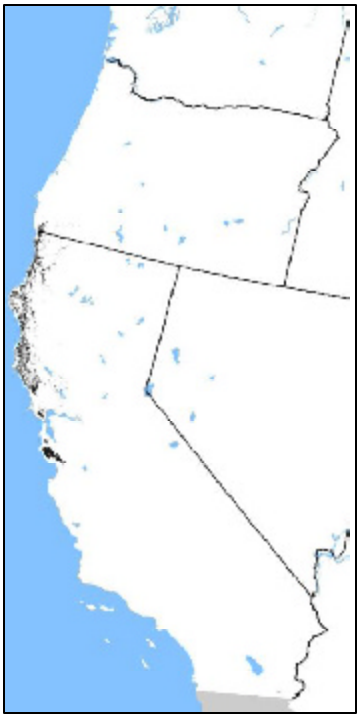


Western spruce-fir forests

Table 12F. Western redwood forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Anna's hummingbird, Wilson's warbler, western screech-owl, rufous hummingbird, varied thrush, western flycatcher, Vaux's swift, northern pygmy owl, Swainson's thrush, Douglas squirrel, Sonoma chipmunk, mule deer, elk	For even-aged management, provide several timber age classes in close proximity.
		For uneven-aged management, provide a variety of dominant tree species and encourage development of overstory, mid-story, and understory vegetation.
		Preserve existing standing snags.
		Maintain no less than 10 percent of the stand in old-growth to ensure availability of snag and den trees.
		Maintain no-harvest buffer zones along streams to protect riparian and in-stream aquatic habitats.
Forest interior birds	Golden-crowned kinglet, spotted owl, varied thrush, western flycatcher	In fragmented landscapes, maintain large blocks of contiguous, mature forested habitat.
		Minimize the effects of fragmentation by conducting uneven-aged timber management practices.
Late successional species	Spotted owl, hairy woodpecker, brown creeper, pygmy nuthatch, black-backed woodpecker	Maintain no-harvest sanctuaries of old-growth forest.
		Maximize rotation length in timber stands managed for harvest, and maintain at least 50 percent of the forested area as mature stands (>100 years old).
		Do not remove snags or downed logs from stands.
		Position long-rotation stands around contiguous and no-harvest mature forest reserves.
		Maintain no-harvest areas at least 300 feet wide along riparian areas.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions specific to the needs of the indentified species.

Western redwood forests



Redwood forests contain the tallest trees on Earth, and require the moist, well-drained soils found along the Pacific coast from central California to southwestern Oregon. Wildlife that depend on old-growth or mature forests, such as spotted owls, northern pygmy owls, and western screech owls can be found in redwood stands. Many species of salamanders inhabit the dense litter layer of the moist forest floor.

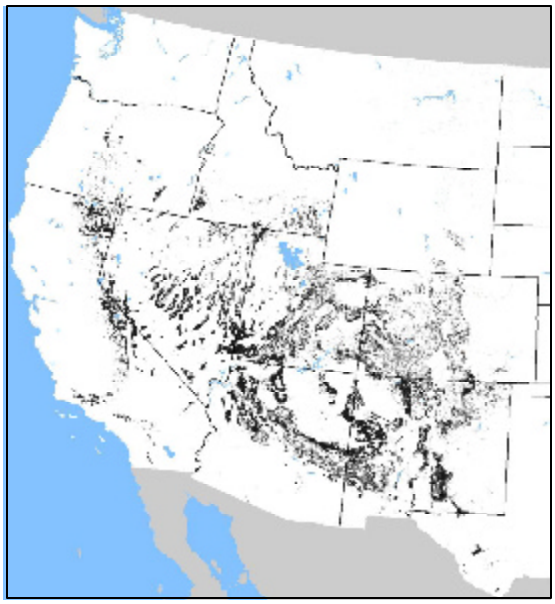
John and Karen Hollingsworth USFWS

Spotted owl

Table 12G. Western pinyon-juniper forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Bushtit, pinyon jay, juniper titmouse, black-chinned hummingbird, rock wren, prairie falcon, golden eagle, greater roadrunner, white-throated swift, scrub jay, sage thrasher, blacktail jackrabbit, ringtail, spotted skunk, gray fox	Avoid large block clearcuts and intersperse small clearcuts and natural woodland openings with blocks of pinyon-juniper, maintain irregular boundaries.
		Remove individual pinyon or juniper trees with a chainsaw or bulldozer, and reseed native grasses and forbes in openings.
		Where pinyon-juniper invades grasslands, cabling or chaining possible if cleared area immediately reseeded with native vegetation.
		Retain vegetation buffer strips along riparian areas and highways.
		Preserve large and mature pinyon and juniper trees, preserve existing snags and mast-producing trees.
		Retain browse species like mountain mahogany, bitterbrush, and sagebrush. Use prescribed burns to open canopies.
Forest interior species	Mountain quail, black-throated gray warbler, gray vireo, Scott's oriole, Lawrence's goldfinch	Maintain large tracts of contiguous forest whenever possible.
		Restrict selective removal of pinyon pine.
		Use prescribed burns to reduce fuel buildup.
Late successional species	Gray vireo, gray flycatcher, pinyon jay, Cassin's kingbird, juniper titmouse, Virginia's warbler	Do not remove standing snags or downed logs from stands.
		Retain no-harvest sanctuaries of mature and old-growth forest.
		Maintain no-harvest areas at least 300 feet wide along riparian areas.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions specific to the needs of the identified species.

The pinyon-juniper forest is found in the upper Sonoran desert and the arid slopes of the southern and central Rocky Mountains. The forest consists mostly of small pines and junipers with sparse herbaceous groundcover. Prickly pear cacti are also present, along with characteristic desert reptiles. The pinyon cones contain large seeds that are important food sources to many wildlife species found in pinyon-juniper woodlands.



Western pinyon-juniper forests

Table 12H. Western aspen forests: general habitat management recommendations by wildlife management objective.

Wildlife objective	Indicator species	Habitat recommendations
Forest wildlife species diversity	Violet-green swallow, mountain bluebird, red-naped sapsucker, broad-tailed hummingbird, ruffed grouse	For even-aged management, use clearcuts (limit to 40 acres) with irregular edges alone or in combination with prescribed burns and herbicide applications to encourage regeneration.
		Preserve mast-producing shrubs and trees for wildlife food.
		Preserve existing standing snags to provide 2-4 large snags (>12-inch dbh) per acre of forest.
		Maintain no-harvest buffer zones along streams to protect riparian and in-stream aquatic habitats.
Forest interior (closed canopy inclusion) species	Red-breasted nuthatch, hermit thrush, gray catbird, rufous-sided towhee	In highly fragmented landscapes, maintain large blocks of contiguous forest habitat.
		Minimize effects of fragmentation by conducting uneven-aged timber management practices.
		Minimize amount of edge created by clearcuts by keeping openings as close to a circular shape as possible.
Early successional species	Swainson's thrush, Wilson's warbler, Lincoln's sparrow, dark-eyed junco, black-billed and yellow-billed cuckoo, gray catbird	Use even-aged management practices to provide patches of brushy habitat.
		Leave snags and stubs with cavities in openings for cavity-nesting species.
Specific rare, threatened, or endangered species	See U.S. Fish and Wildlife Service Endangered Species Homepage and individual state listing.	Provide habitat conditions specific to the needs of the identified species.

Apens often grow in dense, pure stands and are common in most elevations and forest regions of the west. Firs, spruces, and junipers are sometimes found in aspen stands. Aspen stands provide food and cover for gamebirds such as ruffed grouse, and beavers and porcupines. Chokecherry and Rocky Mountain maple can be found in the understory of many mature aspen forests.

Western aspen forests

W. Gilgert

Forest and Timberland Management Plans and Programs

There are a variety of federal, state, private and non-profit organizations that provide landowners with financial and technical assistance to improve fish and wildlife habitats in forests.

Landowner assistance programs

Landowner assistance programs help private landowners develop forest management plans. These programs are part of the U.S. Forest Service Cooperative Forestry department. Cooperative Forestry coordinates partnerships with forestry organizations and federal funding helps support forest recreation, fish and wildlife resources, and timber management. Some forest product companies also offer landowner assistance programs.

The Forest Legacy Program (FLP) is a voluntary federal program. It forms partnerships between landowners and states to protect privately owned forest lands. FLP supports conservation easements, which are legally binding agreements that transfer property rights from one party to another, but the property remains under private management. The landowner negotiates property use with the states. Conservation easements restrict development and require sustainable forestry practices. Landowners must prepare a resource management plan in order to qualify as part of the easement acquisition. The federal government may fund up to 75% of the costs, and the other 25% can come from private, state, or local sources. Tax breaks are another incentive for landowners to participate in the FLP. Program information and guidelines can be found at the U.S. Forest Service website: http://www.fs.fed.us/spf/coop/flp.htm. Landowners can call the Cooperative Forestry Unit at (202)-205-1389.

The Forest Stewardship Program (FSP) is designed to promote multiple-use attitudes to natural resource management on non-industrial private forest lands (NIPF). The FSP develops partnerships with natural resource professionals and NIPF landowners to successfully manage private timberlands for wildlife habitat, recreation, and water quality. State foresters and wildlife biologists help landowners implement management plans that include landowner goals and natural resource issues. Individuals and non-commercial landowners can participate in FSPs if they agree to maintain the plan for at least 10 years. If a landowner wants cost sharing assistance through the Stewardship Incentives Program (SIP), then landowners must complete the FSP. For additional program information, landowners can contact their state forester's office, the Cooperative Forestry Unit, or the U.S. Forest Service website.

The Stewardship Incentives Program (SIP) gives cost share support for NIPF landowners to help them design Forest Stewardship Plans. SIPs encourage long-term management of natural resources, like timber and wildlife, while providing economic incentives. Financial support (as part of FSPs) includes the following forest management activities: reforestation, soil and water protection and improvement, riparian and wetland protection and improvement, fisheries habitat enhancement, wildlife habitat enhancement, and others. The federal government may reimburse the landowner up to 75% of approved expenses, to a maximum amount of $10,000 per year per landowner. This financial support depends on the landowner's commitment to maintain SIP funded practices for at least 10 years. For more information on this program, landowners should contact their state forester's office, the Cooperative Forestry Unit, or the U.S. Forest Service website.

Forestry Incentives Program

Forestry Incentives Program (FIP) is part of the 1996 Farm Bill, and share up to 65% of the costs for tree planting, timber stand improvements (TSI), and other actions on non-industrial private lands. FIP is designed to help non-industrial private landowners maintain forestry practices that protect natural resources and future timber supplies. As with SIP, the federal cost share has a $10,000 limit per landowner per year, but no more than 65% of the cost can be paid. State foresters give NIPF landowners technical advice to develop forest management plans, and certify completed projects for cost shares. To find out about

Table 26. Programs that provide technical and financial assistance to develop fish and wildlife habitat on private lands.

Program	Land eligibility	Type of assistance	Contact
Conservation Reserve Program (CRP)	Highly erodible land, wetland and certain other lands with cropping history. Stream-side areas in pasture land.	50% cost-share for est. permanent cover and conservation practices, and annual rental payments for land enrolled in 10 to 15 year contracts. Additional financial incentives available for some practices.	NRCS or FSA state or county office
Environmental Quality Incentives Program (EQIP)	Cropland, range, grazing land and other agricultrual land in need of treatment.	Up to 75% cost-share for conservation practices in accordance with 10 to 15 year contracts. Incentive payments for certain management practices.	NRCS state or county office
Partners for Fish and Wildlife Program (PFW)	Most degraded fish and/ or wildlife habitat.	Up to 100% finanical and technical assistance to restored widlife habitat under a minimum 10 year cooperative agreement.	Local office of the U.S. Fish and Wildlife Service
Waterways for Wildlife	Private lands.	Technical and program development assistance to coalesce habitat efforts of corporations and private landowners to meet common wateshed level goals.	Wildlife Habitat Council
Wetlands Reserve Program (WRP)	Previously degraded wetland and adjacent upland buffer, with limited amount of natural wetland and existing or restorable riparian areas.	75% cost-share for wetland restoration under 10 year contracts and 30 year easements, and 100% cost-share on restoration under permanent easements. Payments for purchase of 30 year or permanent conservation easements.	NRCS state or county office
Wildlife at Work	Corporate lands.	Technical assistance on developing habitat projects into programs that allow companies to involve employees and the community.	Wildlife Habitat Council
Wildlife Habitat Incentives Program (WHIP)	High-priority fish and wildlife habitats.	Up to 75% cost-share for conservation practices under 5 to 10 year contracts.	NRCS state or county office

State fish and wildlife agencies as well as private groups may have assistance programs or other useful opportunities through state and local contacts.

qualifications and FIP county participants, landowners should contact their state forester's office, local conservation district, local Cooperative Extension office, or the NRCS.

The American Tree Farm System

The American Tree Farm System certifies owners of tree farms and NIPF lands in the U.S. that maintain strict sustainable forestry management practices. Landowners must pass an inspection every five years by a volunteer forester to become certified. In addition to producing timber, landowners must protect watershed quality, wildlife habitat, and soil, and provide recreational opportunities. For more information on the American Tree Farm System, landowners should contact the American Forest Foundation's website at http://www.affoundation.org or call 1-888-889-4466.

Non-governmental contacts

There are many non-governmental and non-profit organizations that landowners can contact for up-to-date information on forest and wildlife management, consulting contacts, publications, taxes, and current issues. Included are some available internet resources. These websites also have contact information and links to related topics.

Some forest conservation organizations.

Organization	Website address
Society of American Foresters	http://www.safnet.org
American Forests	http://www.americanforests.org
Association of Consulting Foresters of America, Inc.	http://www.acf-foresters.com
National Association of State Foresters	http://www.stateforesters.org

Conclusion

Comprehensive forest management can conserve, preserve, or improve fish and wildlife habitat on forested lands while meeting other landowner objectives. Effective forest management plans incorporate silviculture systems that combine several forestry practices suited to local conditions that fit the individual goals of the landowner or manager. Although this leaflet describes basic timber harvest strategies and associated wildlife management techniques, it should not be considered as a definitive answer to every problem. Silvicultural treatments change over time as the goals of landowners and managers shift

Sources of forest wildlife habitat management assistance.

Agency or Group	Assistance Provided	Contact
State Fish & Wildlife Agency	Educational materials, technical guidance, and cost-sharing of habitat management in some cases.	Regional, state or county office
USDA Natural Resources Conservation Service	Technical, financial and educational assistance provided directly to landowners at the local level. Help plan, apply and maintain conservation systems that are site-specific and environmentally and economically sound.	Local county office
USDA Cooperative State Research, Education and Extension Service	Information and educational materials on forest and wildlife management.	Regional, state or county office; partner universities
U.S. Fish and Wildlife Service	Technical, educational, and in some cases financial assistance for habitat restoration and management.	State of local office
National Assiciation of Conservation Districts	Through local conservation districts, educate and assist local land managers conserve soil, water, wildlife, forests, and other natural resources.	Local conservation district office
Private Conservation Organizations	A variety of conservation organizations provide Technical, educational, and in some cases financial assistance for habitat restoration and management. Groups include: Bat Conseration International Ducks Unlimited Longleaf Alliance National Fish and Wildlife Foundation National Wild Turkey Federation Quail Unlimited Quality Deer Management Assoication Rocky Mountain Elk Foundation Ruffed Grouse Society The Wildlife Society Wildlife Habitat Council Wildlife Management Institute	State or local contacts

and management techniques improve. It is important for landowners and managers to enroll the technical expertise of natural resource professionals. These cooperative relationships help conserve natural resources while conducting sustainable forest management practices in the future.

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Wildlife Habitat Management Institute
100 Webster Circle, Suite 3
Madison, Mississippi 39110
(601) 607-3131

In cooperation with partners, the mission of the Wildlife Habitat Management Institute is to develop and disseminate scientifically based technical materials that will assist NRCS field staffs and others to promote conservation stewardship of fish and wildlife, and deliver sound habitat management principles and practices to America's land users.

www.whmi.nrcs.usda.gov

Wildlife Habitat Council
8737 Colesville Road, Suite 800
Silver Spring, Maryland 20910
(301) 588-8994

The mission of the Wildlife Habitat Council is to increase the amount of quality wildlife habitat on corporate, private, and public land. WHC engages corporations, public agencies, and private, non-profit organizations on a voluntary basis as one team for the recovery, development, and preservation of wildlife habitat worldwide.

www.wildlifehc.org

Acknowledgements

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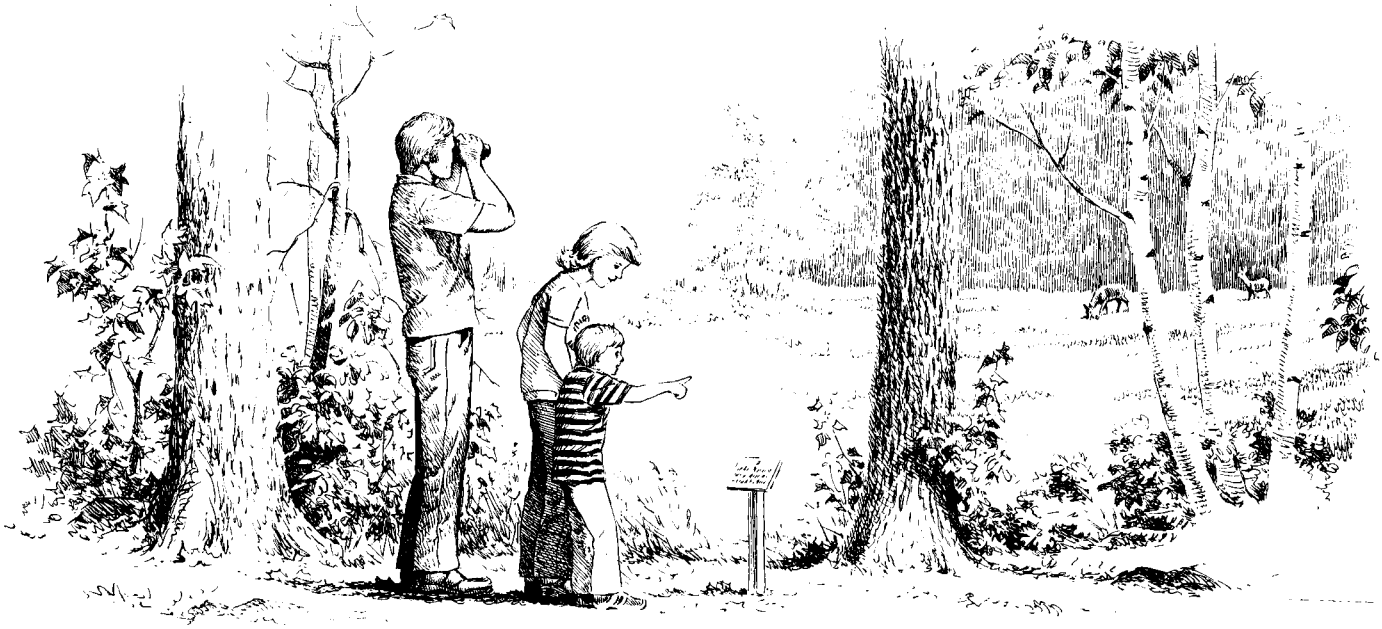
Great Trinity Forest Management Plan

Wildlife Management

Management Practices for Enhancing Wildlife Habitat

PENNSTATE
COLLEGE OF AGRICULTURAL SCIENCES • COOPERATIVE EXTENSION

Management Practices for Enhancing Wildlife Habitat



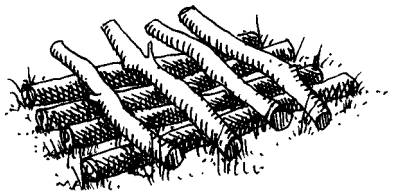
By enhancing wildlife habitat on your property, you can improve the habitat quality for wildlife while increasing wildlife viewing and recreational opportunities. The most common habitat management practices for wildlife are described below. The descriptions are brief and general. For more details about which practices are appropriate for your property, consult a wildlife management specialist.

Brush piles

Brush piles are piles of brush that are assembled to provide resting/escape cover and den sites for wildlife. Brush piles are used for cover by eastern cottontails and other small mammals. Songbirds may use brush piles for perch sites, especially if the piles are located near feeding or nest sites. Also, if brush piles are adjacent to a water source, amphibians and reptiles may use them for breeding, feeding, or resting.

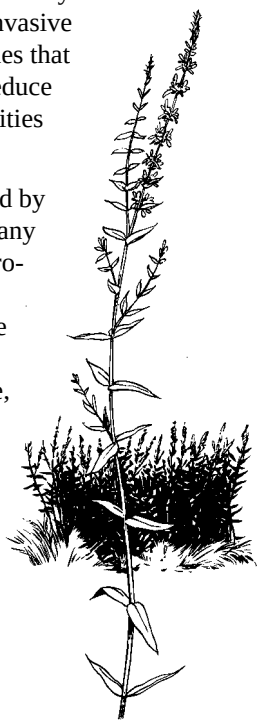
The best brush piles for wildlife start with the largest materials (pole-sized logs) at the bottom and end with the smallest materials (small limbs or shrubs) at the top of the pile. The materials are arranged so that the brush pile is raised slightly above the ground. This makes it easier for animals to get under the brush pile and into cover. Placing the largest materials on the bottom of the pile also slows the brush pile's rate of decay.

Brush piles are generally placed near food sources and in places where low cover for wildlife may be sparse or absent. Forest openings, forest edges, and timbered areas are good places to build brush piles because many types of wildlife feed in openings and along forest edges, often benefiting from the additional cover provided by the piles.



Controlling noxious weeds and non-native invasive plants

Invasive or aggressive plant species are often easily established, but once established they expand beyond those areas for which they were intended. Invasive species are generally non-native species that can out-compete native species and reduce the diversity of natural plant communities (See Table 1).



Purple loosestrife

Invasive plant species can be dispersed by wildlife, livestock, and/or humans. Many were deliberately or inadvertently introduced by humans. Some examples of invasive species that may out-compete native plants in Pennsylvania are multiflora rose, Japanese honeysuckle, and purple loosestrife. Although some of these species provide benefits for wildlife, they can create problems and, in the long run, have limited value for most wildlife. Consequently, many landowners are experimenting with different techniques to control invasive species and replace them with native plants. Wildlife species in Pennsylvania have evolved with the native plant communities and derive the greatest benefits from the variety of native plants. Controlling the expansion of non-native plant species also contributes to conserving biological diversity.

Some species of invasive plants (e.g., multiflora rose, kudzu vine, and mile-a-minute vine) are classified as noxious weeds in Pennsylvania, and it is illegal to plant them. In areas where you are not sure if a particular species may be invasive, contact local resource professionals to find out as much as possible about which species may be problems in your area. Bureau of Forestry service foresters, Natural Resource Conservation Service personnel, Penn State Cooperative Extension agents, and private natural resource professionals can provide information about the control of non-native species.

TABLE 1 - *Non-native species known to have or suspected of having detrimental effects on native plant communities*

Acer platanoides	*Norway maple*
Ailanthus altissima	*tree-of-heaven*
Berberis thunbergii	*Japanese barberry*
Elaeagnus angustifolia	*Russian olive*
Elaeagnus umbellata	*autumn olive*
Lonicera japonica	*Japanese honeysuckle*
Lonicera maackii	*amur honeysuckle*
Lonicera morrowii	*Morrow honeysuckle*
Lonicera tatarica	*Tartarian honeysuckle*
Lythrum salicaria	*purple loosestrife*
Polygonum perfoliatum	*mile-a-minute vine*
Pueraria lobata	*kudzu vine*
Rosa multiflora	*multiflora rose*

TABLE 2 - *Some of the benefits provided for wildlife by snags*

Cavities	*Excavated in snags by primary cavity excavators like woodpeckers* *Used by woodpeckers for shelter and nesting cover* *Used for nest sites by secondary cavity nesters (i.e., those species unable to excavate their own cavities) like the wood duck, eastern bluebird, and gray squirrel.*
Loose bark	*Begins to loosen as a tree dies and forms "bark cavities"* *Bark cavities are used for cover, as roost sites for forest dwelling bats, and as nest sites for brown creepers.*
Insects	*Become abundant in the decaying wood of snags* *Provide a valuable food source for insect eaters like woodpeckers and nuthatches*
Perch Sites	*Perch sites are provided for many birds including songbirds like the indigo bunting (singing perch), raptors like American kestrel (hunting perch), and kingfishers like the belted kingfisher (fishing perch).*

Creating snags

Snags are dead or partially dead standing trees that provide a number of important benefits to a variety of wildlife (see Table 2). Snags provide cavities for nesting and resting, perches for hunting and displaying, and an abundant supply of food for insect eaters. In Pennsylvania, there are over 35 species of birds and 20 species of mammals that use snags at some point in their life cycles. In addition, many species of reptiles and amphibians also use the cavities in snags.

Gray squirrel and pileated woodpecker

Different species of wildlife prefer different types and sizes of snags in a variety of habitats. Some species prefer hard snags (dead or partially dead trees with fairly sound wood and some limbs remaining) while others prefer soft snags (also called "punky," in advanced stages of decay, and rarely with limbs). Some species, like wood ducks and barred owls, require large snags simply because they need large cavities in which to nest. Other species, such as the tufted titmouse, will forage and nest in cavities inside smaller snags. To accommodate a variety of species, many landowners try to maintain several types and sizes of snags.

Gray squirrel

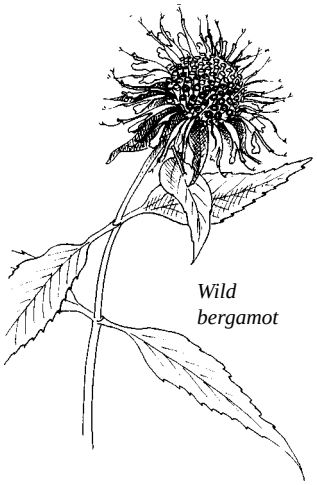
The best method to provide snags for wildlife is to retain existing snags in places where they will not create a dangerous situation for people using the nearby area for outdoor activities like hiking or cutting firewood. There are a number of guidelines suggested for the types, sizes, and numbers of snags that are best for wildlife. A reference where details about snags can be found is *Dead Wood for Wildlife* (number 7 in the Pennsylvania Woodlands series), which is available free of charge from your county extension office. When the abundance or distribution of snags is

inadequate or if particular types of snags are desired, snags can also be "created." Creating snags involves deadening trees so that they remain standing. Success depends on the method used, the tree species you are trying to deaden, the current health of the individual tree, and the specific site characteristics such as the presence of forest pests that may accelerate the tree's death.

Retaining or creating snags is often incorporated into other habitat management practices. For instance, if clearing is planned to create an opening, some of the trees that could be removed while clearing could instead be deadened and left standing for use by wildlife. If a forest-edge cutting or a tree and shrub release is planned, some of the trees that would be removed can instead be deadened and left standing.

Establishing permanent vegetation for wildlife

On some properties, trees, shrubs, and herbaceous plants have been planted to provide benefits for wildlife. In most cases, the plants selected provide either food or cover—or both. Examples of the types of vegetation typically established and the benefits they provide to wildlife are listed in Table 3.



Wild bergamot

Black-eyed Susan

TABLE 3 - *Types of plantings for wildlife*

Plant Type	Examples	Examples of wildlife benefits
Evergreens, conifers	*white pine* *eastern hemlock* *rhododendron*	• *thermal cover for ruffed grouse* • *nest sites for mourning dove* • *food for red squirrel*
Nut trees	*oak* *hickory* *beech*	• *food for wood duck, ruffed grouse, wild turkey, blue jay, black bear, eastern chipmunk, squirrels, white-tailed deer*
Fruiting trees, shrubs, and vines	*black cherry* *elderberry* *blackberry* *dogwood* *grape vine*	• *food for wild turkey, gray catbird, cedar waxwing, many songbirds, black bear, gray fox, white-tailed deer, and small mammals*
Cool-season grasses and legumes	*Kentucky blue-grass* *orchard grass* *red clover* *white Dutch clover* *birdsfoot trefoil*	• *insects for poults of ruffed grouse, wild turkey* • *food for meadow vole, eastern cottontail, white-tailed deer* • *nest sites for field sparrow, song sparrow, meadow vole* • *hunting sites for hawks, owls, foxes, snakes*
Warm-season grasses	*switchgrass* *big bluestem* *little bluestem* *indiangrass* *side oats grama*	• *nesting cover for upland game birds, waterfowl, and ground nesting songbirds* • *foraging cover for upland game birds, waterfowl, songbirds, eastern cottontail* • *food (seeds) for songbirds* • *winter cover for game birds, waterfowl, cottontail rabbits*
Wildflowers, forbs	*cardinal flower* *New England aster* *beebalm* *joe-pye weed* *columbine*	• *nectar for butterflies, moths, bees, hummingbirds* • *seeds for songbirds* • *forage for white-tailed deer*

Fencing and tree shelters

When trying to establish new plants for wildlife, it is sometimes necessary to protect plants from browsing and other damage until the plants are well established. Wildlife species in Pennsylvania that may damage young plants include meadow voles, cottontail rabbits, and white-tailed deer. Meadow voles and cottontails girdle (chew the bark and cambium layer off the stem near the bottom of the plant) woody-stemmed plants while deer browse seedlings, shrubs, and stump sprouts. In agricultural areas, livestock may browse or trample young plants. Consequently, fencing or seedling protectors may be necessary to protect naturally regenerating or newly planted trees and shrubs. Fencing is also used to exclude livestock from streams and wetlands (see ***Stream bank fencing,*** p. 8).

There are a variety of fence types, including woven wire, high-tensile strength, and electric fences, used to protect seedlings. There are also a number of commercially available tree shelters. These shelters are tall plastic tubes (usually made of polypropylene) and are used to protect seedlings from animal browsing. They may, in some cases, accelerate seedling growth by creating a "greenhouse effect" around the seedling. The use of tree shelters is a relatively new method of seedling establishment and the long-term benefits of use have yet to be determined. One of the initial problems found with tree shelters was that songbirds like eastern bluebirds and house wrens fly inside of them (probably to feed on insects), but cannot open their wings to fly out and then die within the tubes. Because of this, it is necessary to cover the top of the tubes with bird-excluder nets. Apart from commercially available tree shelters, some landowners create their own seedling protectors from galvanized fencing. These protectors are simply mini-fences and can be custom made for single plants or groups of plants. All of these methods for protecting plants from damage by wildlife or livestock can be used on naturally occurring vegetation as well as newly planted stock.

Forest edge improvement

Many species of wildlife use edge habitat for nesting, feeding, and traveling. The main goal of forest edge improvement is to increase available food and cover along a forest edge by providing a variety of vegetation types and layers, from the shortest herbaceous vegetation to the tallest trees. Multiple layers present in vegetation provide more places where wildlife can feed and find nesting, resting, or escape cover. In addition, current research suggests that the nesting success of birds is greater along "complex" edges with multiple layers of vegetation than along "simple" edges with fewer layers of vegetation.

Fox

Edges between forests and fields are used by both species that are typically found within the forest and also by species typically found in fields. For example, the black-capped chickadee, a forest species, may nest along forest edges with the field sparrow, a species typically found in field habitat. In addition, "edge specialists," such as the indigo bunting, are typically present along forest edges because it is their primary habitat. Other species like the wild turkey, eastern cottontail, or white-tailed deer may feed along a forest edge because they are able to quickly retreat into the forest for safety. Predators like the red fox or long-tailed weasel may be attracted to forest edges because an abundance of prey may be found there.

A number of methods to enhance forest edge habitat are described in this directory, including planting, letting natural succession occur, and cutting. Adding brush piles and nest boxes will also add habitat components along an edge. The result of forest edge improvement work should be a wider edge habitat that provides a gradual transition from the shorter vegetation in the adjacent habitat to the tallest trees in the forest, while providing food and cover for a variety of wildlife species.

Herbaceous forest openings

Herbaceous forest openings are openings in the forest canopy where enough sunlight reaches the forest floor to support herbaceous vegetation. Herbaceous openings can be of varying size and shape. They provide food, nest sites, and cover for selected species of wildlife. Fields, orchards, haul roads, log landings, utility right-of-ways, or openings created within a forested area may all function as herbaceous openings that provide wildlife habitat. Wildlife species that benefit from herbaceous openings are listed in Table 4. Please note that although herbaceous openings in a forest provide many benefits to a number of species, there are times when creating a forest opening can be detrimental to species that require large unbroken expanses of forest (e.g., the pileated woodpecker, northern goshawk, some neotropical migratory songbirds, and amphibians). Trade-offs between benefits and detriments should be carefully considered before creating new openings.

Wild turkey and poults

TABLE 4 - *Wildlife species that may benefit from herbaceous forest openings*

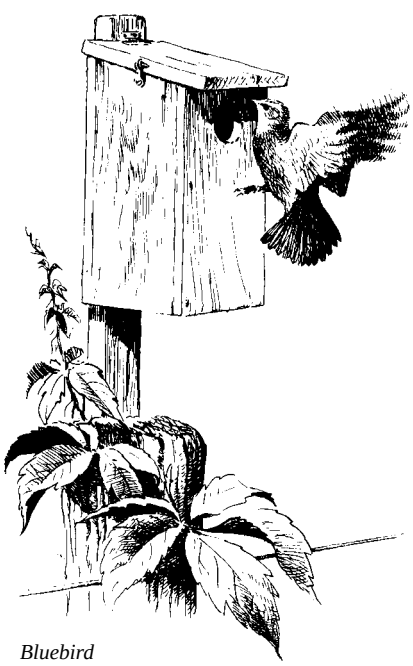
Species	Season *	Use
Reptiles		
Black snake	*Sp, S, F*	*hunting*
Black racer	*Sp, S, F*	*hunting*
Raptors		
Great-horned owl	*Sp, S, F, W*	*hunting*
Cooper's hawk	*Sp, S, F, W*	*hunting*
Red-shouldered hawk	*Sp, S*	*hunting*
Broad-winged hawk	*Sp, S*	*hunting*
Barred owl	*Sp, S, F, W*	*hunting*
Game Birds		
Wild turkey	*Sp, S, F*	*displaying, feeding, cover*
Ruffed grouse	*Sp, S, F*	*feeding, cover*
Woodcock	*Sp, S*	*displaying, feeding, nesting*
Bobwhite quail	*Sp, S, F*	*feeding, cover*

Species	Season	Use
Songbirds		
Eastern bluebird	*Sp, S*	*feeding*
Indigo bunting	*Sp, S*	*nesting (along edge)*
Rufous-sided towhee	*Sp, S*	*nesting (along edge)*
Field sparrow	*Sp, S*	*nesting*
Song sparrow	*Sp, S*	*nesting*
Mammals		
Eastern cottontail	*Sp, S, F, W*	*feeding, nesting, cover*
Meadow vole	*Sp, S, F, W*	*feeding, nesting, cover*
Woodchuck	*Sp, S, F, W*	*feeding*
Gray fox	*Sp, S, F, W*	*hunting*
Red fox	*Sp, S, F, W*	*hunting*
Bobcat	*Sp, S, F, W*	*hunting*
White-tailed deer	*Sp, S, F, W*	*feeding, cover*

** Sp = Spring F = Fall S = Summer W = Winter*

Nest boxes and other nesting structures

One of the most popular ways to improve habitat for wildlife is to provide nest boxes or structures. Nest boxes, platforms, and other types of nesting structures provide nest sites for wildlife in areas where natural nest sites (particularly cavities) are absent or available only in low numbers. They are also used to attract wildlife to specific areas even when nest sites are not limited.



Bluebird

In Pennsylvania, nest boxes are commonly used to provide nest sites for birds such as bluebirds, tree swallows, wrens, and wood ducks. Nest boxes also provide nest sites for mammals like squirrels and bats. Platforms and other structures are used to provide nest sites for species like the eastern phoebe, barn swallow, and some waterfowl.

Releasing trees and shrubs

A tree and shrub release is a technique used to enhance the growth of specific species, individuals, or groups of plants so that they produce more food or cover for wildlife. Releasing a plant involves removing other plants that are shading it and competing for sunlight. Most releases are "crown releases." However, in some cases, releasing roots from competition may also be used. Crowns of selected species are usually released from overhead shading on at least three sides to help increase growth. When a tree or shrub release is being considered to improve wildlife habitat, the trees and shrubs selected for release should be those that provide quality food or cover for wildlife, such as fruiting shrubs.

The wildlife species that will benefit from a tree or shrub release will depend on the wildlife species present on the property and the types of trees and shrubs selected for release (see Table 5). For example, releases can be planned to improve acorn production that will feed squirrels, deer, and turkey. Releasing can also increase evergreen cover for ruffed grouse and mourning doves, or develop vertical structure in an understory that will provide nesting and foraging sites for the wood thrush and other songbirds.

Releasing and pruning old fruit trees

Fruit trees provide food for a wide variety of Pennsylvania's wildlife. For example, white-tailed deer feed heavily on apples in the fall. Other animals that benefit from fruit trees include the black bear, songbirds, and small mammals. Also, as fruit decays on the ground, it creates an environment that is favorable for the presence of earthworms, which is why woodcock can sometimes be seen feeding under fruit trees.

On some properties, old, decadent fruit trees can be found in abandoned fields or young forests. Old fruit trees provide clues to past land use. The property may have been a farm and these fruit trees were part of an orchard or the backyard apple trees. Over time, as other trees grew and shaded these fruit trees, fruit production was greatly reduced. Fruit trees are often still viable, and with a little attention can be returned to fruit-producing condition. "Releasing" these trees may be necessary, especially if a young forest has grown over and around them. Fruit production is very dependent upon light. Removing other trees that are shading the fruit trees will help eliminate competition for sunlight.

TABLE 5 - *Benefits provided by a tree or shrub release*

If you release	you may benefit	by providing
Fruiting species	*songbirds*	*food, nest sites*
	small mammals	*food*
	black bear	*food*
	wild turkey	*food*
Nut-producing species	*small mammals*	*food*
	white-tailed deer	*food*
	ruffed grouse	*food*
	black bear	*food*
	blue jay	*food*
	gray squirrel	*food*
Understory shrubs	*songbirds*	*nest sites, food, cover*
	small mammals	*food, cover*
Evergreens	*ruffed grouse*	*winter thermal cover*
	mourning dove	*nest sites*
	black-capped chickadee	*food, cover*
	red squirrel	*food, cover, nest sites*

Spring seep management

Spring seeps are natural water sources where fresh water from below the ground flows to the surface to form small streams or small bodies of water. Spring seeps can be found in forests or fields, but are often located along hillsides or at the bases of mountains where groundwater flows to the surface. These areas usually have a small, year-round source of fresh water. Spring seeps provide a variety of important benefits for wildlife.

Spring seeps are particularly important during the winter when they may be the only source of fresh water and food. In the winter, groundwater is typically warmer (a constant 50 to 55 degrees Fahrenheit) than air and ground temperatures. Even during the coldest weather, seeps typically remain unfrozen with flowing water and support green vegetation at a time when herbaceous vegetation is scarce. During severe winters, when other sources of water are frozen for extended periods of time, spring seeps are used heavily by wildlife. In early spring, seeps are one of the first areas where vegetation grows. Thus, this food source is available at a critical time of year when most other food sources have been depleted.

During periods of deep snow, spring seeps also provide snow-free travel lanes where wildlife can move and feed. Birds and mammals benefit from the herbaceous vegetation that grows and persists around seeps in the winter when other food is scarce. Insects in and around the seeps provide a year-round source of high-protein food. Deer and small mammals find abundant sources of “browse” and other forage growing around seeps. Bears and other berry eaters benefit from fruit-producing species that grow well in moist conditions. Songbirds benefit from the fruit and insects around seeps, often finding nest sites in the dense vegetation surrounding the seep.

Amphibians and reptiles benefit from seeps that contain slow-moving water. Because most spring seeps do not support fish populations, amphibian eggs can develop without high losses to fish predation. Reptiles such as turtles benefit from the fresh spring water and soft mucky bottom of some seeps where they can bury themselves, seeking relief from very hot weather or hibernating during the winter months. Amphibians and reptiles also benefit from the plant and insect food available around seeps.

The most important management practice for spring seeps is to protect them from any activities that could degrade the seep, such as clear-cutting beside the seep or agricultural pollution. Options for enhancing the habitat associated with a spring seep include releasing or planting beneficial trees and shrubs around the seep and encouraging the growth of herbaceous vegetation around the seep’s perimeter.

Stream bank fencing

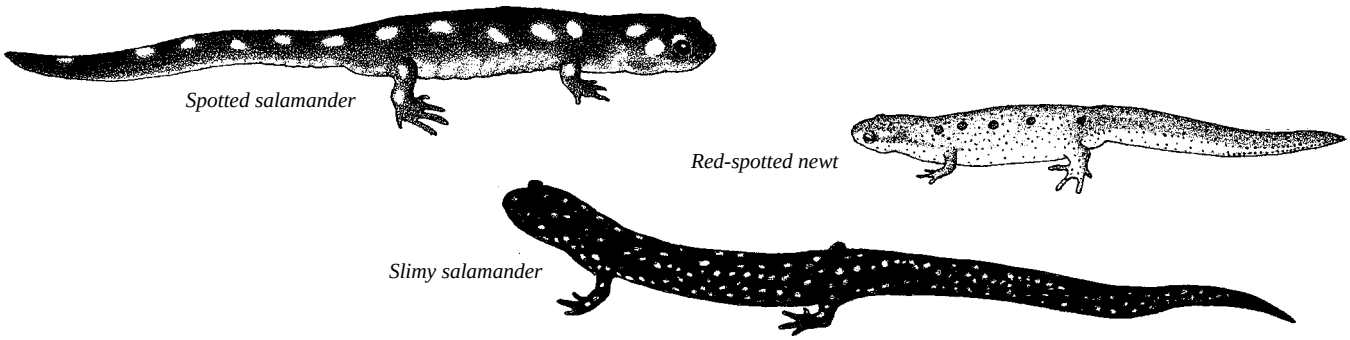
Livestock with free access to streams destroy wildlife and fish habitat, increase erosion and sedimentation, and degrade water quality. Stream bank fencing excludes livestock from sensitive riparian areas. After livestock are excluded, a buffer zone of vegetation grows between the stream and the fence. This new riparian streamside vegetation provides food, cover, and nesting sites for birds and small mammals. Over 80 kinds of birds, including herons, egrets, bluebirds, belted kingfishers, mallards, and pheasants, use streamside vegetation for summer feeding and nesting. Streamside vegetation improves fish habitat by enhancing water quality, providing protective cover, and increasing available food for fish. Stabilized stream crossings provide limited areas where livestock can have access to the stream for drinking and/or crossing the stream.

Temporary pools

Temporary pools are wetland habitats that fill with water during a rainy season and then dry up later in the year. Most people consider temporary pools to be synonymous with vernal pools. “Vernal” means “of, relating to, or occurring in the spring,” and these pools fill with water in the spring and dry up in the late summer or early fall. However, there are also autumnal pools, which fill with water in autumn. Temporary pools are found where small depressions and swales collect runoff or intercept seasonally high water tables.

Although the water supply from these pools is temporary, it is critical because temporary pools are the breeding and hibernating grounds for amphibians like red spotted newts and spring peepers. Temporary pools do not support fish populations so amphibian eggs can develop without high losses to fish predation. These special circumstances make temporary pools essential for the survival of many amphibian populations. Ecologically, amphibians are both predators that prey on small invertebrates and prey contributing to the survival of many other predators. Since the late 1970s, scientists around the world have been reporting disturbing declines in amphibian populations. This decline makes conservation of temporary pool habitats increasingly important. In addition to providing breeding and hibernating habitat for amphibians, temporary pools also support a complex web of interactions between a variety of organisms that include aquatic insects, salamanders, frogs, turtles, snakes, large and small mammals, waterfowl, and songbirds.

The best way for landowners to provide temporary pools for wildlife is to protect any existing pools from destruction. Many temporary pools have been destroyed during development and other land-use changes. (Unfortunately, temporary pools are difficult to identify during the dry season, and



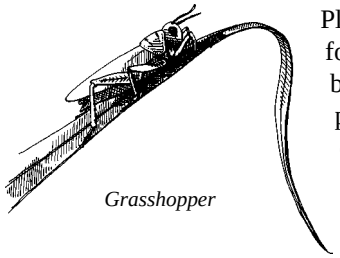
many people don't realize the value of what looks to them like a mud hole.) Temporary pools should be protected from destruction because of the important function they serve within a larger habitat area. Usually, restricting any potentially degrading activities around a temporary pool is all that is necessary to maintain the pool's healthy environment.

Some successful attempts have been made to create temporary pools for wildlife. These newly created temporary pools may help offset some of the losses of natural temporary pools. However, temporary pool creation requires special circumstances that do not exist on all properties.

Warm-season grasses

Native warm-season grasses are prairie grasses that were present when our ancestors settled what was to become the Commonwealth of Pennsylvania. The four main grasses of tall-grass prairie habitat are switchgrass, big bluestem, little bluestem, and indiangrass. Warm-season grasses, also known as "bunch grasses," grow in thick bunches instead of forming mats like many other grasses. These dense bunches of grass interspersed with open spaces between the bunches provide valuable nesting and foraging cover for upland game birds such as turkeys and pheasants, various waterfowl, and other ground-nesting grassland species like savannah sparrows.

Some warm-season grasses may grow to a height of over 6 feet. Because of their growth form and height, these grasses provide excellent cover for wildlife, especially upland game birds and waterfowl. Cottontail rabbits benefit from both the cover and forage produced by warm-season grasses, and many songbirds feed on the small seeds of the plants. Probably one of the most important benefits of warm-season grasses is that, if left uncut, they remain upright throughout the winter, providing valuable cover for many animals at a time of year when most other plants have died or are dormant.


Grasshopper

Planting warm-season grasses for wildlife has recently become a very popular practice due to the high-quality habitat that is provided by a stand of warm-season grasses.

Establishing warm-season grasses requires more patience than effort. After planting, it may take from one to four years for a full stand of grasses to develop.

Because this is a rather recent habitat management practice in Pennsylvania, new information about establishing these grasses is being learned every day. Consequently, if you are interested in establishing warm-season grasses for wildlife, it is best to talk with someone who has planted some themselves before proceeding. There are some very successful methods being implemented throughout Pennsylvania; learning about them will give you first-hand knowledge of what methods might work best on your land.

Wetland restoration

The wetland restoration program in Pennsylvania was initiated by the U.S. Fish and Wildlife Service's Partners for Wildlife Program. Wetland restorations are done on lands that were previously drained (sometimes to make cropland) and which are then restored to their natural state as a wetland by removing the tiles or plugging the ditches that drain them. The resulting wetlands vary in size and usually have an area of open water with emergent wetland vegetation growing around the perimeter of the water. These wetlands provide breeding, nesting, and feeding habitat for amphibians, waterfowl, shorebirds, and songbirds. They are essential "stop-over," resting, and feeding places for migrating species. The excellent cover offered by the prolific growth of vegetation around wetland habitats also provides food and cover for species like the beaver, muskrat, cottontail rabbit, and white-tailed deer. Animals that rely on wetland habitats, as well as animals that are generally considered upland species, benefit from restored wetland sites. Wetlands help to reduce erosion and flooding, also purifying our water supplies by filtering pollutants and sediments out of the water.

For more information about the wetland restoration program, contact your local NRCS office or call the U.S. Fish and Wildlife Service office in State College, Pennsylvania, at (814) 234-4090.

Wildlife corridors

A wildlife corridor is a habitat "patch" that connects two or more areas of undeveloped habitat that are isolated from one another. There are essentially two major types of wildlife corridors, but other areas can mimic these two types on a very local scale.

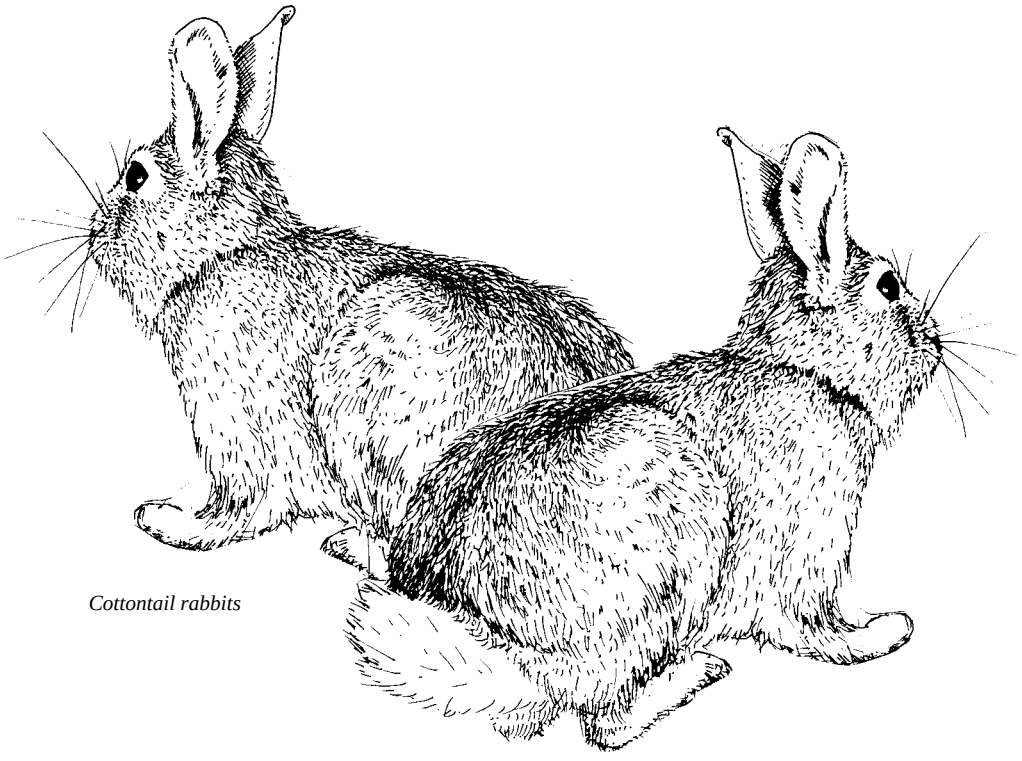
The first type is a corridor that exists on a landscape scale. An example of a landscape-scale corridor is a forested ridge top that connects, like a "bridge" of wilderness, between two or more habitats that are great distances apart. Corridors that are present on the landscape level are generally thought to be serving a connective function, benefiting species that require large expanses of undeveloped habitat because they have large home ranges, disperse over great distances, or need to travel great distances to find mates.

A second type of corridor exists on a smaller scale, usually on a local level, generally connecting two isolated habitats that are not necessarily separated by large distances. In agricultural areas, these types of corridors are often called fencerows or hedgerows. These "strip habitats" provide food and cover for wildlife. If the hedgerow connects two habitats, such as two woodlots on a farm, it may be used as a travel route between the woodlots by some species. This type of corridor can be added to a property, providing additional habitat and potential travel lanes for wildlife.

Another type of wildlife corridor that occurs on a local scale is the buffer strip of vegetation along a stream or river that varies in width. Depending on the length and width of the buffer strip, these areas may function as travel corridors in addition to providing wildlife with valuable food and cover.

Connective corridors established by habitat management practices in Pennsylvania will most likely be wooded patches of habitat that connect two isolated forests or woodlots and will provide additional food and cover for wildlife. Changes in land-use often result in the fragmentation of wildlife habitats, and habitat patches like forests become smaller and more isolated. Perhaps the best reason to plant corridors is that the original landscape was interconnected. New corridors would re-establish some of those past connections. Corridors can also function as a habitat patch, providing wildlife with food and cover whether the animal lives in the corridor or just travels through.

The species of wildlife that will benefit from wildlife corridors in Pennsylvania will depend on what plants and other habitat components exist in the corridor, where it is located, and what species of wildlife are present in the adjacent habitat. Small mammals, such as the gray squirrel and eastern cottontail, and songbirds like song sparrows and gray catbirds are some of the species that may use wildlife corridors for feeding, nesting, or movement.



Cottontail rabbits

The fact sheet series *Pennsylvania Wildlife*, available from all county extension offices, provides additional information on Pennsylvania wildlife and specific habitat management practices. If you are interested in visiting sites where wildlife management practices have been implemented, obtain a copy of *Enhancing Wildlife Habitat: A Directory of Wildlife Habitat Enhancement Demonstration Sites in Pennsylvania* from your local county extension office. The directory includes descriptions of and directions to demonstrations sites across Pennsylvania where wildlife habitat enhancement practices have been implemented.

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TEXAS PARKS AND WILDLIFE

WILDLIFE MANAGEMENT ACTIVITIES AND PRACTICES

COMPREHENSIVE WILDLIFE MANAGEMENT PLANNING GUIDELINES

for the

Post Oak Savannah
And
Blackland Prairie Ecological Regions

Revised
July 2007

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TEXAS PARKS & WILDLIFE

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COMPREHENSIVE WILDLIFE MANAGEMENT PLANNING GUIDELINES
for the
Post Oak Savannah and Blackland Prairie Ecological Regions

(Prepared in partial fulfillment of the requirements of HB 1358 - Wildlife Management Property Tax Valuation and HB3123 - relating to the standards for determining whether land qualifies for appraisal for ad valorem tax purposes as open-space land based on its use for wildlife management.)

Introduction

The Texas Constitution and the legislature provides those landowners with a current 1-d-1 Agricultural Valuation (often known as an Ag Exemption) an opportunity to change from a traditional qualifying agricultural practice to wildlife management as a qualifying agricultural practice while maintaining the current valuation. HB 1358 by Representative Clyde Alexander provided that the landowner must implement and complete at least one management practice from at least three of the seven wildlife management activities listed in **Appendix A**. Most landowners interested in wildlife can meet this requirement, and implement several practices beyond the minimum required.

The 2001 legislative session passed HB3123, co-sponsored by Representative Bob Turner and Representative Clyde Alexander. This bill provided for further clarification of the standards required for determining whether land qualifies for appraisal as open-space land based on wildlife management. As a result of HB3123, more uniform standards of qualifying for wildlife management have been applied statewide.

Wildlife Management Tax Valuation

Land that qualifies for an agricultural valuation is appraised on its productivity value rather than on its market value. While many people refer to such land as having an “ag exemption”, in fact there is no such exemption—it is just a different method of calculating the land’s value for ad valorem tax purposes. Correctly speaking such land has an agricultural valuation.

Under Texas law, wildlife management is legally nothing more than an additional qualifying agricultural practice people may choose from in order to maintain the agricultural valuation on their land. Just as there is no real ag “exemption”, there also is no wildlife “exemption”. Wildlife management is not an additional appraisal, nor is it separate from “traditional” agriculture. For ad valorem tax purposes wildlife management is agriculture. There is no change in the ad valorem tax valuation with wildlife management, only a change in the qualifying agricultural practice.

Acreage Requirements

There are no minimum acreage requirements unless the landowner has purchased or otherwise acquired property that since the previous tax year has also been partitioned out of a larger agriculturally qualified tract. Only when a change in both ownership and tract size occur do minimum acreage requirements apply.

Landowners acquiring property that has been partitioned out of a larger qualifying tract since the previous tax year need to be certain that the property will meet the minimum size as set by the county. Refer to **Appendix B** for the maximum and minimum acreages by region, and to your county Central Appraisal District office for the minimum acreage size adopted. It is important to

note that regardless of the property size, it must still be appraised for open-space use before it is eligible to change over to wildlife management use.

When a qualifying tract of land is broken into smaller tracts and sold, the standards for minimum eligible tract size take effect. These sizes are determined by location within the state. Within each area, the county has the ability to choose within a specified range the minimum qualifying acreage. Tracts below this minimum size are not eligible to manage for wildlife as their agricultural practice for ad valorem tax purposes. The exception is for landowners who are buying property in a Wildlife Management Property Owners' Association. Wildlife management property owners associations are community developments similar to wildlife management co-ops, but differ in that each person buying into the neighborhood must make a legal commitment to practice a certain level of wildlife management. Deed restrictions, conservation easements, property owner agreements, or other legally binding covenants insure that the habitat for wildlife is protected and managed in exchange for landowners being able to maintain an agricultural valuation based on wildlife management. If such legally binding covenants exist, the county may set a 1% or 2% lower minimum acreage requirement.

These same lower minimum acreages also apply to landowners who have habitat for threatened or endangered species, or a species of concern. While the actual presence of the species on the property is not required, a qualified wildlife professional must verify that the habitat for the species does in fact exist on the property before this exception is granted by the county.

Although landowners with smaller tracts of land are encouraged to work cooperatively with their neighbors for some wildlife management practices, such as conducting a population census, each landowner must also individually be doing three practices of an appropriate intensity level on their property, submit their own individual wildlife management plan and be able to qualify on their own.

The Wildlife Management Plan

This guide is intended to provide landowners with information to develop their own plans. The plan may be as simple or as extensive as the landowner chooses. The practices described in this guide are intended only as guidelines. Certain site-specific situations may necessitate changes that can be allowed, if based on trained resource professionals' recommendations.

All landowners are required to develop and submit a wildlife management plan to the county Central Appraisal District along with their 1-d-1 Open Space Appraisal Application. All wildlife management plans must be on the form provided by Texas Parks & Wildlife Department. This form, PWD 885-W7000, is included in **Appendix U.**

While a comprehensive and highly detailed written wildlife management plan as described in these guidelines is not required by the county, it is highly recommended that the landowner go through this lengthier exercise and use this lengthier plan as a guide when filling out the required PWD 885-W7000 wildlife management plan form. The plan must address a separate practice in at least three of the seven wildlife management categories.

A wildlife management plan describes historic and current land use practices, establishes

landowner goals and objectives (also family goals if desired) for the property, and describes specific activities and practices designed to benefit wildlife species of interest and their habitats. **This is the landowner's plan**, designed by the landowner, with the possible assistance of a wildlife biologist of the Texas Parks and Wildlife Department [TPWD], Texas Agricultural Extension Service [TCE], USDA Natural Resource Conservation Service [NRCS, formerly Soil Conservation Service - SCS], Texas Forest Service [TFS], or other qualified wildlife biologist. Efforts to perform activities identified in the plan are completely voluntary on the part of the landowner, except those practices that are necessary to maintain the agricultural appraisal for wildlife management use.

A complete plan will likely include elements of all seven listed wildlife management activity categories. While Texas Parks and Wildlife Department biologists are available to assist landowners in developing a wildlife management plan for ad valorem tax purposes, it should be noted that the Department's participation is not required in order for the wildlife management plan to be valid.

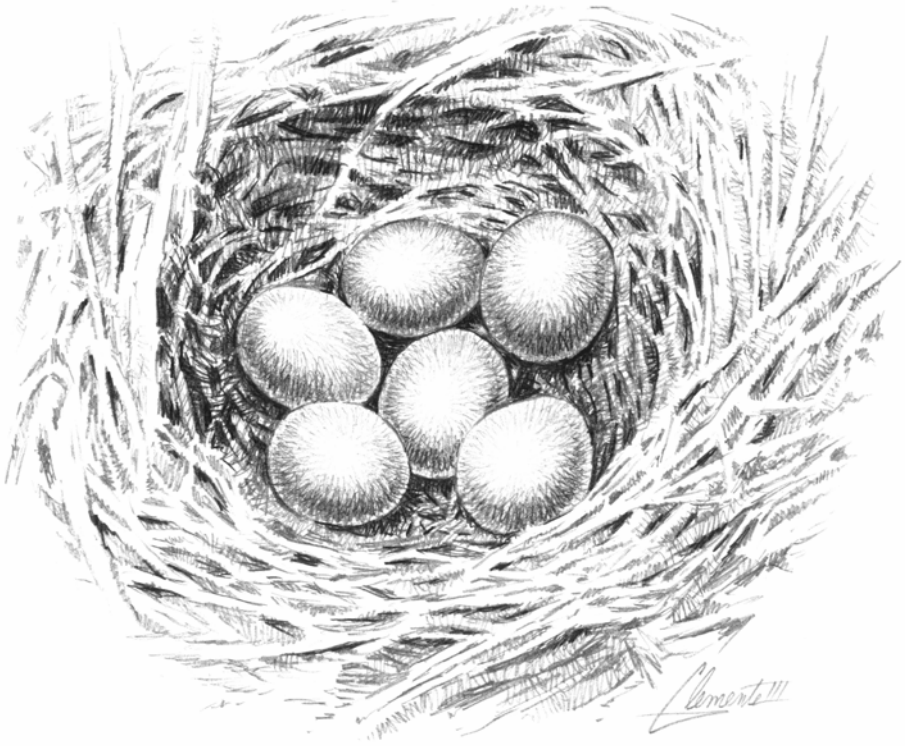
What Paperwork to File

All paperwork for changing the land's qualifying agricultural practice over to wildlife management must be filed with the Chief Appraiser at the county's Central Appraisal District. No paperwork is required to be filed with Texas Parks and Wildlife Department. Landowners will need to complete a 1-d-1 Open Space Appraisal Application available from their Central Appraisal District and attach to it the completed PWD 885-W7000 wildlife management plan that is included in **Appendix U.**

With 95% of Texas privately owned, the wildlife that belongs to the people of Texas depends on private landowners to voluntarily provide them with quality habitat.

Habitat Control

Grazing Management
Prescribed Burning
Range Enhancement
Brush Management
Timber Management
Riparian Management and Enhancement
Wetland Enhancement
Habitat Protection for Species of Concern
Prescribed Control of Native, Exotic, and Feral Species
Wildlife Restoration



HABITAT CONTROL (HABITAT MANAGEMENT)

Introduction

Habitat is defined as the physical and biological surroundings of an organism and provides everything that a living organism needs to survive and reproduce. The three basic requirements of any wildlife species to survive and reproduce are food, water, and shelter. Quite frequently, we as land managers tend to focus on a specific wildlife species and its needs as opposed to the habitat or community in which they live. The key to managing wildlife and our natural resources is to use a holistic approach and promote healthy ecosystems. Single species deserve less attention, while the system in which they thrive requires more. Knowing how a system functions, and applying the techniques with which that system developed is imperative for its continued health and existence.

Ecosystems are dynamic and continuously changing. Succession is the change in plant species composition and structure over time and it is succession that we as land managers are trying to manipulate. Generally the earlier the successional stage the greater the plant diversity and the greater the number of wildlife species that are benefited. This is not to say that some species are not dependant on later successional stages or even several stages, managing for a diversity is important. Maintaining a variety of habitat types, while at the same time promoting plant diversity in both species composition and structure within each habitat type, should be the goal of all good wildlife management programs.

Aldo Leopold, who is known as the “Father of Modern Wildlife Management”, authored a book in 1933 titled *Game Management.* In this textbook Leopold wrote "...game can be restored by the *creative use* of the same tools which have heretofore destroyed it - ax, plow, cow, fire, and gun". Habitat control or habitat management, as it is most often referred, is the active application of these “tools” to the land in order to promote land health and enhanced availability of the 3 basic requirements to all wildlife species. It is very important that land managers today understand basic ecological principles of plant succession; plant growth; food chains; and water, mineral and soil nutritive cycles as they affect range, wildlife, and grazing management. This not only produces high quality habitat and animals, but also can lead to more stable conditions during stress periods such as droughts and winter.

Grazing Management

People often view grazing livestock as being incompatible with managing for wildlife. Although this can be the case, when properly utilized grazing can be beneficial to wildlife habitat. Focusing on good land management as opposed to strictly livestock production allows a landowner to adjust the presence or absence of livestock as well as a grazing time and intensity level that is beneficial for both plant health and diversity.

Grasses evolved with grazing pressure. Historically great herds of bison roamed the central part of the United States and stayed constantly on the move in search of new forage and in front of predators. Bison came into an area, grazed it down, and left. Herds were never in any given area for an extended length of

time. Sheer numbers of bison in the herd did not allow the animals to be selective about plants that were bitten; animals were forced to eat every palatable plant in an area. This type of grazing did several things to sustain a diverse mid- and tall-grass plant community. The intense pressure left a lot of tilled and well fertilized soil, it decreased the overall quantity of grass, allowing sunlight to reach the lower growing forbs (weeds & wildflowers), and allowed those grasses with deeper root systems to respond quicker, during the absence of bison, than those with shallower root systems. While intense for a short time period, this type of grazing provided long rest periods of the range, allowing for rapid responses of annual forbs and grasses. The final result was more plant diversity and more wildlife foods. Bison opened stands of dense grasses, providing more food for deer, turkey, quail, prairie chicken, and songbirds. Without grazing pressure neither the grasses nor the forbs respond the same. The diversity as well as the health of the system is diminished. Undoubtedly, bison were a major force that shaped the ecosystem.

European man brought with him his own form of agriculture and the range appeared unlimited in its ability to support a great number and variety of livestock (cattle, sheep, goats, oxen, hogs, and horses). The demise of the bison and changes in land use patterns eventually brought fences and livestock were increasingly grazed in pastures with limited or no rest periods. Forage availability and production is dependant on stocking rates, rest, and rainfall. Sedentary grazing or limited rotation grazing with even average stocking rates and rainfall can create severely abused and overgrazed range. Grasses are continually grazed beginning with the most palatable first and on down the line until the plant community is primarily less desirable shallow rooted grasses and a few undesirable forbs. Overall plant diversity decreases. An abused range lacks adequate groundcover and available browse to support healthy livestock and wildlife populations. Overgrazing with domestic livestock causes problems in managing for healthy ecosystems.

Good grazing management starts with the basics: 1) the kind and class of livestock grazed 2) stocking rate or intensity 3) duration of grazing to provide rest periods for the pastures and 4) excluding livestock from sensitive areas to promote vegetation protection and/or recovery.

In an ideal program the goal is high intensity short duration. The stocking rate is such that every plant should be bitten off once during each grazed period or rotation. Sedentary grazing allows plants to be bitten over and over starting with the most palatable first. The less desirables keep growing while the more palatable ones continue to get bitten. This can result in a pasture being underutilized, but still overgrazed and eventually the removal of your most desirable species. Having enough animals to bite the plants only once means livestock can only stay in one place for a short period of time before they have to be moved to another pasture. High intensity short duration grazing requires a number of pastures within the grazing system to allow for extended rest periods.

High intensity short duration grazing systems allow livestock to act as a tool to manipulate and enhance wildlife habitat and plant diversity as the bison did historically in our grassland and savannah ecosystems. There are a number of variations of this system, finding one that you are able to implement on your property is the key. If it is unrealistic to divide a property into enough small pastures to both sufficiently graze and rest the range, a small landowner may want to contact neighbors to pool property and allow each property to serve as a pasture in a grazing rotation. Properties without these options may have to use prescribed burning and/or mowing to achieve some of the results and benefits of grazing.

For additional information see Appendix D. Contact the Texas Parks and Wildlife Department's Kerr Wildlife Management Area at 830-238-4483 or write to Kerr WMA, 2625 FM 1340, Hunt, TX 78024 to schedule a visit and see the effects of both grazing systems and "over-rest" situations.

Prescribed Burning

Bison were not the only major force shaping the system in which pronghorn antelope, black bear, wolf, white-tailed deer, turkey, quail, and prairie chicken thrived historically. Fires, natural and man-made, played an integral role in managing that system. Fire is a natural ecological factor to which native vegetation is well adapted. Since the 1850s, man has suppressed fire, and the grasslands and savannahs that were once dotted with occasional mottes of trees and forests only along drainage systems are now dominated by brush and woodlands. Europeans suppressed fire to prevent damage to wooden structures, farmlands, fences, and grazing lands. In turn this eliminated or reduced the role that fire played in maintaining ecosystems that were dominated by herbaceous vegetation.

Prescribed burning is the planned application of fire to set back succession. It improves habitat and plant diversity and returns nutrients to the soil. Burning can improve accessibility, increase both quantity and quality of forage and browse production, suppress brush and cactus, improve grazing distribution of livestock and wildlife, and remove excessive mulch and debris. Prescribed burning is a tool used to maintain desired vegetation composition and structure.

Achieving a management objective requires a particular set of conditions for burning and a specific type of fire or burn prescription. A burn prescription defines the range of conditions and factors under which a fire boss will light a fire to meet these specific objectives. Factors that influence the type of fire and its intensity include time of the year, fuel quantity and moisture, air temperature, humidity, soil moisture, wind speed, geographic area, and direction of the flame front movement in relation to the wind. Generally summer fires are hotter type fires and fall-spring fires are cooler burning fires. As fuel quantity goes up and fuel moisture goes down the higher the intensity of the fire. The same goes for the higher the wind speed and air temperature and the lower the humidity and soil moisture, the hotter the fire. Fire set to move in the same direction as the wind is a headfire and fire set to move against the wind is a backfire. Headfires burn hotter than backfires.

The plant response after a fire is influenced by fire intensity, plant condition at the time of the burn as well as weather conditions and grazing management practices following the burn. For example forbs are prolific seed producers and valuable resource for white-tailed deer and other wildlife species. Forb seedlings are highly susceptible to fire, and a late winter burn after annuals have germinated may reduce forb production for the following growing season. A winter burn used to target certain evergreen trees or shrubs, such as Ashe juniper (cedar) or

yaupon holly, is less likely to harm deciduous trees, such as oaks, than a late summer fire used to target the same species. Burned pastures can be grazed immediately to reduce grasses that compete with forbs or to make use of now palatable prickly pear, then deferred to allow the pasture to rest. Whitetail and exotic wildlife numbers may have to be reduced prior to burning to allow time for preferred plants to reestablish following the burn.

A successful prescribed burn includes 3 basic steps: 1) develop a burn plan which should include management goals and objectives, burn prescription, safety plan, description and map of the burn unit, smoke management, legal requirements, contacts and notifications, control and firing plan, and evaluation 2) a safe and effective execution of the burn on the planned site and 3) good range, livestock, and wildlife management to maximize the effects of the burn. Inexperienced managers should ask for assistance and/or advice from agencies such as Texas Parks & Wildlife or the Natural Resources Conservation Service. While instructional materials are available, it is suggested that the novice assist on a burn conducted by an experienced person before attempting a prescribed burn.

For additional information contact the Texas Parks and Wildlife Department's Kerr Wildlife Management Area at 830-238-4483 or write to: Kerr WMA, 2625 FM 1340, Hunt, TX 78024 to schedule a visit and see the effects of a good prescribed burn program.

Range Enhancement

Mismanagement and overgrazing can lead to abused rangeland. Continuous over-utilization by livestock and/or white-tailed deer and exotics can remove certain desirable and highly palatable plants from a system. Past land use practices such as mechanical clearing or farming may cause some plants to become rare or even nonexistent on certain ranges. Range enhancement is the re-establishment or enhancement of plant communities with native grasses and forbs. These plants provide both food and cover for wildlife and help to meet the three basic requirements.

Seeding mixes should provide for maximum native plant diversity and should include many broadleaf plants which are important forage for wildlife and seed production. Range enhancement should include appropriate plants or seed mixtures as well as methods of application for the particular ecological region where the property is located. Non-native species are not recommended and should be used only in rare and very specific cases. Even then non-natives should not exceed 25% of the seeding mix.

Managing, restoring, and/or protecting native grass prairies is also considered range enhancement. This may or may not include actual reseeding but could include utilizing some of the "tools" to manage for the earlier successional stages of a native prairie. Grazing, burning, and mechanical disturbance (plow) are all options to manage and restore native prairie.

For additional information see Appendix E.

Brush Management

Historically bison and fire had a huge impact on plant communities and with the removal of these major influences plant communities changed. Without fire and a high intensity short duration type grazing regime plant communities began to see an increase in woody plant species and a change from grassland or savannah communities to more brushland or woodland habitat types. As brush continues to increase and begins to form closed canopies, cutting off sunlight to the area underneath, grass and forb production as well as overall diversity

decreases. Some woody species tend to increase at rates greater than others, such as ashe juniper, and can begin to dominate a system. Along with this domination come other changes that take place beyond what is realized by observation. Ashe juniper has had a tremendous impact on the ecosystem by causing an increase in soil erosion and significantly less water absorption. Cedar brakes lose a significant amount of precipitation through transpiration and overland flow, leaving much less water for aquifer recharge to insure adequate groundwater in the future.

As mentioned before a diversity in both plant composition and structure within differing habitat types is the key to successful wildlife management and an area that is dominated by any single type or species of plant is rarely going to meet the needs of even a single species of wildlife. Again, utilizing the "tools" that Leopold described is the key to managing your property and providing the adequate amount and arrangement of brush to meet the needs of a multitude of wildlife species.

While a good grazing management and prescribed burn program can reduce the need for brush management, the axe may be needed when a particular piece of property is beyond the point that utilizing other tools is realistic. The axe is rarely used in the 21st century when dealing with extensive brush or woody encroachment. Today chainsaws, herbicide and mechanical equipment such as bulldozers or tree shears take the place of the axe and serve to set back succession in more advanced stages.

Brush management is only part of a good habitat management program and should be planned carefully as to how it fits in with overall management goals. The primary principles that drive any good brush management program are: 1) extent 2) pattern 3) selection and 4) method. The extent to which brush is going to be cleared is the first step in developing a program. Overall goals of the property should be examined and can help to dictate the amount of clearing needed to meet wildlife, livestock and/or aesthetic expectations. Clearing 100% of the brush may be best from a livestock production standpoint but if your overall goal includes white-tailed deer management you may only want to clear 50%. Individual plant treatment may be all you need depending on the amount of brush you have. The pattern in which brush is cleared should consider wildlife cover and accessibility. This may include cover from predators, nesting cover, and loafing or roosting cover. Maintaining travel corridors that link sections of brush is also very important. Selection includes both the site and the species of brush to be cleared. The site of brush clearing is important to make sure and keep erosion to a minimum. Soil type and slope should be considered. Certain soils may also be selected for clearing because of better forage production. Also removal of desirable plant species should be kept to a minimum. The method is determined by total cost analysis, soil erosion issues, and the type or species of brush which is being targeted.

Timber Management

The forests of Texas are as diverse as the landscape itself. Much of the historic landscape was dominated by grasslands with occasional mottes or scattered groups of trees interspersed. Aside from the pine forests of East Texas, forested areas were generally restricted to bottomlands along major rivers and creeks, or in areas protected from fire. Settlers in East Texas discovered a vast forest comprised of a variety of both pine and hardwood species. Pines, for the most part, dominated the uplands while hardwoods dominated the bottomlands. Agricultural production, commercial timber production, and other changes in land management, including virtual elimination of fire, the forests of today are very different than those present during pre-settlement times.

Forest management may include establishing, maintaining, harvesting, selectively removing or suppressing trees or woody species to allow for the growth of desirable trees, shrubs, grasses, and forbs for forage and nesting or protective cover for a variety of wildlife species. Activities should focus on keeping the proper kind, amount, and distribution of woody cover for selected wildlife species as well as retaining snags for cavity nesters. Forested areas can be managed to produce wood fiber, while at the same time providing quality habitat for wildlife. Timber management strategies can be grouped into 2 categories, even-aged and uneven-aged.

Even-aged management is defined as the application of a combination of management actions, which results in a timber stand comprised of trees that are the same age. Harvest methods used to generate even-aged stands are clearcut, seed-tree, and shelterwood. A clearcut results in the removal of all merchantable timber and is usually followed by site preparation and planting. Both the seed-tree and shelterwood methods rely on natural regeneration. A seed-tree operation results in the removal of all merchantable timber, with the exception of a few, well-spaced high quality trees with good seed production that will be relied upon to regenerate the stand. Approximately 8-10 trees per acre may be retained for seed production. These seed-trees may be harvested after adequate regeneration has become established, or may be left indefinitely. The shelterwood method results in the removal of 40 to 60% of the merchantable timber. The residual trees are relied upon for seed production and seedlings become established in partial sunlight under the shelter of the residual trees. Similar to the seed-tree method, residual trees may be harvested after adequate regeneration has become established. Regardless of the method used, consideration should be given to the size, shape, and distribution of the harvest area prior to the final harvest operation.

Uneven-aged management is defined as the application of a combination of management actions that maintains several age-classes and tree sizes within a timber stand. In order to produce a sustained yield of forest products, uneven-aged management results in continuous canopy coverage, recurring regeneration of desirable species, and the orderly growth and development of trees in several diameter and age-classes. Regeneration is through natural methods. Under an uneven-aged management strategy, individual trees (single-tree selection) or small groups of trees (group selection) are selectively harvested every 5-10 years. An area properly managed under single-tree selection results in a forest that is comprised of evenly distributed large, medium, and small trees of various ages. This system requires the removal of trees of all ages and sizes in order to maintain a healthy stand. To prevent degradation of the stand, the application of this harvest strategy requires the expertise of a forester experienced in uneven-aged management. Diameter cutting (cutting all trees larger than a predetermined size, rather than using tree age as criteria) or "high-grading", can result in a stand comprised of inferior trees after a few cutting cycles and should be avoided.

During harvest, streamside management zones (SMZs), or a band of uncut timber, should be retained on each side of stream channels within the regeneration area. The SMZ should be a minimum width of 66 feet on each side of the channel. Along intermittent and perennial streams, widths of 100 feet or more are preferred. To provide maximum benefit to wildlife, these minimum widths should be extended to an identifiable natural break in topography (crest to crest), or to an area defined by the presence or absence of bottomland hardwoods. In addition to protecting water quality, these areas increase diversity, provide valuable mast production, and serve as wildlife travel corridors.

Effective habitat management often requires the availability and proper use of an array of

management "tools". Due to varying management objectives, no one tool, or in this case timber management system, is the most appropriate for every situation. Misuse of a timber management strategy can cause degradation of habitat quality. As with all land management practices, managers should develop well-defined objectives, and select and properly implement the strategy that is the most appropriate for their management needs.

Note: Property currently appraised with a timber valuation for ad valorem tax purposes does not qualify for conversion to wildlife management.

Riparian Management and Improvement

Riparian area refers to the low lying areas on either side of a stream course. Management or improvement of the vegetation in these areas helps to alleviate erosion and protect water quality. Much of our bottomland hardwood forests that existed historically have been cleared for agricultural production, degraded through improper timber harvest or other mismanagement, or flooded by the construction of flat water reservoirs. Bottomland hardwoods have been referred to as the single most important wildlife habitat type and provide a wealth of benefits for wildlife, erosion control, flood control, water quality, water retention, and ecosystem health. Managers should attempt to restore and/or manage these riparian areas that include bottomland hardwoods, bogs, mixed pine and hardwood forests, and natural wetlands to promote ecosystem health and diversity.

Riparian management and improvements can include providing alternate livestock watering sites, deferring livestock from riparian areas during critical periods, excluding livestock from pastures with riparian areas, herbaceous plantings or seeding in degraded riparian zones, or replanting previously cleared or degraded bottomland hardwoods. Attention should specifically be given to protection of turkey roosting areas and snag retention for cavity nesters. The creation of permanent SMZs, as mentioned above in forest management, is also a vital part of any management program where the property is involved in timber production.

Wetland Improvements

It has been estimated that Texas has lost 54% of its total wetland acreage in the last 200 years. Wetlands were at one time regarded as waste-lands and nothing more than breeding grounds for insects, pests, and disease; they were considered obstacles to progress and development and were readily converted to other land uses. It is only in the recent past that wetlands were recognized as some of the most ecologically important systems on earth. Wetlands are invaluable for their ability to prevent erosion, purify water, prevent and minimize flooding, and replenish groundwater resources. They provide humans with fossil fuels and food and wildlife with invaluable habitat. Managing, protecting, restoring, or creating wetland habitat plays an integral part in a successful wildlife program.

Texas wetlands may include swamps, bottomland hardwoods, marshes, bogs, springs, playa lakes, or saline lakes. They are found along rivers, streams, lakes, and ponds; in uplands where surface water collects and at points of groundwater discharge such as springs or seeps. Wetlands are characterized by 1) water or saturated soils for at least a portion of the year 2) plants that are adapted to wet environments (hydrophytic vegetation) and 3) soils that develop under depleted oxygen conditions (hydric soils). Managing for wetland improvement can involve any practice that enhances, restores, or creates these 3 characters. Setting back succession in an existing wetland by using the axe, cow, plow, or fire to ensure the integrity of the wetland plant community can be important to the production of wetland wildlife food sources. Closing a ditch that was once used to drain an existing wetland or creating a ditch or drilling a

water well to increase water flow into a wetland can be very important to maintaining the hydrology or flooding regime needed for that wetland to continue to function. Cleaning out a seep or spring which is experiencing reduced flow due to siltation can provide more permanent or seasonal water. And building a levee with water control structures to manage the water regime and provide water during the growing season and for fall and winter migrants can be an important habitat source for waterfowl or shorebirds.

The management options for wetlands are as diverse as the wetlands themselves. Where the opportunity exists, wetland management provides unique opportunities for habitat management that benefits a great diversity of wildlife and overall land health.

Habitat Protection for Species of Concern

New and changing land use practices and the exclusion of fire and high intensity short duration grazing by bison has had negative impacts on a number of wildlife species. Endangered, threatened, or rare wildlife species are a by product of endangered and rare habitat. Habitat protection includes managing or developing additional areas to increase nesting sites, feeding areas, and other critical habitat types to overcome limiting factors and meet the 3 basic needs of certain wildlife species.

Habitat protection as it is defined here can include setting aside critical areas of habitat, managing vegetation for a particular species, maintaining overstory vegetation from degradation, and annually monitoring the species of concern. Management for migrating, wintering, or breeding neotropical birds and should follow specific guidelines provided by the Texas Parks and Wildlife Department specific to your ecological region. Leopold wrote "...game can be restored by the *creative use* of the same tools which have heretofore destroyed it - ax, plow, cow, fire, and gun". Broadscale habitat management for nongame species, just as for game species, should include those practices that promote an increase in plant abundance and diversity in both composition and structure.

Contact the Texas Parks and Wildlife Department for approved management guidelines before implementing activities designed to protect or enhance habitat for endangered species. For additional information see Appendix I.

Prescribed Control of Native, Exotic, and Feral Species

The appearance of most Texas rangelands is very different today compared to 150 or 200 years ago. The expansive grasslands, which were dotted with an occasional motte of trees, are no more. Mid- and tallgrass communities have been replaced with shortgrass communities or even pastures of exotic grasses. The expansive native grasslands were replaced by brush and woodlands which in turn influenced the type and number of wildlife species that flourish. The Texas white-tailed deer population is at an all time high and many ranges support more exotic and feral species now than ever before. The changing land management practices, combined with grazing pressure of too many deer, exotics, and livestock have degraded the quality of wildlife habitat across the state. Over-utilized rangelands have poor plant diversity, are often dominated by exotic or lesser quality vegetation, and support poor wildlife diversity. There may be little or no groundcover to capture runoff, rain water is lost, and groundwater is not recharged. The whole system is suffering. Using the gun, as a tool, to manage populations at or below the carrying capacity of the range is essential in providing quality wildlife habitat for a multitude of wildlife species.

White-tailed deer have a high reproduction potential, and in the absence of natural predators, can quickly overpopulate a range. If white-tailed deer are allowed to overpopulate, they can have negative effects on the habitat. Deer consume the most palatable plant species first, and excessive browsing pressure can eliminate these preferred plant species from the range. This reduces plant diversity and has negative impacts on all wildlife species, not just white-tailed deer. Once a range is damaged by overgrazing, it can take years for a range to recover, even after deer numbers are reduced to an appropriate level. The most effective way to regulate deer numbers is through hunting. Hunting allows the land manager to maintain deer numbers at a level that the habitat can support without causing damage to the habitat. In addition to habitat damage, deer from overstocked ranges generally have poor fawn survival, low body weights, and poor antler quality. The most effective way to reduce deer numbers is through the harvest of doe deer at appropriate levels. Once deer numbers are at a desired level, doe harvest must be continued to maintain the population at a desirable level.

Each time a deer hunter chooses to shoot a deer, or not to shoot a deer, a management decision that will affect the future of that deer herd and habitat is made. For example, choosing to shoot, or not to shoot a doe, affects the sex ratio and reproductive potential of the herd. Choosing to shoot, or not to shoot, a yearling buck affects the current and future age structure of the buck population. Therefore, not only can the gun be used to manipulate deer numbers, it can also be used to manipulate sex ratios, reproductive potential, and age structure of the herd.

Exotic and feral species, that may include feral hogs or any number of exotic ungulates, compete directly with native wildlife species for available habitat. Population reduction or elimination of these non-native species will benefit your native wildlife management program (see Predator Control Activity for additional information on feral species).

In addition land managers should attempt to control or eradicate exotic vegetation that in many cases can dominate native habitats or in the least reduce overall vegetation diversity. Native vegetation, as opposed to introduced species, provides for better, more productive wildlife habitat. Removal of species such as chinaberry, Chinese tallow, weeping lovegrass, coastal bermuda grass, King Ranch bluestem, and Kleberg bluestem will reduce competition with native vegetation. Effective control of exotic vegetation is dependant on the species and the method used should be an accepted or proven practice in the ecological region where the property is located.

Wildlife Restoration

Wildlife restoration has experienced numerous success stories. These efforts have resulted in stable populations of beavers, wood ducks, and white-tailed deer. Without the aid of private landowners these successes would not have been possible. Landowners provide trapping sites for capture of the animals to be relocated, but more importantly they mange the habitat on which these animals are dependant. Wildlife restoration means restoring or improving habitat for targeted species as part of an overall reintroduction program in a Texas Parks and Wildlife Department approved restoration area.

Erosion Control

Pond Construction and Repair
Gully Shaping
Streamside, Pond, and Wetland Revegetation
Herbaceous and/or Woody plant Establishment on Critical Areas
Dike/Levee Construction and Management
Establishing Water Diversion

Erosion Control

Any active practice that attempts to reduce or keep soil erosion to a minimum for wild animals' benefit is erosion control.

Erosion is the detachment and movement of soil by moving water, wind or ice. When raindrops hit an uncovered soil surface, they dislodge and detach soil particles *(splash erosion).* If there is more rainfall than the ground can absorb, the resulting runoff carries these detached soil particles away.
Erosion is a natural process that cannot be stopped; however, human activity such as earthmoving and tillage can accelerate the process. The erosion process advances through several stages.

- **Sheet erosion** is the removal of a fairly uniform layer of soil from the soil surface by shallow overland flow.
- **Rill erosion** occurs as shallow sheet flow concentrates into small channels. Flow in these channels causes further erosion and carries soil particles away.
- **Gully erosion** is an accelerated form of rill erosion where the channels are much deeper and carry away larger quantities of soil.

Raindrop impact on bare soil surface can also form a "crust" or pan on the soil surface that can be difficult for water to infiltrate. This creates more runoff and less water available to plants, which can decrease plant growth and ground cover leading to further erosion.

According to the U.S. Department of Agriculture the United States loses more than 2 billion tons of topsoil each year to erosion. Erosion removes fertile soil rich in nutrients and organic matter, which reduces the ability of plants to establish, grow and remain healthy in the soil. A reduction in plant growth and subsequent plant residue causes less soil cover, allowing the erosion process to perpetuate and become worse. This in turn affects the wildlife species dependent upon the affected plant communities.

Water Quality and Conservation

Erosion not only causes loss of soil productivity but also creates water quality problems once the sediment leaves the site and enters surface waters. The EPA has declared that sediment contamination of our surface waterways is one of the biggest threats to our nation's water resources. When eroded sediment is transported from its site of origin to nearby water bodies it can also carry fertilizers, pesticides and other contaminants attached to the soil particles.

Water that is loaded with sediments can lead to reduced drainage capacity, increased flooding, decreased aquatic organism populations, decreased commercial and recreational fishing catches, clogged and damaged commercial and industrial irrigation systems, increased expenditures at water treatment plants to clean the water, and decreased recreational and aesthetic value of water resources. Some erosion control practices include:

Pond construction is building a permanent water pond to prevent, stop or control erosion as

an approved Natural Resource Conservation Service (NRCS) watershed project while providing habitat diversity and benefiting wildlife. Whenever possible, owners should use ponds to help create or restore shallow water areas as wetlands and for water management.

Gully shaping involves reducing erosion rates on severely eroded areas by smoothing to acceptable grades and re-establishing vegetation. An area should be seeded with plant species that provide food and/or cover for wildlife.

Streamside, pond and wetland revegetation means revegetating areas along creeks, streams, ponds and wetlands to reduce erosion and sedimentation, stabilize streambanks, improve plant diversity and improve the wildlife value of sensitive areas.

Establishing native plants on critical areas is one method of controlling erosion. These plants also can provide food and/or cover for wildlife and restore native habitat. Some of the ways to establish these plants are listed below.

- Establish and manage wind breaks/shelterbelts by planting multi-row shelterbelts (at least four rows that are 120 feet wide by 1/4 mile), renovate old shelterbelts (re-fence, root-prune and replace dead trees) and establish shrub mottes.
- Establish perennial vegetation on circle irrigation corners by revegetating at least every other corner to reduce erosion and sedimentation, improve plant diversity and improve wildlife habitat.
- Plant permanent vegetation on terraces and field borders to reduce erosion, improve plant diversity and improve wildlife habitat.
- Conserve tillage/no-till farming practices by leaving waste grain and stubble on the soil surface until the next planting season to provide supplemental food or cover for wildlife, control erosion and improve the soil tilth.
- Manage Conservation Reserve Program (CRP) cover by maintaining perennial cover established under the CRP on erodible sites using proper management techniques such as haying, prescribed grazing or burning.

Dike, levee construction or management is a way to establish and maintain wetlands or slow runoff to control or prevent erosion and to provide habitat for wetland-dependent wildlife. Levee management may include reshaping or repairing damage caused by erosion and revegetating levee areas to reduce erosion and sedimentation and stabilize levees. This practice may include fencing to control and manage grazing use.

Water diversion systems also can be installed to protect erodible soils and divert water into wetlands to provide habitat for resident and migratory water birds and wetland-dependent species.

Minimizing Erosion

Building and construction projects can be major causes of erosion. Landowners can take steps to minimize erosion during these projects by following a few simple, commonsense precautions.

- Plan construction activities during the spring and summer months, so that erosion control measures can be in place when rain comes.
- Examine your site carefully before building. Be aware of the slope, drainage patterns and soil types. Proper site design will help you avoid expensive stabilization work.

- Preserve existing vegetation as much as possible. Limit grading and plant removal to the areas under current construction. (Vegetation will naturally curb erosion, improve the appearance and the value of your property, and reduce the cost of landscaping later.)
- Use fencing to protect plants from fill material and traffic. If you have to pave near trees, do so with permeable asphalt or porous paving blocks.
- Preserve the natural contours of the land and disturb the earth as little as possible. Limit the time in which graded areas are exposed.
- Minimize the length and steepness of slopes by benching, terracing, or constructing diversion structures. Landscape benched areas to stabilize the slope and improve its appearance.
- As soon as possible after grading a site, plant vegetation on all areas that are not to be paved or otherwise covered.
- Control dust on graded areas by sprinkling with water, restricting traffic to certain routes, and paving or gravelingaccess roads and driveways.

Temporary Measures to Stabilize the Soil

Grass provides the cheapest and most effective short-term erosion control. It grows quickly and covers the ground completely. To find the bet seed mixtures and plants for your area, check with your local nursery, the Texas Department of Agriculture, the Natural Resource Conservation Service, the Texas Cooperative Extension Service and Texas Parks and Wildlife Department.

Mulches hold soil moisture and provide ground protection from rain damage. They also provide a favorable environment for starting and growing plants. Easy-to-obtain mulches are grass clippings, leaves, sawdust, bark chips and straw. Straw mulch is nearly 100% effective when held in place by spraying with an organic glue or wood fiber (tackifiers), by punching it into the soil with a shovel or roller, or by tacking a netting over it. Commercial applications of wood fibers combined with various seeds and fertilizers (hydraulic mulching) are effective in stabilizing sloped areas. Hydraulic mulching with a tackifier should be done in two separate applications: the first composed of seed fertilizer and half the mulch, the second composed of the remaining mulch and tackifier. Commercial hydraulic mulch applicators - who also provider other erosion control services - are listed under "landscaping" in the phone book.

Mats of excelsior, jute netting and plastic sheets can be effective temporary covers, but they must be in contact with the soil and fastened securely to work effectively.

Roof drainage can be collected in barrels or storage containers or routed into lawns, planter boxes and gardens. Be sure to cover stored water so you don't collect mosquitoes, too. Excessive runoff should be directed away from your house and into wildlife watering facilities. Too much water can damage trees and make foundations unstable.

Structural Runoff Controls

Even with proper timing and planting, you may need to protect disturbed areas from rainfall until the plants have time to establish themselves. Or you may need permanent ways to transport water across your property so that it doesn't cause erosion. To keep water from carrying soil from your site and dumping it into nearby lots, streets, streams and channels, you need ways to reduce its volume and speed. Some examples of what you might use are:

- **Riprap** (rock lining) to protect channel banks from erosive water flow.
- **Sediment trap** to stop runoff carrying sediment and trap the sediment.
- **Storm drain outlet protection** to reduce the speed of water flowing from a pipe onto open ground or into a natural channel.
- **Diversion dike or perimeter dike** to divert excess water to places where it can be disposed of properly.
- **Straw bale dike** to stop and detain sediment from small unprotected areas (a short term measure).
- **Perimeter swale** to divert runoff from a disturbed are or to contain runoff within a disturbed area.
- **Grade stabilization** structure to carry concentrated runoff down a slope

Using Livestock to Repair the Effects of Erosion

Just as overgrazing can cause erosion, erosion can also be caused by under-utilization by livestock and permanent deferral. Lack of grazing can cause an algal cap to develop on the surface of the soil that with time becomes impenetrable to water. A proper stocking rate keeps the soil turned over, prevents compaction, and allows rainfall to infiltrate the soil preventing run off, and reducing erosion potential.

For information on which plants provide the best erosion control and wildlife benefit, consult the Texas Plant Information Database at http://tpid.tpwd.state.tx.us/index.asp.

Algal capping on the soil causes a nearly impenetrable barrier to rainfall, increasing the potential for erosion. Proper grazing helps prevent capping from occurring.

Predator Control

Imported Red Fire Ants
Brown-headed Cowbirds
Grackle, Starling, and House Sparrow Control
Coyotes
Feral Hogs
Raccoons, Skunks, Feral Cats and Dogs

PREDATOR CONTROL

There is no disputing the fact that predators including reptiles, birds, and mammals impact native wildlife populations. Whether that impact is negative or harmful is debated by farmers, ranchers, wildlife professionals and the general public.

Natural systems including predator – prey relationships are complex and evaluating predator impacts on native species may be difficult to say the least. Livestock injury and/or loss by predators are measurable with economic consequences and rarely tolerated by ranchers and managers. Loss of native species such as mule deer predation by mountain lions in West Texas may not be realized when in comparison to livestock but may have an economic impact on ranchers with possible lower lease returns and loss of trophy animals.

Landowners, livestock and wildlife managers should recognize the goal of predator control should be to protect livestock and minimize losses of native wildlife due to predation, not necessarily maximizing the take of predators.

Landowners and managers must evaluate the need for predator control on their property by assessing the abundance and diversity of predators present, the potential impacts by those predators on desired wildlife species and livestock, and the long-term habitat management goals of the property. For example, removing large predators from high deer density areas will only increase deer populations impacting plant diversity and cover, thus affecting the wildlife species dependant on those plants for food, shelter, and nesting cover.

It may be difficult for landowners new to an area or those not familiar with the needs of wildlife to evaluate the impacts of predators on the resident and migratory species on their property. The mere presence of some predatory species should prompt an immediate response from the landowner or manager. Feral cats, dogs, and hogs should be removed by whatever means from wildlife habitat and should not be tolerated by owners and managers. Imported red fire ants are another example of a species that should be controlled by every means available.

The Brown-headed Cowbird, a parasitic nester that impacts more than 225 species of birds, should be controlled by trapping when possible and only after attending a certification course given by Texas Parks and Wildlife Department at various times of the year.

Native predator species such as raccoons, ringtails, opossums, skunks, fox, and rat snakes can have localized impacts on resident bird populations especially ground nesting species such as turkey, quail, and a number of songbirds. Control of predators such as these may not need to be a top priority if habitat conditions are where they should be, offering abundant ground and understory cover for shelter, food and nesting.

Coyotes, bobcats, and mountain lions once considered predators of the “wilderness” are now found in close proximity to suburban areas as urban “sprawl” or expansion encroaches on rural farm and ranch lands. As property is developed into this habitat, interaction with these highly adaptable and mobile species is occurring more frequently. A common sense approach should be taken when considering control of these species. The landowner or manager must evaluate the predicted outcome of control measures prior to starting any control. For example, in many parts of the Edwards Plateau, as well as the State and nationwide, there are too many white-tailed deer and controlling the predators that feed on them would cause increased populations

and further loss of habitat for other wildlife species.

Some precautions can be taken when large predators are present in an area close to people. Pets and newborn livestock should be protected by any means available i.e. fencing, enclosures, housing, etc… Keep pet foods from the outdoors and restrict wildlife feeding to a safe and comfortable distance from the house. Control of prey species numbers in the form of deer harvest
to at or below carrying capacity should discourage any large predators from becoming residents in the area.

If control measures are warranted, consult with a wildlife professional prior to using any measures other than shooting or trapping. Extreme caution should be taken and only the experienced should consider methods such as poisoning.

Some species may not be recognized as predators but cause damage and loss of wildlife by actions other than direct take. For example, European Starlings and English House Sparrows displace native cavity nesting birds such as woodpeckers by taking over and actively defending nest cavities.

The presence of large grackle and blackbird colonies deter other birds from nesting in some areas. Brown-headed and Bronzed Cowbirds have tremendous impacts on songbird populations across the nation. A single female cowbird can lay up to 40 eggs per season, impacting literally hundreds of songbird species including a number of threatened and endangered species in the Edwards Plateau. Trapping and shooting are the most economic means of control with caution taken to release non-target species from traps and proper identification made prior to shooting.

A landowner or manager should first manage the wildlife habitat on his or her property, increasing the plant diversity and abundance of species that provide food, shelter, and nesting cover for all wildlife species prior to implementing a full scale predator control program for all predator species.

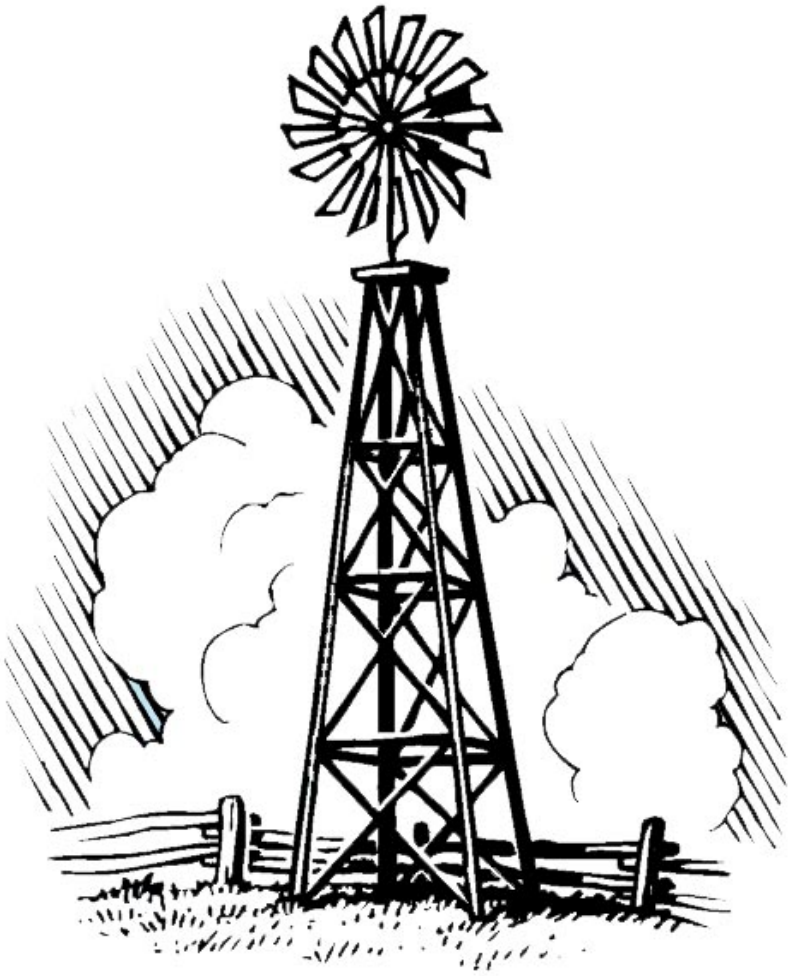
For the majority of landowners that feel predator control would be useful in meeting the criteria for H.B. 1358, the bill implemented to allow agricultural appraisal for land used to manage wildlife, a few basic practices will work. The size and location of the property, amount of wildlife habitat and the goals of the landowner will influence the practices used.

Fire ant control and cowbird trapping is not dependant on the criteria above. As well as live trapping of small and medium-sized mammals such as raccoons, opossums, rats, skunks, and others. The control of sparrows, starlings, grackles and feral animals can and should occur on any size property. On larger tracts of land, control of large predators may benefit wildlife present but should be carried out by knowledgeable land managers and/or wildlife professionals when methods other than shooting or live trapping are utilized.

On properties throughout the Post Oak Savannah, Blackland Prairie and across the State, landowners and managers have implemented every known control method for predators and yet they thrive. Landowners need to have a long range wildlife management plan in place defining the goals of any of the activities occurring on the property including predator control. Once in place, activities can be monitored and results can be recorded to aid in future management decision making.

Providing Supplemental Water

Marsh and Wetland Restoration or Development
Well, Troughs, Windmill Overflows, and Other Watering Facilities
Spring Development and/or Enhancement



Providing Supplemental Water

Natural water exists in all wildlife environments. Supplemental water is provided when the owner actively provides water in addition to the natural sources. This category of wildlife management activity includes providing supplemental water in habitats where water is limited or redesigning water sources to increase its availability to wildlife. Many people mistakenly believe that water sources suitable for livestock are also suitable for wildlife. Unfortunately that is not always the case, particularly for young wildlife and many bird species. Wildlife water developments are in addition to those sources already available to livestock and may require protection from livestock.

Marsh or wetland restoration or development can provide supplemental water in the form of shallow wetlands for wetland-dependent wildlife, even in areas where inadequate water does not limit wildlife. Owners may include seasonally available water such as:

- greentree reservoirs;
- specific shallow roost pond development;
- seasonally flooded crops and other areas;
- moist soil management;
- cienega (desert marsh) restoration, development and protection; and
- maintaining water in playa lakes.

Based on the wildlife's needs and the suitability of the property, managing water levels annually is desirable.

Managing well, trough and windmill overflow can provide supplemental water for wildlife and provide habitat for wetland plants. Owners also may drill wells if necessary and/or build pipelines to distribute water. Building devices—known as wildlife water guzzlers—to collect rainfall and/or runoff for wildlife in areas where water is limited also helps protect wildlife, but these devices must be a part of an overall habitat management program.

Spring development and/or improvements can be designed to protect the immediate area surrounding a spring. Excluding and/or controlling livestock around springs may help to maintain native plants and animal diversity. Other ways to protect areas include moving water through a pipe to a low trough or a shallow wildlife water overflow, making water available to livestock and wildlife while preventing degradation of the spring area from trampling.

Improvements also could include restoring a degraded spring by selectively removing appropriate brush and revegetating the area with plants and maintaining the restored spring as a source of wildlife water. Maintaining critical habitat, nesting and roosting areas for wildlife, and preventing soil erosion must be considered when planning and implementing brush removal. This practice should be planned and implemented gradually and selectively over a period of time.

Providing Supplemental Food

Grazing Management
Food Plots
Feeders and Mineral Supplementation
Managing Tame Pasture, Old Fields and Croplands
Transition Management of Tame Grass Monocultures

Providing Supplemental Food

Most wildlife environments have some natural food. An owner supplies supplemental food by providing food or nutrition in addition to the level naturally produced on the land.

Food plots are one way to establish locally adapted forage to provide supplemental foods and cover during critical periods of the year. Livestock should be generally excluded from small food plots. The shape, size, location and percentage of total land area devoted to food plots should be based on the requirements of the targeted species.

Feeders and mineral supplements also can help dispense additional food to selected wildlife species during critical periods. These can be as simple as properly placed bird feeders, or more elaborate types of turkey feeders. Once a feeding program has been initiated, it is important to keep it implemented and insure all feeders are kept full. It is also important to clean all feeders regularly to avoid contamination from aflatoxin. Harmful aflatoxin in feed should not exceed 20 parts per billion.

Feeders for deer should not be used except to control excessive numbers of deer and/or exotic ungulates as defined within a comprehensive wildlife management plan with a targeted harvest quota that is regularly measured.

Mineral supplements also may be supplied to wildlife in several ways, however, this practice must be a part of an overall habitat management plan that addresses all animal groups and considers the habitat's carrying capacity.

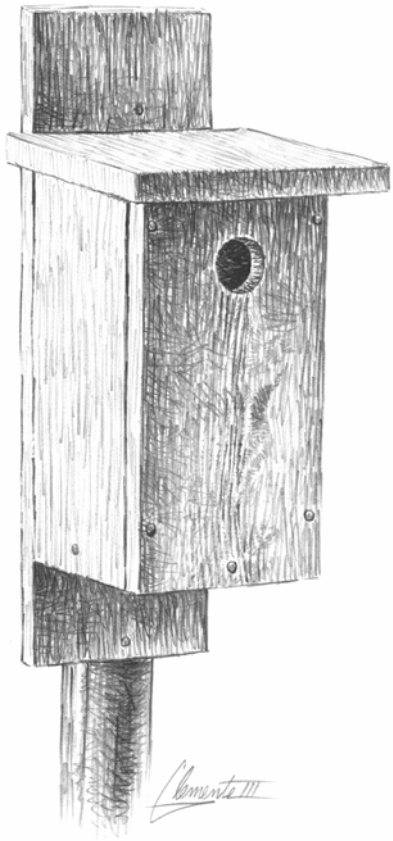
Managing tame pasture, old fields and croplands can increase plant diversity, provide supplemental food and forage and gradually help convert the land to native vegetation. Recommended practices may include:

- overseeding or planting cool season and/or warm season legumes (for example, clovers, vetches and peas) and/or small grains in pastures or rangeland;
- using plants and planting methods appropriate to the county;
- shallow tillage (discing) that encourages habitat diversity, the production of native grasses and forbs or increases bare ground feeding habitat for selected species; and
- no till or minimum till agricultural practices that leave waste grain and stubble on the soil surface until the next planting season—which provide supplemental food or cover, control erosion and improve soil tilth.

Legumes should be planted annually until all pastures are shifted to native vegetation.

Providing Supplemental Shelter

Nest Boxes
Brush Piles and Slash Retention
Fence-line Management
Hay Meadow, Pasture, and Cropland Management for Wildlife



Providing Supplemental Shelter

Cover or shelter is an important part of wildlife habitat. In fact, it is an integral part along side food and water. The arrangements of these key habitat requirements (often called juxtaposition) will often determine the success of wildlife species in a given area. Wildlife cover can take many forms and can vary greatly from one species of wildlife to another. Some species of wildlife are very specific in their need for cover while other are quite opportunistic and can readily adapt to what's available. However one thing is common when it comes to cover; they all require it.

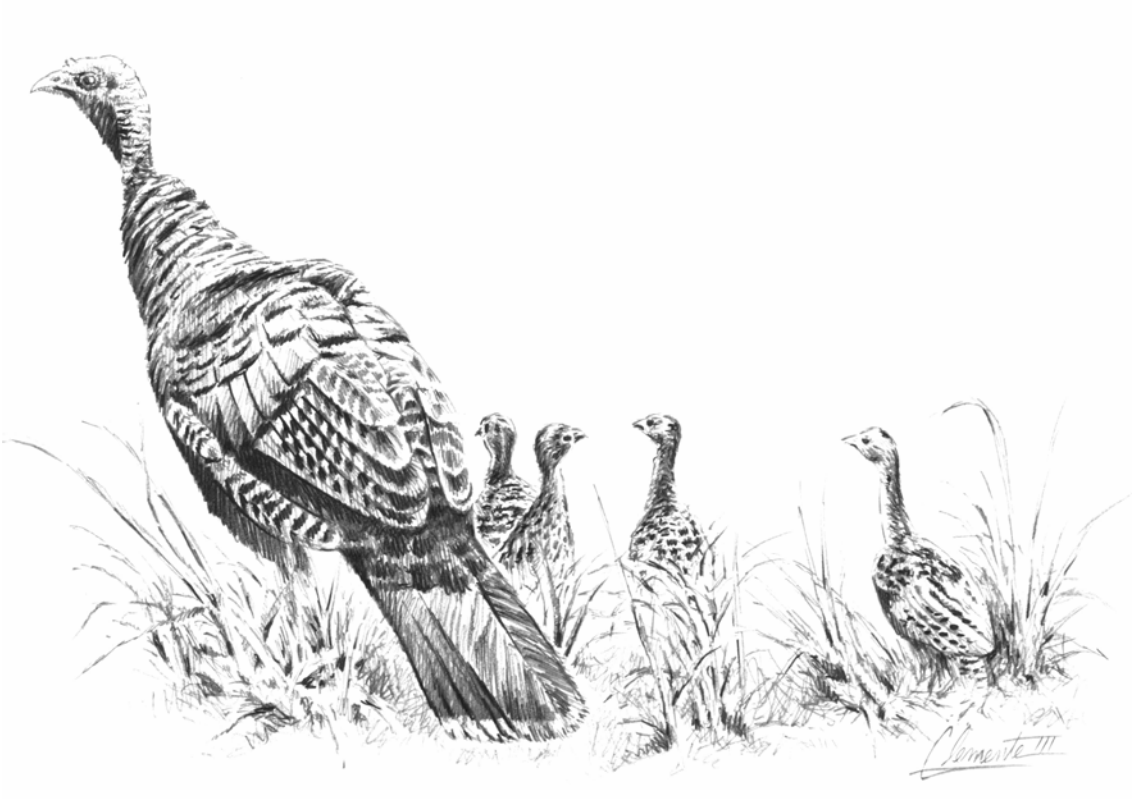
Although supplemental shelter can be provided in many ways, it will never take the place of good conservation and management of native habitats. When land is properly managed for wildlife habitat, quality cover and shelter will usually be available. Unfortunately in much of Texas, many areas have been so altered, neglected, and abused that one of more of the key requirements of wildlife (including shelter) is absent or in short supply. This is where the opportunity exists for supplementation.

Before beginning on any wildlife management practice, you must determine what wildlife species you are managing for and what its specific needs are. Some need cover on a large scale while others may need a relatively small amount of cover. Some live and reproduce exclusively on the ground while others spend most of their lives in the air or in trees. Management should be targeted to those populations of wildlife in your area and their specific needs.

Cover and shelter can be provided for wildlife in many ways. Some species of birds and mammals nest and reproduce in cavities. Nest boxes and snags (dead, standing trees) can be created for these wildlife species. Brush piles can be created to provide cover for many species of birds, reptiles, and small mammals. Other properties lack cover on a larger scale impacting larger wildlife species such as white-tailed deer. Trees and shrubs can be planted to provide this cover requirement. Mowing can be deferred in certain areas to let grasses and weeds (forbs) grow up providing both food, cover and nesting sites for some species of wildlife. Fence lines can be allowed or encouraged to grow up in trees, shrubs, and vines in areas where cover is limited. Mesquite or other brush can be half cut early in the growing season on provide low growing, ground cover in areas where this is lacking.

Census

Spotlight Counts
Standardized Incidental Observations
Stand Counts of Deer
Aerial Counts
Track Counts
Daylight Deer Herd and Wildlife Composition Counts
Harvest data Collection and Record Keeping
Browse Utilization Surveys
Census of Endangered, Threatened, or Protected Species
Census and Monitoring of Nongame Wildlife Species
Miscellaneous Counts



Census

Census counts are periodic surveys and inventories to determine the number, composition or other relevant information about a wildlife population to measure if the current wildlife management practices are serving the targeted species. Such surveys also help evaluate the management plan's goals and practices. Specifically, this activity estimates species numbers, annual population trends, density or age structure using accepted survey techniques. Annual results should be recorded as evidence of completing this practice. (Refer to Appendices L and M for more comprehensive information on conducting census.)

Spotlight counting animals at night along a predetermined route using a spotlight should follow accepted methodology, with a minimum of three counts conducted annually.

Aerial counts using a fixed-wing aircraft or helicopter to count animals also should follow accepted methodology for the region and be performed by a trained individual.

Daylight wildlife composition counts are driving counts used to census wildlife in daylight hours. Annual population trends on dove, quail, turkey and deer, as well as sex/age structure on deer, should be determined by sightings along a standardized transect of a minimum of five miles at least three times during a season.

Harvest data collection/record keeping means tracking annual production of wildlife. Age, weight and antler development from harvested deer, and the age and sex information from game birds and waterfowl should be obtained annually.

Browse utilization surveys annually examine deer browse plant species for evidence of deer use on each major vegetative site on the property. The surveys should be conducted in a way that can be repeated.

Census and monitoring of endangered, threatened or protected wildlife through periodic counts can improve management and increase knowledge of the local, regional or state status of the species.

Census and monitoring of nongame wildlife species also can improve management or increase knowledge of the local, regional or state status of the species. These practices can include developing checklists of wildlife diversity on the property and should be a part of a comprehensive wildlife management plan.

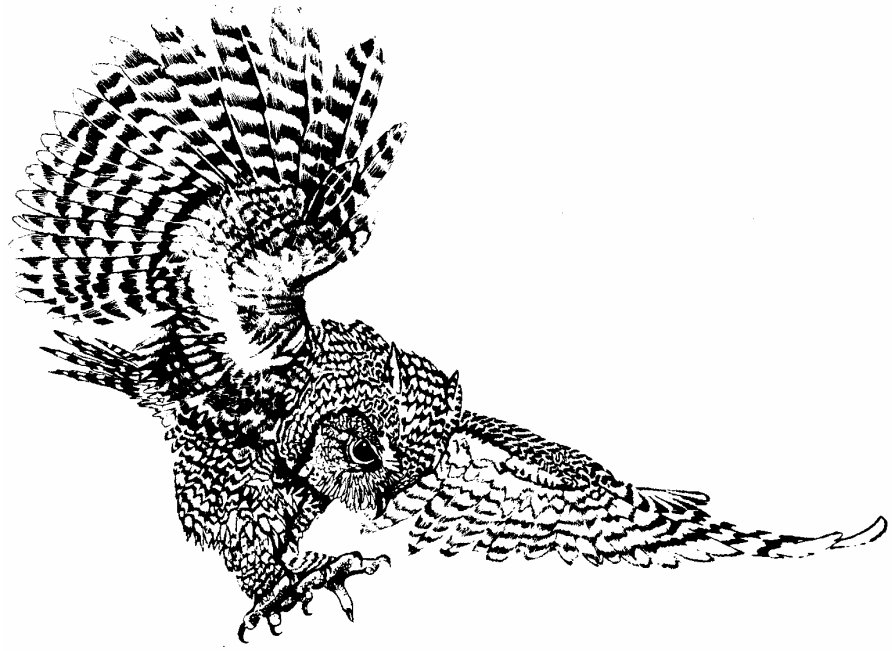
One of the most important things for a landowner to remember when designing a census protocol of nongame species on their property is the ability to be consistent. In other words, be able to do the same thing in the same way at the same time each and every time the census is conducted.

APPENDICES

STANDARD WILDLIFE HABITAT AND POPULATION MANAGEMENT RECOMMENDATIONS

For the

POST OAK SAVANNAH
AND
BLACKLAND PRAIRIE ECOLOGICAL REGIONS



Appendix A

General Habitat Management Considerations, Recommendations, and Intensity Levels

Fundamental requirements which must be considered when managing wildlife habitat include food, cover, water and the proper distribution of these elements.

Wildlife and habitat management should be directed at maintaining a productive and healthy ecosystem. The ecosystem consists of the plant and animal communities found in an area along with soil, air, water and sunlight. All management activities should be aimed at conserving and improving the quantity and quality of soils, water and vegetation.

Managing for plant diversity is essential. A diverse habitat has a good mixture of various species of grasses, forbs (weeds), and browse (woody) plants. Many of these plants will be at various stages of growth, which adds another element of diversity. The diversity of vegetation increases the availability of food and cover for wildlife species. A greater diversity of plants results in more food being made available during different periods of the year. The volume and diversity of plants protects the soil from erosion. Also, the decomposition of vegetation helps restore needed minerals to the soil to sustain plant life. Vegetation improves the water cycle by increasing water infiltration into the soil and reducing surface runoff.

An ecologically based habitat management program serves to improve water cycling, mineral cycling, and energy flow and manipulate plant succession. These processes enhance vegetative quantity, quality and diversity. A greater diversity of all life forms, including microorganisms, insects, reptiles, amphibians, birds and mammals may be achieved under sound management. The land's long term health is improved and conserved for future generations to utilize as a source of income, recreation and for aesthetic enjoyment.

Plant communities with a diversity of grasses and native broad-leaved weeds (called forbs) are more productive than those comprised primarily of grasses. The climax plant community of most rangelands is comprised primarily of perennial grasses with a relatively low forb component. While this may be suitable for livestock and some grassland wildlife, most species are dependent on the seeds and foliage of forbs. Periodic disturbances such as fire, soil disturbance, livestock grazing, and mowing can set back plant succession and maintain a diverse plant community, simulating conditions under which plants and animals evolved within ecosystems in Texas.

Below is an example of a plan format that many landowners in the Post Oak Savannah and Blackland Prairies may find applicable to their property, depending on their particular goals and objectives. A fill-in-the-blank plan following this format is attached in Appendix U. This is presented to help landowners develop a Wildlife and Habitat Management Plan. To meet the requirements of the wildlife management tax valuation,

a landowner must annually implement and complete at least one management PRACTICE from at least three of the seven wildlife management ACTIVITIES (i.e. Habitat Control, Erosion Control, Predator Control, Providing Supplemental Supplies of Water, Providing Supplemental Supplies of Food, Providing Shelter, and Making Census Counts to Determine Population). Again, a complete plan will likely include more than three activities, and may include several practices under each activity.

It is important for the landowner to be able to document the wildlife management activities that have taken place during the tax year. Receipts, photographs, and maps are some of the types of documentation a landowner might want to consider using for this purpose. If requested to do so by the county, the landowner may have to file an annual report, including documentation, on management activities undertaken during the year. The required fill-in-the-blank report form is attached in **Appendix U.**

Wildlife and Habitat Management Plan

General Information

Tract Name: _____ County: _____

Owner: _____ Manager: _____

Address: _____ Address: _____

Address: _____ Address: _____

Phone: _____ Phone: _____

Phone: _____ Phone: _____

Individual Preparing the Plan: _____

Date: _____

Is property leased for hunting? Yes ☐ No ☐
Consultation is with: Owner ☐ Lessee ☐ Manager ☐
Location of Property: Distance and direction from nearest town

Is acreage under high fence? Yes ☐ No ☐

Acreage:

Cropland: Non-native Pasture:
Native Grass Pasture: Upland Woods:
Bottomland Woods: Wetlands(optional):
Ponds/Lakes: Other(specify):

Total Acres:

Current Habitat Description:

Describe vegetation association or type (eg., Post Oak Woods, Forest and Grassland Mosiac; Post Oak Woods/Forest; WaterOak-Elm-Hackberry Bottomland Forest; Elm-Hackberry Parks/woodsite, Mesquite; Crops; Native or Introduced Grasses, etc). State dominant plants occurring and/or crops grown on the property. The description can include the soil types and vegetation associated with the various soil types. Describe livestock and wildlife water sources (eg., permanent or seasonal streams, springs, stock tanks, water troughs) that are present. Documentation may include any SCS (now NRCS), TPWD, or other plan, map or aerial photo that may exist for the tract to identify soils, vegetation and water sources. The plant list should include browse plants utilized by deer, if deer management is a goal (see appendix F). Also, state the degree of use on key browse plants utilized by livestock and deer.

_____
_____
_____
_____

Past History of Land Use and Wildlife:

Describe past land use practices that have been implemented such as prescribed burns, range or pasture reseeding, timber management, etc. Describe past history of timber management, cropping, livestock, and wildlife management (census, harvest, etc.). Present other information such as the presence of unique cover types, turkey roosts, or etc. Also indicate presence of feral hogs or other exotics that compete with native wildlife.

_____
_____
_____

Goals and Objectives:

A discussion and outline of landowner (also family if desired) goals and objectives for the property is necessary to define direction and to realistically assess the set of activities and practices that should be incorporated to integrate wildlife and habitat enhancement.

(Select one or more to guide the wildlife and habitat planning process)

1. Improve habitat for native game species (as designated in the Texas Hunting Guide.)

2. Improve habitat for native nongame species (those species not listed as game

species, e.g. songbirds).

3. Manage for habitat and wildlife diversity.

4. Restore, maintain or improve native habitats for wildlife diversity.

5. Generate revenue from native wildlife resources.

6. Improve habitat for rare native species.

7. Protect sensitive habitats or critical species.

8._____

9._____

10._____

11._____

12._____

Management Practices Normally Beneficial for Representative Wildlife in the Post Oak Savannah and Blackland Prairie Ecoregions	White-tailed Deer	Fox Squirrel	Cottontail Rabbit	Wild Turkey	Bobwhite Quail	Mourning Dove	Wood Duck	Red-Tailed Hawk	Brown Thrasher	Eastern Bluebird	Big Brown Bat	Houston Toad
A. HABITAT CONTROL												
Grazing Management	X	X	X	X	X	X	X	X	X	X	X	X
Prescribed Burning	X		X	X	X	X		X	X	X	X	X
Range Enhancement (Reseeding)	X		X	X	X	X		X	X	X	X	X
Brush Management	X	X	X	X	X	X		X	X	X	X	X
Timber Management	X	X	X	X		X	X	X	X	X	X	X
Riparian Management / Enhancement	X	X	X	X		X	X	X	X	X	X	X
Wetland Enhancement	X		X				X	X			X	X
Habitat Protection-Species of Concern												X
Prescribed Control-Native,Exotic,Feral Species	X	X	X	X	X		X					X
Wildlife Restoration	X			X								
B. EROSION CONTROL												
Pond Construction	X					X	X				X	
Gully Shaping												
Streamside, Pond, Wetland Regeneration	X		X				X				X	X
Herbaceous &/or Woody Plant Establishment	X	X	X	X	X	X	X		X	X		
Dike / Levee Construction / Management							X				X	
Establish Water Diversion												
C. PREDATOR CONTROL												
Predator Management	X		X	X	X		X			X		X
Imported Red Fire Ant Control	X		X	X	X	X			X	X		X
Cowbird Control						X						
Grackle / Starling / House Sparrow Control						X				X		
D. PROVIDING SUPPLEMENTAL WATER												
Marsh / Wetland Restoration							X				X	X
Spring Development &/or Enhancement	X	X		X			X					
E. PROVIDING SUPPLEMENTAL FOOD												
Grazing Management	X	X	X	X	X	X	X	X	X	X	X	X
Prescribed Burning	X		X	X	X	X	X	X	X	X	X	X
Range Enhancement	X		X	X	X	X		X		X	X	X
Food Plots	X		X	X	X	X						
Feeders & Mineral Supplementation	X											
Managing Tame Pasture, Old Fields, Croplands	X		X	X	X	X		X		X	X	
Transition Mgt. of Tame Grass Monocultures	X		X	X	X	X		X	X	X	X	X
F. PROVIDING SUPPLEMENTAL SHELTER												
Nest Boxes, Bat Boxes		X					X			X	X	
Brush Piles & Slash Retention			X		X			X	X	X		
Fence Line Management		X	X	X	X	X		X	X	X		
Hay Meadow, Pasture, & Cropland Management	X		X	X	X	X		X		X		
Half Cutting Trees & Shrubs			X		X							
Woody Plant / Shrub Establishment	X	X	X						X			
Natural Cavity / Snag Development		X					X	X		X	X	
G. CENSUS												
Spotlight Counts	X											
Aerial Counts	X											
Track Counts	X											
Daylight Deer Herd / Wildlife Composition Counts	X											
Harvest Data / Record Keeping	X	X	X	X	X	X	X					
Browse Utilization Survey	X											
Census & Monitoring of Endangered, Threatened,												X
Census & Monitoring of Nongame Species								X	X	X		
Miscellaneous Counts		X	X	X	X	X	X				X	

Specific Habitat Management Practices, By Activity

HABITAT CONTROL

GRAZING MANAGEMENT

(Refer to Appendix D - Livestock Recommendations, for information to help prepare a specific grazing proposal for the plan.)

Continuous grazing without rest is detrimental to wildlife.

Grazing management, which may include deferment, is the planned manipulation of livestock numbers and grazing intensities to increase food, cover, or improve structure in the habitat of selected species. Grazing management includes: 1) kind and class of livestock grazed, 2) determination and adjustment of stocking rates, 3) implementation of a grazing system that provides planned periodic rest for pastures by controlling grazing intensity and duration, and/or 4) excluding livestock from sensitive areas to prevent trampling, allow for vegetative recovery, or eliminate competition for food and cover. Planned deferments can be short or long term up to 2 years. Extended rest from grazing (two years or more, if necessary) may be required on some ranges. Seasonal stocker operations may be appropriate to manipulate habitat. Supplemental livestock water (earthen tanks, troughs, wells, piping) to facilitate deferred-rotation grazing of livestock and disperse grazing pressure may be incorporated into planning to improve wildlife habitat. Similarly, it is important to plan and design fence construction to facilitate deferred-rotation grazing of livestock. Fencing can also be used to enhance or protect sensitive areas, woodlands, wetlands, riparian areas and spring sites as designated in plan. Activities should be reviewed annually.

Grazining management systems might include:

- 1 Herd / 3 Pasture (preferably as a step in moving toward a 1 herd / multiple pasture {4+} grazing system)
- 1 Herd / 4 Pasture
- 1 Herd / multiple pasture multiple herd / multiple pasture (goal is to move toward always resting 75% of area)
- High intensity/low frequency (HILF)

- Short duration system
- Other type of grazing system (ex. a short-term stocker system):
- Planned Deferment (e.g., number of years livestock will be deferred from the property, etc.):

PRESCRIBED BURNING

(Refer to Appendix E - Vegetation Management Recommendations, for information to help prepare a specific burning proposal for the plan.)

Using a drip torch to create a prescribed fire is an excellent management practice that simulates the natural cycles that these ecosystems evolved under, and enhances habitats and plant diversity.

Prescribed burning is the planned application of fire to enhance habitat and plant diversity, increase food, manipulate cover, or improve structure in the habitat of selected species. Plans should indicate a minimum percent of acreage and general burning cycle **(eg., minimum of 15 percent of acreage annually burned over 7 years in the Post Oak Savannah and Blackland Prairie)**. Attach a written burning plan as an addendum to the Wildlife and Habitat Management Plan (burn plans and prescribed burning should only be attempted with aid of professionals). The plan should include a map that shows the areas to be burned and the planned dates (month and year) that each area will be burned during the burning cycle. It should also designate areas to be protected from burning, and should incorporate flexibility during periods/ years when conditions are not favorable. Specific areas (eg., sensitive sites) to be protected from burning should be briefly described and shown on a map.

RANGE ENHANCEMENT (Range Reseeding)

Establish native herbaceous plants (grasses and forbs) that provide food and cover for wildlife or erosion control benefits. Plant species selected and methods for establishment should be applicable to the county (non-native species are generally not recommended, but if required for a specific purpose, non-native species should not exceed 25 percent of the seeding mix). If non-native species must be used to achieve a specific goal, species used **must not** be invasive or aggressive. Seeding mixtures providing maximum native plant diversity are recommended. Many herbaceous broadleaf plants (known as forbs - weeds and wildflowers) are beneficial to wildlife for

forage and/or seed production. A list of key species adapted to the Post Oak Savannah and Blackland Prairie are: little bluestem, big bluestem, Indiangrass, sideoats grama, switchgrass, native sunflower, tick clovers, three-seeded mercury, ragweeds, crotons, vetches, dayflower, cutleaf primrose, bur clover, sweet clovers, smartweeds, lespedezas, partridge pea, sensitive briar, snow-on-the-prairie, Illinois bundleflower, and Engelmann daisy.). Encourage "weed and wildflower" species by selective application of chemical, biological (eg., grazing management) and/or mechanical means on native rangelands, Conservation Reserve Program lands, and tame grass pastures (eg., coastal bermuda). Some periodic weed control may be needed in fields converted to native rangeland to assist in the establishment of desirable vegetation. This practice must be a part of an overall habitat management plan and designed to reestablish native habitats within a specified time frame. **Range Enhancement should annually affect a minimum of 10% of the total area designated in the plan, or a minimum of 10 acres annually, whichever is smaller, until the project is completed.**

BRUSH MANAGEMENT

(Refer to Appendix E - Vegetation Management Recommendations, for information to help prepare a specific brush management proposal for the plan.)

Brush management may be the removal or establishment of woody plants.

It can be the selective removal or suppression of target woody species, including exotics, to allow the increased production of desirable trees, shrubs, grasses, and forbs for forage and nesting or protective cover for selected species. **Brush Management practices should annually affect a minimum of 10% of the total area designated in the plan, or a minimum of 10 acres annually, whichever is smaller.** This practice includes retaining the proper kind, amount, and distribution of woody cover for selected species. Brush management planning must consider wildlife cover requirements, soil types, slope angle and direction, soil loss and erosion factors, and subsequent planning to control re-invasion. This practice also includes retention of snags to provide cover and nesting sites for cavity nesting animals. When used, herbicides should be applied in strict accordance with label directions.

This practice can include the planting of native tree and shrub species per acre per year for the area designated in the plan to provide food, corridors and/or shelter using species and methods as described in appendices.

RIPARIAN MANAGEMENT AND ENHANCEMENT

Annually and seasonally protect the vegetation and soils in riparian areas (low areas on either side of stream courses) from mismanagement, such as caused by excessive, long-term livestock trampling or caused by poor timber harvest practices. Riparian management and enhancement can include providing livestock with alternate watering sites, deferring livestock grazing in pastures with riparian areas during critical periods of the year, total exclusion of livestock from pastures with riparian areas, and fencing riparian areas to exclude or provide short duration grazing by livestock. Establish trees, shrubs, or herbaceous vegetation along streams or water courses to provide food, cover, and travel corridors, and to reduce erosion. Corridors should be at least 100 yards wide. Restore important forested habitats including bottomland hardwoods and turkey roost sites. **A minimum of one Riparian Management and Enhancement project must be implemented and maintained every 10 years to qualify.** See Appendix E.

Proposed riparian management and enhancement projects might include:

- Fencing
  - complete fencing of riparian areas
  - partial fencing of riparian areas
- Deferment from livestock grazing
  - complete deferment
  - partial deferment.
- Establish vegetation
  - trees
  - shrubs
  - herbaceous
  - both sides of stream
  - one side only

Over 50% of Texas' wetlands have disappeared. Wetland management, restoration or creation is extremely important for wetland dependent wildlife.

WETLAND ENHANCEMENT

Annually provide seasonal or permanent water for roosting, feeding, or nesting habitat for wetland wildlife. This practice involves shallow wetland management, creation or restoration, greentree reservoir creation or management, and other moist soil management such as rotational grazing or exclusion (fencing out) of livestock from wetlands, especially during the growing season.

Annual management as described in management plan, such as water level manipulation qualifies. **Construction and maintenance of a new project will qualify for 10 years**.

HABITAT PROTECTION FOR SPECIES OF CONCERN

Planned protection and management of land or a portion of land to provide habitat for an endangered, threatened or rare species, such as fencing off critical areas, managing vegetation structure and diversity within species parameters, establishing and maintaining firebreaks to protect critical overstory vegetation, and annually monitoring the species of concern. This practice includes the management/protection of nesting sites, feeding areas, and other critical habitat limiting factors, and the development of additional areas. (Refer to Appendix I for information on the management of the federally endangered Houston Toad and federally threatened Southern Bald Eagle, both of which may occur in portions of the Post Oak Savannah and Blackland Prairie).

The broad-scale management of habitat for migrating/wintering/ breeding neotropical birds (primarily songbirds) should follow guidelines in appendix for zones of importance (See Appendix J).

A minimum of one project must be implemented every 10 years to qualify.

Houston toads occur in the southern post oak on certain soil types.

Proposed projects for habitat protection for species of concerns might include:

- Planned protection/management projects:
- fencing
- firebreaks
- prescribed burning
- habitat manipulation (e.g. thinning, etc.)
- control of nest parasites
- native/exotic ungulate control
- other_____

PRESCRIBED CONTROL OF NATIVE, EXOTIC AND FERAL SPECIES

Feral hogs compete directly with native wildlife, and very destructive of habitats.

Use legal means to control the number of grazing and browsing animals. Maintain the population density of native wildlife (particularly white-tailed deer — see Appendix F) at the carrying capacity of the habitat to prevent overuse of desirable plant species and enhance habitat for native wildlife species. Populations of exotics, feral animals, and wildlife should be strictly controlled to minimize negative impact on native wildlife and habitat. This should incorporate harvest and vegetative monitoring over time to assess control intensity and impact on habitat to meet plan objectives.

Remove or control exotic vegetation impacting native habitats and wildlife populations (eg., large stands of Chinese tallow tree, kudzu, weeping lovegrass, etc.). Convert tame pasture grasses (such as large areas of coastal bermuda, klinegrass, old world bluestems) to native vegetation. **The removal or control of exotic vegetation or the conversion of tame grass pastures must affect a minimum of 10% of the area designated in the plan, or 10 acres annually, whichever is smaller**.

WILDLIFE RESTORATION

Restoration or enhancement of habitat to good condition for target species, and reintroduction and population management of TPWD approved native species within the carrying capacity of the habitat as part of an approved restoration area at a scale capable of supporting a sustainable population (eg., eastern turkey).

EROSION CONTROL

POND CONSTRUCTION AND MAJOR REPAIR

Construction or major repair of a permanent water pond for the purpose of preventing, stopping, or controlling erosion as part of an approved NRCS erosion control structure. The project must provide habitat diversity and wildlife benefits. Creation/restoration of shallow water areas as primary production wetlands, and associated water level control and management, should be associated with ponds at every opportunity. **A minimum of one project must be implemented and maintained every 10 years to qualify**.

GULLY SHAPING

Reducing erosion rates on severely eroded areas by smoothing with top soil to acceptable grades and reestablishing vegetation, primarily native vegetation, with sensitivity to existing wildlife cover and woody vegetation that provides travel corridors. Area must be interseeded with species that provide food and/or cover for wildlife to be applicable (see range enhancement guidelines). This practice may include the feeding of large numbers of cattle on gully sites to contour the eroded areas by way of hoof action to aid in the recovery of the site. **A minimum of one project must be implemented and maintained every 10 years to qualify.**

STREAMSIDE, POND, AND WETLAND REVEGETATION

Re-vegetating areas along creeks, streams, ponds, and wetlands to reduce erosion and sedimentation, stabilize stream banks, improve plant diversity, and improve wildlife value of sensitive areas. This practice can include: (a) the construction of permanent or temporary fences to exclude, limit, or seasonally graze livestock in order to prevent erosion; (b) the use of native hay to slow and spread water runoff, in areas where vegetation has been recently reestablished (seeds in the hay aid in re-vegetation); (c) establishing vegetative buffer areas or filter strips along water courses or other runoff areas; (d) establishment of 3:1 upland buffer to lake basin/wetland acreage in diverse grass/legume/forb mixture to prevent sedimentation; (e) the installation of rip-rap,

dredge spoil, or other barrier material - placement of material along erodible embankments to prevent erosion and protect wildlife habitat; (f) the establishment of stream crossings to provide permanent low water crossings in order to reduce or prevent erosion. **A minimum of one project must be implemented and maintained every 10 years.**

Proposed streamside, pond, and wetland restoration project(s) may include the following techniques:

- native hay bales
- fencing
- filter strips
- seeding upland buffer
- rip-rap, etc.
- stream crossings

PLANT ESTABLISHMENT ON CRITICAL AREAS (erodible)

Primarily for erosion control, the establishment of native woody or herbaceous vegetation can also provide food and/or cover for wildlife and restore native habitat. This practice can include: (a) establish and manage wind breaks/shelter-belts by planting multi-row shelter-belts (at least 4 rows in 120' width by1/4 mile in length), renovate old shelter-belts (re-fence, root-prune, and replace dead trees), and establish shrub mottes, improve plant diversity, and improve wildlife habitat; (b) establish perennial vegetation on terraces and field borders (30 yard minimum width) to reduce erosion, improve plant diversity, and improve wildlife habitat; (c) conservation tillage/no-till farming practices by leaving waste grain and stubble on the soil surface until the next planting season to provide supplemental food or cover for wildlife, control erosion, and improve the soil tilth; (d) manage Conservation Reserve Program cover by maintaining perennial cover established under the Conservation Reservation Program (expired contracts) on erodible sites using proper management techniques such as haying, prescribed grazing or prescribed burning. **A minimum of 10 seedlings per acre must be planted annually on 10 acres or a minimum of 10%, whichever is smaller, of the total designated area treated annually.**

DIKE/LEVEE CONSTRUCTION/MANAGEMENT

To establish/maintain wetlands or slow runoff to control or prevent erosion, and to provide habitat for wetland dependent wildlife. Levee management may include reshaping or repairing damage caused by erosion, and re-vegetating levee areas to reduce erosion and sedimentation, and stabilize levees. This practice may include fencing to control and manage grazing use, or installation of water control structures. This practice must be a part of an overall habitat management plan. **A minimum of one project must be completed and maintained every 10 years.**

ESTABLISH WATER DIVERSION

Install water diversion systems that will protect erodible soils and divert water into wetlands to provide habitat for resident and migratory water birds and wetland dependent species. Seed diversion areas to species tolerant of seasonally standing water. **A minimum of one project must be completed and maintained every 10 years.**

A flashboard riser box attaches to a pipe installed in a levee to create a shallow water wetland for wildlife.

PREDATOR CONTROL

PREDATOR MANAGEMENT

The management of predator populations to increase survival of target species. Key native predator species may include coyote, raccoon, bobcat, mountain lion, and rat snakes, while exotic predators may include feral house cat, feral dog, and feral hogs (see imported red fire ants in separate paragraph). Predator Control alone will not be an applicable practice unless it is part of an overall plan to manage the habitats and populations of the target species. Texas Parks and Wildlife Department advocates elimination of feral/exotic predators, with the thoughtful management of native predators as an integral part of functioning natural systems. **The predator control plan should be prepared or approved by a competent professional and include the list, duration and intensity of methods to remove the target species annually.**

IMPORTED RED FIRE ANT CONTROL

To protect native wildlife species, or their food base, including native fire ants which seem to restrict the spread of the imported fire ants**; proper treatment of at least 10 acres or 10% of infested area per year, whichever is more.** Treatment will comply with pesticide label instructions, and information is available in Appendix P and on the internet at http://fire ant.tamu.edu

CONTROL OF COWBIRDS

Reducing populations of these birds for the purpose of decreasing nest parasitism of target neotropical bird species (eg. endangered Black-capped Vireos and other songbirds) in a PLANNED PROGRAM (see Appendix J, K, and Q). **Removal of at least 30 cowbirds annually is required to qualify.**

GRACKLE/STARLING/HOUSE SPARROWS CONTROL

Reducing populations of grackles and/or starlings and/or house sparrows for the purpose of controlling avian diseases and reducing overcrowding to exclusion of other avian fauna in a planned program (see Appendix J) particularly targeting white-winged dove and other neotropical birds. **Removal of at least 30 grackles/starlings/house sparrows annually is required to qualify.**

Proposed Grackle/Starling/House Sparrow Control Project(s) may include:

- trapping
- shooting
- scare tactics

PROVIDING SUPPLEMENTAL WATER

* This category includes providing supplemental sources of water <u>specifically for wildlife</u> in habitats where water is limited. Wildlife water developments are in addition to those sources already available to livestock and <u>may</u> require protection from livestock.

MARSH/WETLAND RESTORATION OR DEVELOPMENT

Provide supplemental water in the form of shallow wetlands for wetland dependent wildlife. Applicable even in areas where water is not a critical limiting factor for upland species of wildlife. May include seasonally available water such as greentree

reservoirs, specific shallow roost pond development, seasonally flooded crops and other areas, artificially created wetlands, marsh restoration-development-protection, prairie pothole restoration/development/protection, and moist soil management. Based on wildlife needs and suitability of the property, the annual manipulation with control structures is desirable. **Minimum requirement of one marsh/wetland restored or developed per 10 years; or annual water management of project or existing wetland.** Call for TPWD OR NRCS for professional assistance when creating/enhancing wetlands.

WELL/TROUGHS/WINDMILL OVERFLOW/OTHER WILDLIFE WATERING FACILITIES

Designing and implementing water systems that provide supplemental water for wildlife and provide habitat for wetland plants. This practice may include modifying existing water systems to make water more accessible to wildlife (eg. fenced windmill overflows available to wildlife on the ground). It may also include drilling wells if necessary and/or constructing pipelines to distribute water and/or diverting water with specialized wildlife watering facilities. Water may be distributed on a ¼ mile basis to enhance distribution and abundance of a variety of wildlife species. **A minimum of one project per 10 years must be completed to qualify. Consistent water management for wildlife at sites qualifies.**

Proposed Well/Troughs/Windmill Overflow/Other Wildlife Watering Facility Project(s) may include: (see Appendix O):

- Drill new well:
  - windmill
  - pump
  - pipeline
- Modification(s) of existing water source:
  - fencing
  - overflow
  - trough modification
  - pipeline
- Distance between water sources {waters}_____

- Type of Wildlife Watering Facility
  - PVC/Quickline/Other Pipe Facility
  - Drum with Faucet or Float
  - Small Game Guzzler
  - Windmill Supply Pipe Dripper
  - Plastic Container
  - In-ground Bowl Trough
  - Big Game Guzzler
  - Inverted Umbrella Guzzler
  - Flying Saucer Guzzler

- Ranch Specialties Wildlife Guzzler
- Other_____

Capacity of Water Facility(ies): _____

SPRING DEVELOPMENT AND/OR ENHANCEMENT

Implementing methods designed to protect the immediate area surrounding a spring. This practice may include excluding and/or controlling livestock around springs to maintain native plant and animal diversity and/or moving water through a pipe to a low trough or shallow wildlife water overflow, making water available to livestock and wildlife while preventing degradation of the spring area from trampling and other animal impacts. It could also include restoring a degraded spring by the controlled, possibly multi-year, removal of dense brush and the revegetation of drainages and canyons with herbaceous plants at historic springs, and maintaining the restored spring as a source of wildlife water. Maintaining critical habitat, nesting and roosting areas for wildlife and preventing soil loss and erosion must be considered when planning and implementing brush removal. **A minimum of one project per 10 years must be completed to qualify; or existing or restored springs consistently managed to prevent degradation qualifies.**

Proposed Spring Development and/or Enhancement Project(s) may include the following:

- Fencing
- Water diversion/pipeline
- Brush removal
- Spring clean out
- Ponds, stock tanks, water impoundments (see stock ponds, tanks, lakes)

PROVIDING SUPPLEMENTAL FOOD

GRAZING MANAGEMENT

(This is identical to Grazing Management in Activity A. Refer to Grazing Management in Activity A for information to prepare a specific grazing proposal for the plan under this Activity).

PRESCRIBED BURNING

(This is identical to Burning Prescribed in Activity A. Refer to Prescribed Burning in Activity A for information to prepare a specific burning proposal for the plan under this Activity)

RANGE ENHANCEMENT (Range Re-Seeding)

(This is identical to Range Enhancement (Reseeding) in Activity A. Refer to Range Enhancement (Range Reseeding) in Activity A for information to prepare a specific range enhancement proposal for the plan under this Activity)

FOOD PLOTS

Cowpeas are an excellent summer forage for white-tailed deer.

The establishment of locally adapted annual (spring and fall) or perennial forages on suitable soils to provide supplemental foods and cover during critical periods of the year. Livestock should be generally excluded from small food plots. The shape, size, location, and percentage of total land area should be based on requirements for the target species (eg., 2-5% of area for white-tailed deer) and should meet goals of a comprehensive wildlife plan. **A minimum of 1% of the acreage should be planted in both winter and summer food plots.**

Managing the habitat for proper nutrition should be the primary management goal. Supplemental feeding and /or planting of food plots are not a substitute for good management. These practices should only be considered as "supplements" to the native habitat, not as "cure-alls" for low quality and/or poorly managed habitats. Supplemental feeding should always be combined with population management, or the resulting artificially higher numbers of animals will have a negative impact on native plants. Consult with the NRCS, TCE, TPWD, and local seed dealers for food plot mixtures suitable for your area, as well as local soil conditions. Plant according to soil tests (through TCE County Extension Agent) and fertilize as necessary.

Proposed Food Plots Project(s) may include the following considerations:

- Size(s)_____
- Fencing required?
    - yes
    - no
- Plantings:
    - cool season annual crops, i.e. wheat, rye, clovers, etc.
    - warm season annual crops, i.e. sorghums, millets, cowpeas, etc.
    - annual mix of native plants
    - perennial mix of native plants

- Irrigation required?
    - yes
    - no
- Fertilizer recommended?
    - Yes
    - no

FEEDERS AND MINERAL SUPPLEMENTATION

Dispensing supplemental foods from artificial devices to meet the dietary requirements of selected wildlife species during critical periods of the year. Attractants for hunting do not apply unless used for selective harvest to control excessive numbers of deer and/or exotic ungulates as defined within a comprehensive wildlife management plan with a targeted harvest quota that is regularly measured and achieved or nearly so. Aflatoxin levels in feed should not exceed 20 ppb. Mineral supplementation may be supplied by other means than from artificial devices (poured on ground, blocks, etc.). This practice must be a part of an overall habitat management plan that addresses all animal units and attempts to maintain populations below_carrying capacity. **A minimum of one free-choice feeder per 320 acres in use during the recommended time period, with a minimum of 16% crude protein feed (See Appendix F for deer), required to qualify.**

Proposed Feeders and Mineral Supplementation Project(s) should include the following considerations:

- Purpose:
    - supplementation
    - harvesting of wildlife
- Targeted wildlife species
- Feed type
- Mineral type
- Feeder type
    - Number of feeders
    - Method of mineral dispensing
    - Number of mineral locations
- Year round
    - Yes
    - No, if not, when practiced_____

MANAGING TAME PASTURE, OLD FIELDS AND CROPLANDS

This practice may include: over-seeding or planting cool season and/or warm season legumes and/or small grains in pastures, easements (pipelines), or range land in order to provide a supplemental food for wildlife, using plant materials and establishment methods applicable to the county; periodic ground disturbance through shallow discing that encourages habitat diversity, the production of native grasses and forbs for supplemental foods, increasing bare ground feeding habitat for selected species.

Conservation tillage practices are recommended that leave waste grain and stubble on the soil surface until the next planting season to provide supplemental food or cover for wildlife, control erosion, and improve soil tilth. Shred, disk, and/or fertilize native vegetation to improve the growth and quality of plants. Many broadleaf plants (forbs - weeds and wildflowers) are beneficial to wildlife for forage and/or seed production. Encourage "weed and wildflower" species by selective application of chemical, biological (eg., grazing management) and/or mechanical means on native range lands and improved grass pastures. **A minimum of 5 percent of the designated area must be treated annually to qualify.**

TRANSITION MANAGEMENT OF TAME GRASS MONOCULTURES

Annually overseed improved grass pastures with locally adapted legumes (eg., clovers, vetches, peas) to increase the plant diversity, provide supplemental wildlife foods, and gradually convert the tame pastures to native vegetation as per wildlife and habitat plan. Legumes should be planted annually until all pastures are established to native vegetation. **A minimum of 25 percent of the designated area must be treated annually to qualify.**

PROVIDING SUPPLEMENTAL SHELTER

The best shelter and cover for wildlife is provided by a well managed habitat. Some practices can be implemented to provide types of shelter that may be limited in the habitat.

NEST BOXES, BAT BOXES

The installation of artificial boxes or cavities to provide nesting or denning habitat for selected species. **Number and location of nest boxes should be consistent with habitat needs and territorial requirements of the target species, and sufficient over the area to provide a real supplement to the target population and address an identified severe limiting factor as part of a comprehensive wildlife management plan.**

Proposed Nest Boxes, Bat Boxes Project(s) may include:

- Target species?

- Box type:
  - cavity type.
  - bat boxes.
  - raptor poles.

BRUSH PILES AND SLASH RETENTION

The planned placement and/or retention of brush piles to provide additional wildlife cover in habitats where cover is a limiting factor for the selected species. This practice also includes slash retention, or leaving dead brush on the ground where it was cut or uprooted, to provide wildlife cover and protection for seedlings of desirable plant species. Stacking posts or limbs in tepees can provide cover for small game and other wildlife in open areas. **A minimum of 1 percent of the designated area must be treated annually to qualify.**

FENCE LINE MANAGEMENT

Maintain, establish, or allow the establishment of trees, shrubs, forbs, and grasses on fence lines to provide wildlife food and cover, minimum of 30 yards wide. This practice is only applicable where cover is limiting in the habitat, i.e. cropland or tame pasture. **A minimum length of 100 yards of Fence Line Management per 1/4 mile of fence is required annually to qualify.**

HAY MEADOW, PASTURE AND CROPLAND MANAGEMENT FOR WILDLIFE

Intensively managed hay fields can benefit wildlife if mowing is delayed until after July 15.

Mowing/swathing of hay fields should be postponed until after the peak of nesting/rearing period of ground-nesting birds and mammals (July 15). Mow/shred 1/3 of open areas per year, preferably in strips or mosaic types of patterns, to create "edge" and structural diversity. A wide bar should be placed on the front of the tractor at a height of 1’ when mowing to help flush wildlife using this cover. Weeds are an important source of food for many wildlife species, therefore minimize weed control practices. Use no till/minimum till agricultural practices to leave waste grain and stubble on the soil surface until the next planting season to provide supplemental food or cover for wildlife, control erosion, and improve soil tilth. Other forms of supplementing and providing shelter include roadside right-of-way

management for ground-nesting birds, establishing perennial vegetation on circle irrigation corners, levees, dikes, terraces, fencerows and field borders, establishing multi-row shelterbelts or renovating old shelterbelts, and protecting and managing old homesites, farmsteads and Conservation Reserve Program cover. **Annually mow/shred 25% of open areas per year, preferably in strips or mosaic types of patterns, to create "edge" and structural diversity**.

Proposed Hay Meadow, Pasture and Cropland Management Project(s) should consider:

- Acreage to be treated
- Shelter establishment:
  - irrigation corners
  - road side management
  - terrace/wind breaks
  - field borders
  - shelterbelts
- Conservation Reserve Program lands management
- Type of vegetation for establishment:
  - annual
  - perennial
- List species and percent of mixture
- Deferred mowing
  - Period of deferment
- Mowing
  - Acres mowed annually
- No till/minimum till

HALF-CUTTING TREES OR SHRUBS

The practice of partially cutting branches of a live tree or shrub to encourage horizontal, living cover near the ground, providing supplemental cover in habitats where cover is lacking (see TPWD Bulletin 48) relative to an overall plan for target wildlife species. This practice is best done in the early or middle part of the growing season. **A minimum of one clump of trees/shrubs per 100 yards on at least 10 percent of acreage or 10 acres, whichever is smaller, annually to qualify.**

In open areas with very little near-ground cover, cutting half-way through the lower mesquite limbs and breaking them to the ground can form a "cage" that provides escape and roost cover for wildlife.

WOODY PLANT/SHRUB ESTABLISHMENT

Planting and protecting native seedlings to establish wind rows and shrub thickets, or to restore wooded habitats within former croplands, tame pastures or CRP land. **Plant a minimum of 500 seedlings annually; or 4 rows in a 120 foot width by a 1/4 mile in length.** Plantings should consist of native trees and shrubs that produce hard or soft mast, or provide nesting or escape cover. Plantings should be made in groups to provide both cover and additional food, rather than scattered individual trees. See last Appendix for list of native plants and shrubs.

Girdling trees is an effective means of creating snags, but be selective by avoiding mast producing trees (oaks, hickories) and judicious in extent.

NATURAL CAVITY/SNAG DEVELOPMENT

Retain and create snags for cavity-dwelling species. Undesirable trees can be girdled or individually treated with herbicide and left standing. **A minimum of 5 snags per acre, on 5 percent of the acreage, must be retained/created annually to qualify.**

CENSUS

A spotlight survey is an effective method to track deer populations, as well as rabbits and furbearers. This can also bring neighbors together in a common activity.

This activity provides an estimate of species numbers, population trends, population density, age structure, or sex ratio using accepted survey techniques. Results of annual surveys should be recorded on appropriate forms as evidence of completion of this practice. Selection of specific survey techniques should be appropriate to the species of interest and at a level of intensity to achieve proper management of the resource in connection with a comprehensive wildlife management plan.

Note: **For census activity to qualify for deer, a combination of methods must be used to obtain a reasonable assessment of the deer herd for habitat and harvest management. For most properties, this will require spotlight surveys, daylight or incidental observations, and harvest data for all deer (age, weight, and antler measurements). Similar intensity should be applied for other species to qualify in this activity.**

SPOTLIGHT COUNTS

Counting animals at night along a predetermined route using a spotlight. Spotlight counts should follow accepted methodology. **A minimum of three counts, or a minimum of 15 surveyed miles, must be completed annually.**

AERIAL COUNTS

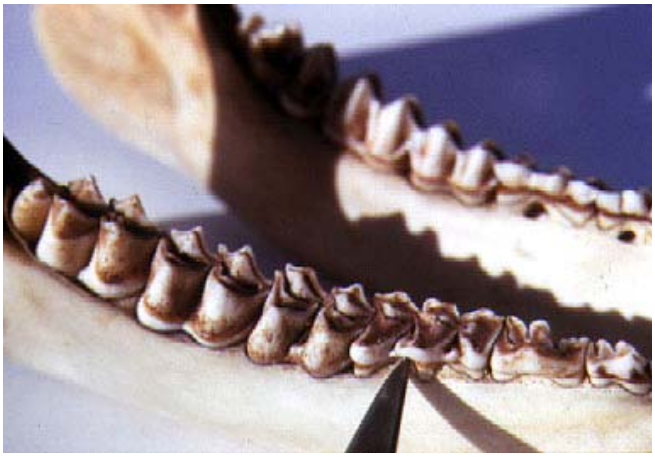
Use of a fixed-wing aircraft or helicopter to count animals. **Counts should employ accepted methodology for the region and be performed by a trained individual annually.**

DAYLIGHT DEER HERD/WILDLIFE COMPOSITION COUNTS/PHOTO STATIONS

Counts used to census deer in daylight hours to enhance information of sex/age structure (buck/doe/fawn), as well as determine annual trends in populations through dove, quail, and turkey sightings. **Counts should be conducted on standardized transects along 5 mile minimum lines and run at least 3 times (if shorter lines or used, a total of at least 15 miles must be surveyed), or through other standardized methodology to obtain at least 100 observations. On smaller tracts, as least five separate, two hour counts during early morning or late afternoon from deer stands (blinds) may be used.**

HARVEST DATA COLLECTION/RECORD KEEPING

Collect all age, weight, and antler development data from harvested deer. Age and sex information should be obtained from game birds and waterfowl to determine sex ratios and annual production.



Keeping good harvest records is essential to understanding effects on target populations. Lower jaw bones are used to age deer, and deer aging publications may be obtained from Texas Parks and Wildlife or your County Extension Agent.

BROWSE UTILIZATION SURVEYS

Annually (normally during the winter) examine deer browse species for degree of utilization on each major vegetative site on the property through vegetation

analysis and stem counts.

CENSUS OF ENDANGERED, THREATENED, OR PROTECTED WILDLIFE

Regular, periodic counts of the target species used to enhance management or increase knowledge of local, regional, or state status.

CENSUS AND MONITORING OF NONGAME WILDLIFE SPECIES

Regular, periodic counts of nongame wildlife species used to enhance management or increase knowledge of local, regional, or state status. This practice would also include developing checklists of wildlife diversity for the property, and should be a part of a comprehensive wildlife management plan.

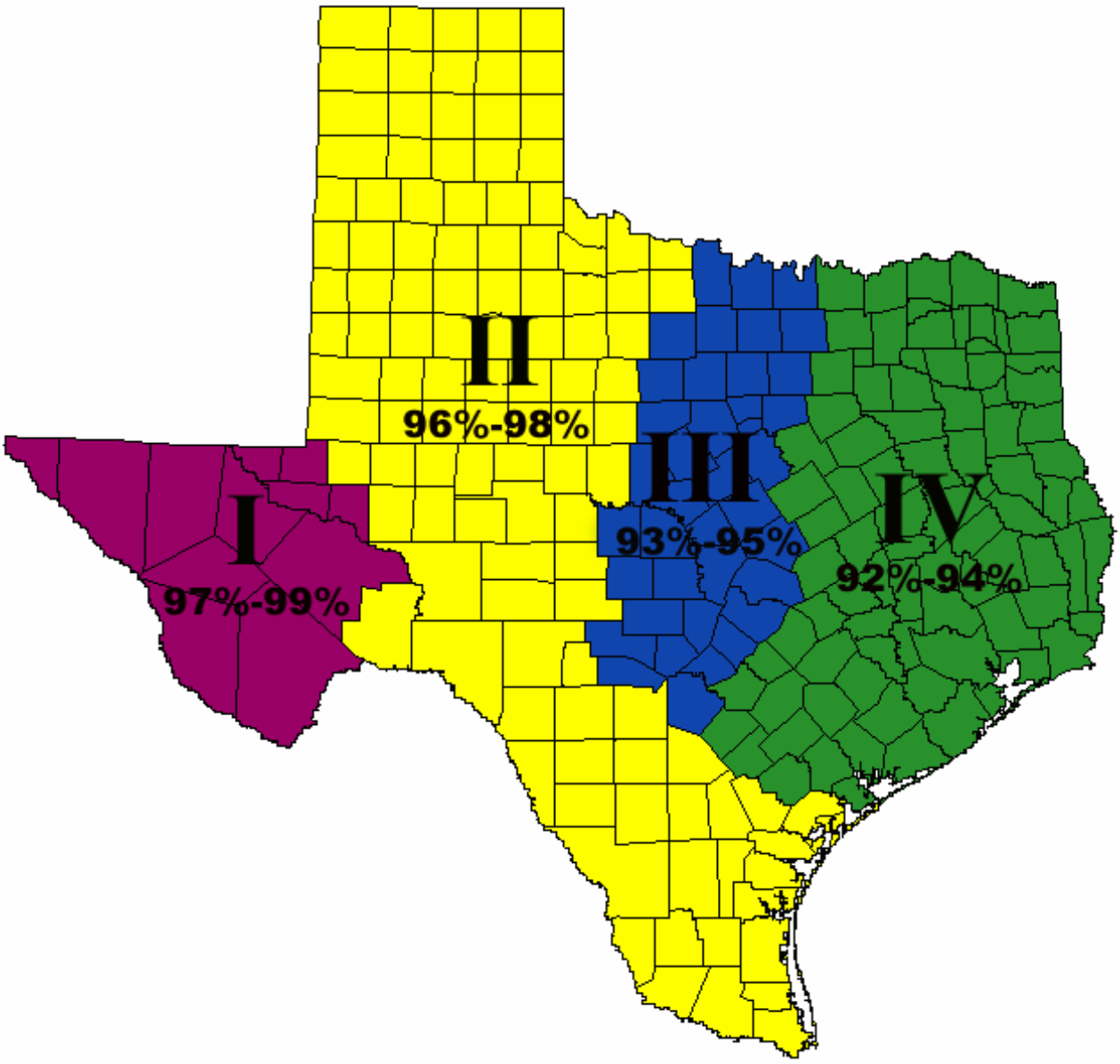
MISCELLANEOUS COUNTS:

Specific species may require special survey techniques. These may include the following and should be addressed in the management plan:

- Time/area counts
- Roost counts
- Song bird transects and counts
- Quail call and covey counts
- Point counts
- Drift fences and pitfall traps
- Small mammal traps
- Bat census (ex. Departures)
- Other. Describe: _____

Appendix B

Determining Qualification for Wildlife Management Use



Minimum Eligible Tract Size

With the exception of property being fragmented into smaller tracts, there are no minimum acreage requirements for conversion to wildlife management. For properties that since the previous tax year have been reduced in size *AND* had a change in ownership, the tract size must meet the minimum size as established by the county in order to qualify for wildlife management use. If the property does not meet the minimum size, but has threatened or endangered species, or deed restrictions, property owners' agreements, conservation easements or other legally binding covenants that obligate the landowner to do active wildlife management, then it is possible to still qualify based on a slightly lower minimum acreage as established by the County. These minimum sizes do not apply unless both of these conditions (change in size and change in ownership) exist. Refer to the flowchart on the next page to help determine your eligibility. Your county tax office can tell you the minimum acreage requirements.

Region 1— less than 97% (33.3 acres) or more than 99% (100 acres)
Brewster, Crane, Culberson, El Paso, Hudspeth, Jeff Davis, Loving, Pecos, Presidio, Reeves, Ward, and Winkler counties.

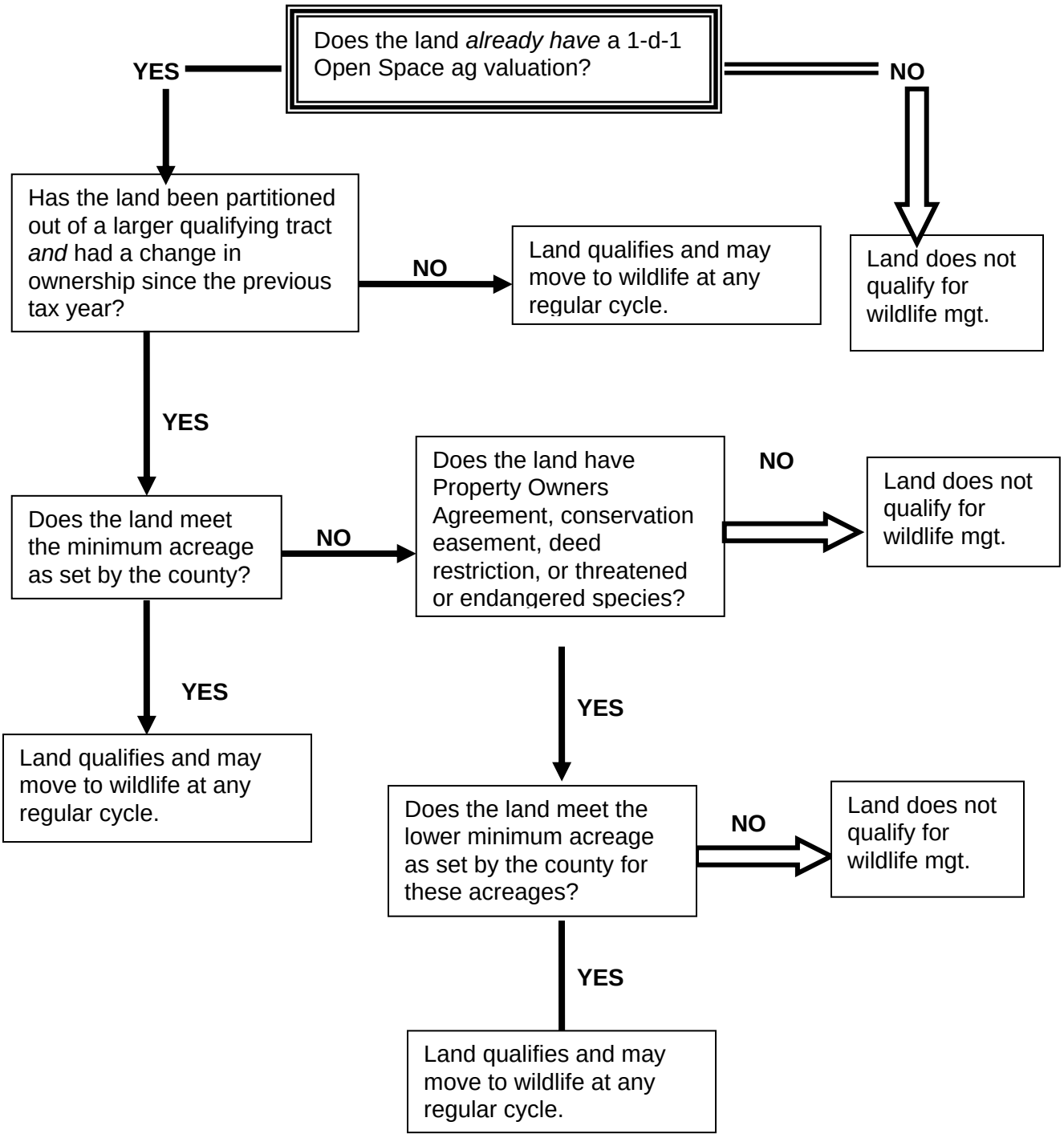
Region 2— not less than 96% (25 acres) or more than 98% (50 acres)
Andrews, Aransas, Archer, Armstrong, Atascosa, Bailey, Baylor, Bee, Borden, Briscoe, Brooks, Callahan, Cameron, Carson, Castro, Childress, Cochran, Coke, Coleman, Collingsworth, Concho, Cottle, Crockett, Crosby, Dallam, Dawson, Deaf Smith, Dickens, Dimmit, Donley, Duval, Ector, Edwards, Fisher, Floyd, Foard, Frio, Gaines, Garza, Glasscock, Gray, Hale, Hall, Hansford, Hardeman, Hartley, Haskell, Hemphill, Hidalgo, Hockley, Howard, Hutchinson, Irion, Jim Hogg, Jim Wells, Jones, Kenedy, Kent, Kimble, King, Kinney, Kleberg, Knox, Lamb, La Salle, Lipscomb, Live Oak, Lubbock, Lynn, McMullen, Martin, Maverick, Medina, Menard, Midland, Mitchell, Moore, Motley, Nolan, Nueces, Ochiltree, Oldham, Parmer, Potter, Randall, Reagan, Real, Refugio, Roberts, Runnels, San Patricio, Schleicher, Scurry, Shackelford, Sherman, Starr, Sterling, Stonewall, Sutton, Swisher, Taylor, Terrell, Terry, Throckmorton, Tom Green, Upton, Uvalde, Val Verde, Webb, Wheeler, Wichita, Wilbarger, Willacy, Yoakum, Zavala, and Zapata counties.

Region 3— not less than 93% (14.2 acres) or more than 95% (20 acres)
Bandera, Bell, Bexar, Blanco, Bosque, Brown, Burnet, Clay, Comal, Comanche, Cooke, Coryell, Denton, Eastland, Erath, Gillespie, Hamilton, Hays, Hood, Jack, Johnson, Kendall, Kerr, Lampasas, Llano, McCulloch, Mason, Mills, Montague, Palo Pinto, Parker, San Saba, Somervell, Stephens, Tarrant, Travis, Williamson, Wise, and Young counties.

Region 4— less than 92% (12.5 acres) or more than 94% (16.6 acres)
Anderson, Angelina, Austin, Bastrop, Bowie, Brazoria, Brazos, Burleson, Caldwell, Calhoun, Camp, Cass, Chambers, Cherokee, Collin, Colorado, Dallas, Delta, DeWitt, Ellis, Falls, Fannin, Fayette, Fort Bend, Franklin, Freestone, Galveston, Goliad, Gonzales, Grayson, Gregg, Grimes, Guadalupe, Hardin, Harris, Harrison, Henderson, Hill, Hopkins, Houston, Hunt, Jackson, Jasper, Jefferson, Karnes, Kaufman, Lamar, Lavaca, Lee, Leon, Liberty, Limestone, McLennan, Madison, Marion, Matagorda, Milam, Montgomery, Morris, Nacogdoches, Navarro, Newton, Orange, Panola, Polk, Rains, Red River, Robertson, Rockwall, Rusk, Sabine, San Augustine, San Jacinto, Shelby, Smith, Titus, Trinity, Tyler, Upshur, Van Zandt, Victoria, Walker, Waller,

Washington, Wharton, Wilson, and Wood counties.

Determining Qualification for Wildlife Management



Appendix C

Wildlife Management Plan Overview

Use this list to assist in planning your wildlife management activities

TREATMENTS	Practice	Year 1	Year 2	Year 3	Year 4	Year 5
Habitat Control:						
HC: Wildlife & Habitat Management Plan						
HC: Grazing Management						
HC: Prescribed Burning						
HC: Range Enhancement (re-seeding)						
HC: Brush Management						
HC: Vegetation Surveys						
HC: Fence Modification						
HC: Riparian Management and Enhancement						
HC: Wetland Enhancement						
HC: Habitat Protection/Species of Concern						
HC: Prescribed Control of Species						
HC: Wildlife Restoration						
Erosion Control:						
EC: Pond Construction						
EC: Gully Shaping						
EC: Streamside, Pond, Wetland Revegetation						
EC: Native Plant Establishment on Erodible Areas						
EC: Dike/Levee Construction/Management						
EC: Establish Water Diversion						
Predator Control:						
PC: Predator Management						
PC: Control of Brown-headed Cowbirds						
PC: Grackle/Starling Control						
Supplemental Water:						
SW: Marsh/Wetland Restoration or Development						
SW: Well/Trough/Windmill Overflow						
SW: Spring Development and/or Enhancement						
Supplemental Food:						
SF: Grazing Management						
SF: Prescribed Burning						
SF: Range Enhancement (Re-seeding)						
SF: Fence Modification						
SF: Food Plots						
SF: Feeders and Mineral Supplementation						
SF: Managing Tame Pasture, Old Fields, Croplands						
Providing Shelters:						
PS: Nest Boxes, Bat Boxes						
PS: Brush Piles and Slash Retention						
PS: Fence Line Management						
PS: Cropland Management						
PS: Half-Cutting Trees or Shrubs						
PS: Woody Plant/Shrub Establishment						
PS: Natural Cavity/Snag Development						
Census:						
C: Spotlight Counts						
C: Aerial Counts						
C: Daylight Wildlife Counts						
C: Harvest Data Collection & Record Keeping						
C: Browse Utilization Surveys						
C: Endangered, Threatened or Protected Species						
C: Nongame Wildlife Species						
C: Time/area Counts						
C: Roost Counts						
C: Song Bird Transects and Counts						
C: Quail Call and Covey Counts						
C: Point Counts						

Appendix D

Livestock Management Recommendations

CATTLE MANAGEMENT OPERATIONS ARE THE SINGLE-MOST IMPORTANT FACTOR THAT EFFECT DEER AND MOST OTHER WILDLIFE POPULATIONS IN THE POST OAK SAVANNAH AND MOST OF THE BLACKLAND PRAIRIE. Stock cattle at the NRCS (formerly SCS) recommended rate. Moderate to light stocking rates for well-managed pastures in this area are generally: one animal unit (cow with calf) per 8 - 15 acres on native grass; 3 - 6 acres on tame pasture; 50 - 75 acres on wooded areas. Where possible, rotate cattle in one herd through 3 - 10 pastures, letting pastures rest for at least as long as they are grazed. Rotate cattle out of wooded tracts wherever possible beginning in late August (when berries on American beautyberry begin to ripen) on through February - and/or - begin fencing off woods, especially bottomland areas to exclude cattle during this same fall/winter period. This practice will prevent cattle from competing with deer for browse and forbs - American beautyberry, greenbriar, elm, hackberry, yaupon, rattanvine, grape, tickseed clover, etc. - that deer normally require for healthy maintenance and growth. Also, fence off or exclude one or more acres of native pasture in scattered locations to provide tall grasses and weeds for fawn nursery areas and quail/turkey nesting areas.

Fences can be constructed of only 3-strand barbwire to discourage access by cattle. The bottom wire (this can be a smooth wire) should be at least 18 inches above the ground to permit deer easy travel under the fence instead of having to jump over. Top wires should be at least 12 inches apart.

A single electric wire fence 30 inches above the ground is also usually enough to discourage cattle, but permit deer easy access. Cost of electric fencing, using a solar charger- powered battery, is about one-third cost of barbed wire fencing.

Grazing Management Plan should include:

Kind of Livestock: Brahman, Hereford- Brahman Cross, Angus, Horses, etc.
Type of Livestock: Cow/calf, Steers, etc.
Stocking rate: One animal unit per _____acres.
Type of Grazing System: Three Pasture, Eight Pasture, Planned Deferment 1-2 years, etc.
Intensity and Duration: High Frequency-Short Duration, Controlled Grazing, etc.

Because "weeds" (broadleafed herbaceous plants) compete with grasses for growing space, nutrients, and moisture, their presence in rangeland plant communities is usually considered to be undesirable by most range managers, but they are important for wildlife. A well-planned livestock grazing system allows for a greater plant diversity, including a good component of forbs.

A range that has not been grazed for a long period of time, and is otherwise not periodically disturbed, can almost "stagnate" and become dominated by relatively few species of plants and exhibit limited variety and diversity. Therefore, total long-term deferment from livestock grazing is not normally recommended for optimum range and wildlife habitat management. Several growing seasons of deferment may be needed to allow an abused range to recover, but grazing should again be implemented after sufficient recovery is made.

Livestock should be considered as "tools" that can be used to maintain good wildlife habitat. A well-planned livestock grazing system is one that allows adequate rest periods for plants to recover after grazing. Most domestic livestock are selective grazers and consume the most nutritious and palatable plants first. Whenever a plant is eaten, there is not only a reduction in top growth but also a reduction in root growth. This reduces the plant's ability to rapidly regrow following defoliation. During the growing season, herbaceous plants need at least 30 to 60 days of rest to recover from grazing. Woody plants need as long as 4 to 6 months of rest to allow for regrowth. The recovery periods depend upon the severity of defoliation, moisture conditions, and temperature.

During continuous year-long grazing when livestock are left in a pasture for 365 days of the year, the most palatable plants are repeatedly defoliated. Frequent, repeated use will not allow seed production or plant recovery. Continuous grazing, even at light to moderate stocking rates, will remove the most desirable and palatable plants while the least preferred/least palatable plants that receive less grazing pressure become more dominant because of a reduction in competition. The result is a change in the species composition and an overall reduction in plant species diversity. Continuous grazing should not be used as a grazing method if the land manager's desire is to improve habitat for wildlife.

Several livestock grazing methods and systems have been developed which provide adequate periods of rest and allow vegetative recovery. There are many variations of these systems and the land manager needs to select the one that fits his particular situation. Some commonly used deferred-rotation grazing systems are: three pasture/one herd rotation, four pasture/one herd rotation, high intensity/low frequency (HILF), short duration, and four pasture/three herd rotation, or rest rotation. Regardless of the type of deferred-rotation grazing system used, the length of time that an individual pasture should be grazed, and the length of time that it would need to be rested before being grazed again, would be dependent on the size of the pasture, its grazing capacity, the time of year (growing season versus non-growing season), the amount of rainfall received since being grazed, and the class of livestock. Grazing schedules and livestock stocking rates for pastures within a grazing system need to be flexible and continually reevaluated based on rainfall patterns, seasons of the year, and local range conditions. Knowing how long to graze and how long to rest is more an art than a science, dependent more on environmental factors and the on-site conditions than on the calendar.

Below are brief descriptions of the different deferred-rotation grazing systems. There

are many variations of each system and the land manager can modify the grazing schedules to fit the local situation.

Three pasture/one herd rotation - The one herd of livestock is rotated through the pastures every 3 months. This allows each pasture to receive 6 months of rest before being grazed again. Over time, the pastures are grazed during different seasons of the year, with a 3 year interval before an individual pasture is grazed during the same time period again. For example, a pasture grazed from April through June during the first cycle, would be grazed from January through March during the second cycle, October through December during the third cycle, and July through September during the fourth cycle, before being grazed again during the April through June period during the fifth cycle. (This system should preferably be a step in moving toward a 1 herd/multiple pasture {4+} grazing system that provides a minimum of 75% of the land being rested at any one time.)

Four pasture/one herd rotation - The one herd of livestock is rotated through the pastures every 2 months. Each pasture also receives 6 months of rest before being grazed again, but the interval before an individual pasture is grazed again during the same time period is reduced to 2 years. For example, a pasture grazed April and May during the first cycle, is grazed December and January during the second cycle, and August and September during the third cycle, before being grazed again April and May during the fourth cycle.

High intensity/low frequency (HILF) - The number of pastures in this system is variable, but typically requires a minimum of 6 to 8 pastures. The livestock are kept in one herd, and each pasture is grazed intensely by the entire herd for approximately 1 to 1 1/2 months (high intensity), followed by a long period of rest (low frequency). The following are the calculations for determining how long each pasture should be grazed under a HILF system, using a system with 7 pastures as an example:

1.) add 1 to the number of pastures in the system (1+7=8)

2.) divide the number of days in a year by the answer from step 1 to determine how many days each pasture should be grazed (365 days divided by 8 = 46 days of grazing per pasture).

It would take 322 days (7 pastures X 46 days each = 322 days) to complete the grazing cycle, and each pasture would receive 276 days of rest between grazing periods.

Short duration system - This system requires that a ranch be divided into numerous pastures, typically a minimum of 12 to 20. The livestock are kept in one herd and the herd is rotated rapidly through the pastures. Each pasture is grazed intensely for a short period of time (a few days), followed by several months of rest. The length of the grazing cycle needs to be based on the season of the year and the amount of rainfall received during the cycle. For example, a 90 day cycle could be used during the growing season when plants recover more rapidly after being grazed. Each pasture in a short duration system that has 15 pastures, for example, would be grazed for approximately 6 days each (90 days divided by 15 pastures = 6 days per pasture)

during the spring and summer growing season. The grazing cycle would be completed in 90 days. Each pasture would receive 84 days of rest between grazing periods, which would hopefully be enough for sufficient plant recovery if adequate rain was received during the cycle. The cycle could be lengthened during the non-growing system when dormant warm-season plants can withstand heavier grazing pressure without damage. Each pasture in the 15 pasture system would be grazed for 10 days at a time under a 150 day cycle used during the winter, with 140 days of rest between grazing periods.

Four pasture/three herd rotation - The livestock are divided into 3 herds and stocked within 3 of the 4 pastures. One herd is moved to a vacant pasture every 4 months. This allows for an individual pasture to be grazed for 1 year and rested for 4 months. The four pasture/three herd system is the least preferred because of the long period of time that livestock remain in each pasture.

Rest-Rotation Grazing – One pasture in a multiple pasture system receives a year of rest on a rotational basis at least every third or fourth growing season. The system allows for year-long escape cover, nesting and foraging habitat, as well as seed-set.

A ranch must be divided into at least two pastures before even the least complex two pasture/one herd deferred-rotation grazing system can be implemented. If not cross-fenced, the land manager would need to have access to other areas where livestock could be moved to during the prescribed rest periods. Electric fencing is a lower cost/less labor intensive alternative to barbed wire for dividing a ranch into multiple pastures. For a deferred-rotation grazing system to be most effective, all the pastures in the system should be more or less equal in size and/or have similar grazing capacities (e.g., pastures on the most productive, deep soils of a ranch would have higher livestock grazing capacities and should therefore be smaller than pastures on shallower, less productive soils).

Individually fenced improved grass pastures on a ranch should be incorporated into a deferred-rotation grazing system. Rotating livestock through the tame grass pastures would help provide longer/more frequent periods of deferment for the native pastures since most species of non-native forages can generally withstand more intensive grazing pressure than native plants can. Note: most species of "improved" livestock forages (such as coastal bermuda, Klein grass, Old World bluestem, etc.) do not have much value to wildlife, except possibly as cover for some species, especially if grown in dense monocultures with very little diversity of native plants.

Since livestock are confined to individual pastures in a deferred-rotation grazing system, each pasture needs to have at least one source of water available when livestock are in that pasture. Creeks may provide adequate water during most of the year, but water from seasonal streams may become limited or inaccessible during extended dry periods. Also, concentrated livestock activity around creek waterholes can cause excessive damage to the plants and soils in the area. Earthen stock tanks and/or water piped to troughs from a well may provide better, more reliable, sources of water. One water source can serve several pastures if properly located. For example, one water

trough could serve two pastures if straddled by a cross-fence, or a trough in a separately fenced "waterlot" constructed at the juncture of several cross-fences could serve numerous pastures.

A deferred-rotation grazing system will fail to produce the desired results of maintaining a healthy and diverse plant community if the range is overstocked with animals, both domestic and wild. The appropriate livestock stocking rate for a specific ranch is dependent on that ranch's herbaceous plant productivity and past grazing history. The stocking rate can vary from year to year, and seasonally within a year, depending on environmental factors. Stocking rates should be calculated on grazeable land, excluding dense woods or brush, or water. The impact of grazing animals should be closely monitored and the number of livestock on a ranch may need to be frequently adjusted to account for the variations in a ranch's grazing capacity.

A rule-of-thumb livestock stocking rate for well managed native grasslands in the Post Oak Savannah and Blackland Prairie of east and central Texas is 1 animal unit (a.u.) per 8-15 acres; 3 - 6 acres on tame pasture; and 50 - 75 acres on primarily wooded areas. The combined total of all animals on the range, including all classes of livestock as well as deer and exotics, must be considered when determining stocking rates. The following equivalent values of animal unit standards can be used for planning the management of rangelands:

Cattle	
weaned calves to yearlings	0.6 animal unit
steers and heifers (1 to 2 years)	1.0 animal unit
mature cows, with or without unweaned calves at side	1.0 animal unit
bulls (2 years and over)	1.3 animal unit
Sheep	
5 weaned lambs to yearlings	0.6 animal unit
5 mutton or ewes (1 to 2 years)	1.0 animal unit
5 mature ewes, with or without unweaned lambs at side	1.0 animal unit
5 rams	1.3 animal unit
Goats	
6 weaned kids to yearlings	0.6 animal unit
6 muttons or does (1 to 2 years)	1.0 animal unit
6 does, with or without unweaned kids at side	1.0 animal unit
6 bucks or muttons over 2 years	1.3 animal unit
Horses	1-1.5 animal unit
Deer	

6 deer 1.0 animal unit

Exotics (depends on the species; use animal unit standard set for similar size domestic animal)

A well-planned cattle grazing system is compatible with wildlife habitat management. Since cattle primarily consume grass, they do not normally compete with most wildlife for the same food sources, unless forced to due to excessive stocking rates and/or continuous grazing pressure. However, goats and sheep more directly compete with wildlife. Goats prefer browse (the foliage of woody plants); sheep prefer forbs. The foliage and seeds of forbs and woody plants are important food sources for many species of wildlife. Excessive goat browsing also reduces the amount of low-growing woody brush needed for cover for many wildlife species and can limit the reproduction of woody plants. It is recommended that sheep or goats not be stocked on a ranch if maintaining and improving the habitat for wildlife is an objective, unless 4-6 months rest can be periodically provided in pastures to allow for the adequate recovery of woody plants.

It is recommended that when leasing grazing rights, there be a written livestock grazing lease agreement that as a minimum specifies a maximum stocking rate and that a rotational grazing system will be used. Grazing schedules (how long each pasture will be grazed and how long each will be rested) and stocking intensities need to be flexible and continually reevaluated based on rainfall patterns, seasons of the year, and local range conditions. The landowner needs to retain the rights to require the lessee to reduce, and in some instances increase, the number of livestock depending on range conditions, and to require that range plants receive appropriate periods of rest. As a suggestion, it may be to the landowner's benefit to receive grazing lease "payment" in the form of facilities/habitat improvements (fence repair, additional cross-fence construction, cedar control, prescribed burning, discing to encourage forb growth, etc.) in lieu of monetary reimbursement. A good, trustworthy lessee can be an asset to a landowner, helping to maintain and improve the quality of the habitat as well as serving as the landowner's "eyes and ears" in his absence. Conversely, a lessee who is more concerned with maximum, short-term economic gains rather than the long-term sustained health of the land can be a liability.

Appendix E

Vegetation Management Recommendations

In the Post Oak Savannah and Blackland Prairie, managing native vegetation (browse, weeds, grasses) to prevent continuous overuse by deer or cattle so that the native vegetation provides the majority of nutrition year-around for deer and other wildlife should be of primary concern. Over 50 percent use of most species on a continuous basis will stress vegetation, causing less production or killing of the plant.

Managing or planning for the long term, considering wet years as well as drought years, and not carrying more livestock or deer than the land will support during poor as well as good years should be the overall goal.

Wildlife have a certain requirement for cover. Cover provides a sense of security from disturbance and protection from inclement weather and predators. The amount and kind of cover vary with the species. A stand of herbaceous plants may provide adequate cover for some bird species and small mammals, while other species require woody cover (trees and shrubs) in lieu of or in addition to herbaceous cover. The best cover for a large species such as white-tailed deer in the Post Oak Savannah and Blackland Prairie is a pattern or mosaic of woody brush and trees interspersed within open areas at an approximate 1/1 ratio of open area to woody cover. Clumps or strips of brush should be wide enough so that an observer cannot see through them from one side to the other during the winter months when deciduous species are bare of leaves. Cover strips should be as continuous as possible to provide travel lanes. Deer and other wildlife can be displaced by disturbance from an area without adequate escape cover. A habitat that provides several different types and arrays of cover benefits more species of wildlife than a habitat that has limited types, amounts, and distribution of cover.

During the past 30 - 40 years, an estimated 25 percent or more of the Post Oak Savannah has been planted to mono-culture tame grasses such as Coastal or common bermuda, bahia, Klein grass, etc. (often requiring the clearing of hardwood timber). Overseeding these existing pastures with clovers, or gradually returning this acreage to native grasses and forbs can make these areas more productive for wildlife.

Upland hardwoods and the associated understory vegetation over the area presently vary from heavily over-browsed by cattle and sometimes deer, to a dense yaupon understory shading out virtually all other browse and mast- bearing species. Good cattle management, utilizing rotation and/or excluding cattle from wooded areas via fences, coupled with periodic winter prescribed burning could revitalize these sites, making them much more productive. Sound deer and feral hog (including other large exotics, such as axis, sika,etc.) harvest strategies are also needed to prevent overuse of food and cover. Native white-tailed deer and feral hogs (and large exotics if present) are the only wildlife species present in the Post Oak Savannah and Blackland Prairie that can degrade or virtually destroy the habitat for not only themselves, but for the

many smaller mammal and bird species that rely on the same vegetation for food and/or cover.

Many bottomland hardwood sites have also been heavily grazed/browsed by cattle, and in some instances deer. As with upland sites, rotation or exclusion of cattle, coupled with sound deer and feral hog harvest strategies can improve these situations. Large (1,000 acres +), unbroken tracts of climax stands of bottomland hardwoods are scarce. At least 65 percent of bottomland hardwoods have been lost to reservoir construction and agriculture activities. Loss and fragmentation of this nesting habitat for neotropical migratory songbirds appears to be a prime factor in the decline of many species that require relatively unbroken tracts of hardwoods. Harvest of high quality (high-grading) large oaks and pecans (high mast producers) in the past in some sites has resulted in mostly "weedier species, less valuable for wildlife" such as ash, elm, hackberry, sweetgum, etc. dominating these sites. Good timber management, utilizing a competent agency or private timber consultant, can prevent this scenario and help restore these abused sites to a more productive state.

Riparian area management has often been overlooked by land managers. These areas may have been impacted through poor timber harvest practices, and/or excessive, long-term livestock use. These low areas along stream courses, laying between uplands and streams/rivers, are capable of producing very important cover and food sources if managed properly. Riparian areas also function as important protected travel corridors, connecting feeding areas, fawning/nesting areas, and roost areas. These corridors (at least 100 yards wide) can provide connections to other wildlife populations and also prevent soil erosion. Reestablishment of native trees, shrubs, or herbaceous vegetation where needed can return this acreage to a functional, more productive part of the habitat. Providing alternate livestock feeding and watering sites by planned rotational grazing of livestock or fencing livestock out of these areas are also sound management techniques. It is usually best to defer or protect riparian areas from grazing during the growing season - April through October.

Management of vegetation, whether it be deciduous post oak woodlands, bottomland hardwoods, mesquite woods, or open grasslands, requires long-term planning. Any vegetation manipulation practice will have an impact on resident wildlife species, either good or bad, depending on the type of treatment used, the degree of use, and location. Before implementing vegetation control techniques, determine what the long-term effects will be for each wildlife species that occurs in the area and minimize the negative impacts. Consider the location and size of sensitive wildlife habitats that provide important nesting or roosting sites, feeding areas, desirable wildlife food producing plants, cover, water, and space needs. Wildlife can be displaced by disturbance from an area without adequate escape or security cover. The amount and distribution of cover on adjacent lands need to be taken into consideration when assessing the cover needs of wide-ranging wildlife species such as deer and turkey. A small ranch would need a larger amount of security cover on a percentage basis than would a larger ranch where the vastness of the area provides security.

The control of plant species such as ashe juniper, eastern red cedar, mesquite, prickly pear, Chinese tallow tree, locust, elm, and hackberry that invade a variety of rangeland sites is often warranted. When these species dominate an area, they diminish plant diversity and the quality of habitat for most wildlife species. Vegetation manipulation may be in the form of prescribed burning, range reseeding, native grass restoration, and mechanical, biological, or herbicide control of trees, brush, or weeds, and is important to create and maintain open rangelands for grassland dependent wildlife. Most of these practices will require the use of specialized equipment or machinery for plowing, discing, bulldozing, spraying, or other vegetation or soil manipulation procedures. The cost effectiveness of the different control measures must be considered prior to initiation of control measures.

Prescribed burning is an effective, low-cost habitat management tool that can be used to enhance plant diversity by stimulating the production of a variety of forb and grass species and to maintain woody plants at the low heights most beneficial to wildlife. Livestock as well as wildlife can benefit from a properly planned and conducted prescribed burn. However, there are legal constraints and liabilities in the use of fire. The land manager should be well-trained and knowledgeable on the proper use of fire before attempting a prescribed burn. Refer to Texas Agricultural Extension Service bulletin "Prescribed Range Burning in Texas" for details on the use of fire as a range management tool.

Prescribed Burning Recommendations: To maintain oak woodlands with dense, diverse, understory, prescribe burn about 15 percent of upland woodland sites during late November (after frost and leaf drop) through February (before green-up) on a rotating basis, burning each site every 5 - 7 years to remove old growth and stimulate new growth of browse and forbs (weeds and wildflowers). About 50 - 100 acres per burn site would be the maximum size to burn on these particular land tracts. In order to have enough low-level fuel to produce a hot fire, one or two years of cattle exclusion from wooded tracts may be necessary to allow growth of vegetation normally grazed by cattle. Prescribe burning of these woods shortly after leaf drop and before winter rains and time compact leaf litter, may be necessary for some tracts and should be considered.

To restore and maintain oak savannah / native grasslands, prescribe burn about one-third of native grass openings each year, burning each site every three years, on a rotating basis, to remove old growth and young, invasive woody growth such as cedar, locust, and persimmon. This will stimulate new growth of plants that may have become dormant due to not having occasional fires to stimulate growth. Pasture burn sites should normally be less than 40 acres and be burned in late summer (late August through September) weather conditions permitting. See TCE publication Prescribed Range Burning in Texas for good general guidelines, especially for native pastures. About seven times more insects are usually found in burned native grass areas compared to unburned areas, thus providing much more spring and summer high protein food for quail, turkey, and other insect-eating birds, especially for the young.

General burn prescriptions for Post Oak Savannah and Blackland Prairie woodland and native pastures are:

1. Prepare disked bare-ground fire guard around all sites before burning. Disked fire guards, which can include roads and right-of-ways, should be 15 to 20 feet wide. (These disked areas can be planted to winter supplemental food plots between burn years.

2. Humidity should be between 25 - 40 percent.

3. Wind speed should be between 10 - 15 miles per hour.

4. Always burn into the wind first (backfire) 50 yards into the woods or pasture, then set fire with the wind (headfire). The entire burn may be conducted with a backfire, depending on fuel and weather conditions and burning experience of crew.

5. Initiate burns in the morning, after 9:00 a.m.

Consult with TPWD, Natural Resources Conservation Service (NRCS, formerly Soil Conservation Service, SCS), or Texas Forest Service, and notify local volunteer fire department before conducting burns.

It is often necessary for a pasture or woodland to receive a period of deferment from livestock grazing to allow for a build-up of enough fuel (herbaceous or non-woody plant litter) to carry a fire. Cattle should be excluded from burned areas for at least 3 months to allow regrowth of new, tender vegetation.

Prescribed burning can be the most inexpensive and effective habitat management technique for the Post Oak Savannah and Blackland Prairie area.

The use of mechanical equipment to control woody plants will typically result in an initial growth of forbs and annual grasses and the resprouting of many woody species. Soil disturbance associated with mechanical controls releases the natural seed bank found in the soil, increasing the quantity, quality, and distribution of plants beneficial to wildlife. However, without periodic follow-up treatments of fire, herbicides, or additional mechanical manipulations, and/or without proper livestock grazing management, these sites will eventually again become dense stands of regrowth brush and trees. Mowing (shredding) areas of herbaceous plants and/or low density woody plants is another form of mechanical treatment. Mowing should be postponed until after the peak of the nesting/young-rearing period of local ground-nesting birds and mammals. One-third of open areas can be mowed per year, preferably in strips or mosaic types of patterns, to create "edge" and structural diversity.

Biological control is the use of heavy grazing pressure by livestock such as goats to control or suppress woody plants and sheep to control herbaceous weeds. Under certain management goals, biological control of woody plants and forbs can be a

legitimate practice if done correctly. However, it is not normally a recommended wildlife habitat management practice. Long-term heavy grazing pressure by goats, which prefer woody browse but will also consume forbs, will eliminate all leaves from woody plants up to a height of four feet. The creation of this "browse line" and the resulting park-like appearance of the woody plant community will have negative effects on the wildlife species that also depend on the low-growing foliage of woody plants for both forage and cover. Heavy grazing pressure by sheep, which prefer forbs, will reduce or eliminate forbs that are also beneficial to wildlife.

There are many specifically formulated herbicides on the market today that can selectively control unwanted vegetation to enhance wildlife habitat. Determining the proper product and application technique requires consultation with TCE, NRCS, or TPWD personnel. Always advise that wildlife is a goal for your projects of this type. If herbicides are improperly used, they can have a significant negative impact on many plant communities and may suppress or eliminate plants other than the target species. Selective application methods, rather than broad-scale applications, are recommended to avoid the elimination of plants that are important to wildlife.

Control of Mesquite, another woody invader infesting many range sites in central Texas may be necessary on some sites. Its growth form varies from a multi-stemmed shrub to an upright tree. Adaptable to a variety of soil types, mesquite can colonize and dominate open rangelands, old fields, and other areas where ground cover has been reduced and fire eliminated from the environment. Mesquite sprouts from buds along a compressed, buried section of the stem called the "crown". Control by grubbing, bulldozing, root plowing, and chaining of mature-size trees has proven successful under proper soil moisture conditions. Several approved herbicides are also available for control. Shredding, on the other hand, or other practices that only remove top growth but do not involve removal of the crown, is not recommended and may result in further sprouting. Any control planning should proceed with good common sense and a sense of aesthetics.

Mesquite seed pods are readily eaten by wildlife and livestock, resulting in the dispersal of undigested seeds across the landscape. Seeds may remain dormant for extended periods of time and germinate when the right conditions or soil disturbances occur. Young mesquites can quickly become established and grow rapidly, particularly when competition from other plants is reduced by heavy grazing pressure.

Like red cedar or ashe juniper, mesquite does have some redeeming qualities. It provides seed pods that are a beneficial although sporadic food source, microclimates for cool season grasses and forbs that may be important to plant diversity, nitrogen fixing roots, and cover that is beneficial to many wildlife species.

Range enhancement involves range reseeding and native grass restoration. Establishing native herbaceous plants (grasses and forbs) that provide food and cover, benefits wildlife and provides erosion control benefits. Plant species selected and methods for establishment should be applicable to the county. Non-native species are

generally not recommended, but if required for a specific purpose, non-native species should not exceed 25 percent of the seeding mix. Seeding mixtures providing maximum native plant diversity are recommended. Key grass species adapted to the Post Oak Savannah and Blackland Prairie are: little bluestem, big bluestem, indiangrass, sideoats grama, and switchgrass. Many herbaceous broadleaf plants (known as forbs - weeds and wildflowers) are beneficial to wildlife for forage and/or seed production. Some important ones for these ecoregions are: native sunflower, tick clovers, three-seeded mercury, ragweeds, crotons, vetches, dayflower, cutleaf primrose, bur clover, sweet clovers, smartweeds, lespedezas, partridge pea, sensitive briar, snow-on-the-prairie, Illinois bundleflower, and Engelmann daisy.). Encourage "weed and wildflower" species by selective application of chemical, biological (eg., grazing management) and/or mechanical means on native rangelands, Conservation Reserve Program lands, and tame grass pastures (eg., coastal bermuda). Natural Resource Conservation Service personnel in the area can provide detailed recommendations on range and native grass reseeding, designed to meet individual goals. Refer to Appendix K for native grass restoration guidelines.

Farming Practices: Delaying of shredding or mowing of hay or native grass pastures until after July 15 will usually avoid killing of young fawns or ground nesting birds by accident.

Use Integrated Pest Management to minimize pesticide applications (consult the Texas Department of Agriculture, Austin). If necessary, spot spraying is much preferred over broadcast spraying especially for broad-spectrum herbicides. Spray early in the spring while plants are still small, requiring less spray. Many "weeds" are important to wildlife.

To provide weed seeds (ragweed, croton, sunflower, partridge pea,trailing wild bean, etc.) that are the basis of quail, dove, and other seed-eating bird's fall and winter diets, shallow disk 10 - 20 foot wide strips in sandy soil around the edge of brush and woods after the first freeze. This practice will promote growth of these important forbs the following spring and summer.

Appendix F

Specific Management Recommendations for White-tailed Deer

Before entering into a discussion on the management of white-tailed deer, it should be noted that because of the large home range size of deer, adjacent lands are also included in the home ranges of many of the deer on a ranch less than 3,500 acres in size. Only those deer within the interior of a larger ranch may have home ranges located totally within the ranch, while those in a wide band around the ranch's perimeter likely move back and forth onto adjacent lands. The quality of a ranch's deer population will in large part be dependent on the habitat quality and deer population management strategies (i.e. hunting pressure and deer harvest) found on the adjacent lands. As 60 percent of the acreage in east Texas and much of central Texas is comprised of land tracts 200 acres or less, it is important for landowners to work with neighboring adjacent landowners to achieve deer/wildlife management goals. Formation of landowner wildlife management co-ops or associations is a practical, workable solution. TPWD or TCE personnel can assist with formation of these WMA's.

General:

The key to producing a productive and healthy white-tailed deer population is dependent upon the quantity, quality, and variety of food plants produced by the habitat or range. Food availability can be improved by: (1) harvesting deer, including does, to maintain total deer numbers at or below the capacity of the habitat; (2) not stocking with exotic big game animals, or keeping their numbers at a low level, since exotics compete with white-tailed deer for browse, forbs, and mast; (3) stocking the range with a moderate number of domestic animals (preferably species that do not directly compete with deer) and utilizing some form of a deferred-rotation system of grazing, and; (4) controlling invading "noxious" woody vegetation, such as cedar, mesquite, or Chinese tallow tree not needed for cover or food to reduce competition and increase the production of grasses for cattle and the production and availability of browse and forbs preferred by deer.

Understanding food habits of deer is fundamental to management. Studies have shown that deer prefer forbs (weeds and wildflowers) and browse (leaves and twigs from trees or shrubs). Grasses make up a very small portion of a deer's diet and they are utilized only when tender and green. Deer cannot digest mature grasses. Forbs are generally high in protein and important to deer size, antler development, and fawn production.

However the production, quality, and palatability of forbs is highly dependent on rainfall and the season of the year. Forbs will be absent or unpalatable at least during portions of a year, typically during late summer and late winter. Key browse plants occurring in east and central Texas include honeysuckle, rattan-vine, post oak grape, Carolina jessamine, trumpet creeper, bumelia, dogwoods, American elderberry, Oklahoma plum, sugar hackberry, winged elm, and cedar elm, which are rated as "preferred" species. "Moderately preferred", but also good, species include skunkbush sumac, flameleaf sumac, coralberry, poisonivy, possumhaw, blackjack oak, chinkapin oak, post oak, yaupon, Texas redbud,, common greenbrier, netleaf hackberry, and Virginia creeper. Many woody plants also produce mast (acorns, fruits, or beans) that is readily eaten by deer, but mast production is erratic and therefore it is not as reliable as a food source as the foliage. Oaks and pecans are important mast producers.

Not all of the above species are found throughout the Post Oak Savannah or Blackland Prairie. Browse is the stable component of deer diets and, unlike forbs, is available throughout the year and is relatively drought resistant. Although utilized by deer throughout the year, browse becomes most important during the winter and summer stress periods when forbs are absent or unpalatable. The woody species found in an area are dependent the ranch's geographic location and soil types. The quantity and species diversity of woody plants is typically greatest on the deeper soils of riparian areas along the stream courses and lowest on the shallow soils of the prairies.

Antler development (main beam length, antler spread, basal circumference, and number of points) is dependent upon three factors: nutrition (quantity and quality of food), age, and genetics. Nutrition: Nutrition can be optimized by the methods discussed above: controlling the numbers of deer and exotic ungulates, utilizing a rotational system of domestic livestock grazing with moderate stocking rates, and controlling noxious vegetation. Supplemental feeding and supplemental plantings, in conjunction with the above practices, can be used to help meet the nutritional needs of deer. Both practices will be discussed in more detail in a later section.

Age: Maximum antler development of buck deer is attained at 5 to 6 years of age. Allowing bucks to reach older ages through selective harvest will allow them to attain their potential antler growth.

Genetics: Spike antlered bucks are the result of inadequate nutrition, genetics, or a combination of these two factors. Research has shown that yearling (1 1/2 year old) bucks have the potential to normally produce 8 points as their first set of antlers if nutrition is adequate and they have the proper genetic background. Conversely, bucks may only produce spike antlers as yearlings if they have "spikes genes", even with adequate nutrition. Although the subsequent sets of antlers of yearling spikes generally will not be spikes, their antlers tend to be inferior to those of bucks that were forked antlered as yearlings. Consequently, the incidence of inferior antlered bucks in the population should be minimized by the combination of optimizing nutrition (habitat management) and including spike antlered bucks in the total deer harvest.

Stocking deer from another area into a deer population in an attempt to introduce new genes and improve quality is a controversial and much discussed subject. The genetic contribution of one individual buck is limited where it is introduced into a population where other bucks are already present and also breeding does. There is no research available that indicates that introducing several bucks improves quality. Unless the pedigrees of the deer (bucks as well as does) stocked are known, there is a good chance that undesirable, but not easily recognizable, characteristics are being introduced. Stocking deer is costly. Also, the animals may have difficulty adapting to their new environment and mortality can be unusually high. It is much better to work with the resident population and cull bucks with poor antler characteristics and retain bucks with desirable characteristics. There are numerous examples where the "native" deer in a area where the average antler quality has been historically low have produced outstanding antlers through a combination of good habitat management, population management, and supplemental feeding. Deer within these populations had the genetic potential for large antlers, but were unable to express their potential because of inadequate nutrition and/or they were harvested before reaching mature ages.

Cover Requirements:

The best cover for white-tailed deer is a pattern or mosaic of woody brush and trees interspersed within open areas at an approximate 1/1 ratio of open area to woody cover. Clumps or strips of brush should be wide enough so that an observer cannot see through them from one side to the other during the winter months when deciduous species are bare of leaves. Cover strips should be as continuous as possible to provide travel lanes.

Population Characteristics:

Maintaining the deer population density within the food supply is very important to prevent die-offs during extreme habitat conditions, such as during droughts. Maintaining deer numbers within the carrying capacity will improve fawn production and survival, increase body size and improve antler development, and prevent habitat deterioration from overuse. The rule-of-thumb winter carrying capacity for east and central Texas is 1 deer per 10 acres in bottomlands and 1 per 25 acres in uplands.

Overuse of preferred vegetation on rangeland that is overpopulated with deer and/or overstocked with domestic animals on a long term basis can kill individual plants and prevent woody plant seedlings from being established, leading to a decline in the carrying capacity.

The objective is to maintain deer numbers at a level where every deer in the population is receiving adequate nutrition without causing a degradation in the quantity and quality of native range plants. Factors such as fawn production, body size, antler development, and degree of browse utilization are good indicators to monitor to evaluate if a range is stocked at, above, or below its carrying capacity. As with cattle, it is better to maintain the deer population just below carrying capacity of the range.

An unbalanced sex ratio favoring female deer results in a limited number of bucks available for harvest. Also, a surplus of does can contribute to a rapid increase in deer numbers with the potential for exceeding the carrying capacity of the range. The recommended sex ratio for a free-ranging deer herd in east and central Texas is 2 does per 1 buck.

The fawn production objective is .75 fawns per doe or better.

Method(s) Used to Determine Population Density and Composition:

The spotlight deer census technique is the primary method used to estimate population density (acres per deer). It can also be used to make an estimate of herd composition (buck/doe/fawn ratio). Refer to **Appendix L** for detailed information on conducting spotlight deer censuses.

Incidental daylight observations of deer should be used to improve herd composition estimates and for rating the quality of antlered deer. Daylight observations (totaling100 deer, if possible) should be recorded by sex, age (adult or fawn), and antler quality (number of points, spread, etc.). Daylight observations can be made by slowly driving pasture roads during early morning and late evening hours. On smaller tracts, or where driving is not practical, observations from deer stands during these same time periods (before the hunting season) can be used. Hunters can also record observations of deer during the opening weekend of hunting season to supplement herd composition estimates. Refer to **Appendix M** for detailed information on conducting incidental daylight observations.

The surveys should be conducted on an annual basis during the late summer and early fall (August 1-September 15), during the time of the year when bucks have identifiable antlers and fawns are old enough to be up and moving around yet still small enough to be recognized as fawns. Replicating the spotlight census 3 to 5 times (a minimum of 15 surveyed miles) during the annual census period will increase the sample size and improve the population estimates. A minimum of 100 daylight observations (or as many as practical) of deer should be recorded. Binoculars should be used to aid in identifying deer.

The aerial (helicopter) census technique is another deer census technique that can possibly be used in central Texas, but it is not well-suited for estimating deer density (number of deer) in areas with dense woody cover and/or a tall overstory of trees which is typical of most of the Post Oak Savannah and Blackland Prairie. The greatest values of an aerial census are the herd composition and buck antler quality estimates that can be made by observing a large sample size of deer in a short period of time. A total coverage aerial census could be used periodically, perhaps every 3-5 years, to verify and support density, herd composition, and antlered buck quality estimates derived from annual spotlight censuses and incidental observations.

Biologists with the Texas Parks and Wildlife Department can provide assistance to establish the census route(s), demonstrate the techniques, and help conduct the initial census. The landowner/manager will then be encouraged to conduct all subsequent censuses and provide the data to the Department biologist for assistance in analyzing it and making harvest recommendations.

Recommendations for Harvest or Other Use:

Harvest is the key method to manage a deer population. It is utilized to maintain deer numbers within the carrying capacity, or food supply produced by the range. Harvest also is used to obtain and maintain a desired adult sex ratio and a desired age structure of the population by adjusting both the buck and doe kill.

Bucks: The harvest rate of bucks will be dependent on the objectives of the land owner/manager. One of the concerns that the Texas Parks and Wildlife Department has about the deer herd in many areas of east and central Texas is the young age structure of the buck segment of the herd. Typically, 50% or more of the annual buck harvest is composed of 1 1/2 year old bucks, an indication of heavy hunting pressure. If one of the deer management objectives is to produce bucks with larger antlers, they must be allowed to reach older ages, which means that the harvest of young, immature bucks should be restricted. Restricting hunters to mature bucks only (in addition to spikes) is a good management strategy. Deer body characteristics, in addition to antler characteristics, should be used to determine the relative age of bucks "on-the-hoof". However, since many of the deer on a ranch will also roam onto neighboring lands, the benefits of not harvesting young bucks may be partially negated if these bucks are subject to being harvested on adjacent lands. For a deer population management program to be most successful in an area, most or all the land managers in the area must have similar deer harvest strategies.

Under a Quality Management strategy, buck harvest must be restricted to 20% or less of the estimated buck population. This limited harvest will result in low hunter success rates, but will permit a significant portion of the buck population to reach maturity (4 1/2 years old and older) and increase the proportion of bucks in the population. This strategy may only have limited success on smaller tracts of land (5,000 acres or less that are not high-fenced) where hunting pressure on surrounding lands is moderate to heavy.

Under a Quantity Management strategy, up to 50% of the estimated buck population can be harvested annually to provide maximum hunter success. This strategy will result in a relatively young, immature buck herd, with most of the bucks harvested being 1 1/2 to 2 1/2 years old.

Under an Optimum Management strategy, 30% to 33% of the estimated buck population is harvested annually to allow for a generally acceptable level of hunter success while restricting pressure on bucks that allows a portion of the buck population to reach older age classes.

The harvest of spike antlered bucks should be included in the buck harvest quota, not added to the quota, regardless of the management strategy used. Spikes may comprise from 20% to 50% of the total buck harvest quota. Harvesting spikes will remove poor quality bucks from the herd at an early age. Also, if spike antlered bucks comprise a portion of the buck harvest quota, hunting pressure will be reduced on the better quality bucks.

Does: The recommended doe harvest will depend upon the overall deer density, the estimated carrying capacity of the range, the observed sex ratio, and fawn production and survival.

Note: Specific harvest recommendations for both bucks and does should be made annually after deer censuses are completed.

Records Management:

Records should be kept to monitor the status of the deer herd and measure the success of management over time. As a minimum, record keeping should include:

1.) annual deer population data (census data)
2.) number of deer harvested annually
3.) biological data from deer harvested, to include:
a.) field dressed weight
b.) antler measurements: inside spread, number of points, main beam lengths, circumference of antler bases. The Boone and Crockett antler scoring system can be used to measure overall antler quality.
c.) age: the manager can age the deer at the time they are harvested or the lower jaws can be removed from deer and stored for later aging by a biologist until the manager is proficient at aging.
d.) presence or absence of lactation (milk production) of does (to supplement fawn production estimates).

Note: Weight, antler, and lactation data from a deer, without knowing the age of the deer, is of minimum value. Conversely, age without corresponding weight/antler/lactation data is of minimum value.

Supplemental Feeding / Food Plots:

Managing the habitat for proper nutrition should be the primary management goal. Supplemental feeding and/or planting of food plots are not a substitute for good habitat management. These practices should only be considered as "supplements" to the native habitat, not as "cure-alls" for low quality and/or poorly managed habitats. Summer (June - mid-September) is the most stressful, critical season of the year for deer in the Post Oak Savannah and Blackland Prairie, not during the winter, especially if there is a good acorn crop. Fawns are being born and nursed. Bucks are growing

antlers. An abundance of high nutrition is essential during this usually dry, hot period of the year when new vegetative growth is on the down-swing.

Supplemental feeding in particular is not a recommended practice unless it is integrated with other deer population/habitat management practices. It may be beneficial if the herd is harvested adequately each year and the range is in good condition. However, most deer feeding programs which provide sufficient additional nutrients to be of value are expensive and take a long term commitment. The most popular feed used to supplement the diet of deer is corn, although it is one of the poorest types of deer feed available. Corn is low in protein (7-10%) and high in carbohydrates. It does not provide adequate protein levels needed for development of bone and muscle. Knowing these limitations, corn may be used 1) as an energy supplement (carbohydrates) during very cold periods of the winter, and 2) to "bait" and hold deer in an area. If supplemental feeding is integrated into the overall management, the preferred method is to use a 16% to 20% protein pelleted commercial feed, fed free-choice from feeders distributed at the rate of one feeder per 160 - 320 acres located adjacent to adequate escape cover. Feed areas would have to be fenced to exclude livestock. Refer to the Texas Parks and Wildlife bulletin "Supplemental Feeding" for details.

Planting food plots may be a more effective method to supplement well managed native habitats than feeding, especially in East and Central Texas where annual rainfall normally exceeds 35 inches. However, like feeding, its cost effectiveness needs to be taken into account, considering factors such as climate, soil type, slope and drainage, labor, material, and equipment costs, and fencing from domestic livestock. Like feeding corn, food plots are typically used to bait and hold deer in an area. To provide optimum nutritional benefits to deer, the Texas Agricultural Extension recommends that 1) food plots comprise between 2% to 5% of the total land acreage, 2) at least one-half the food plots be planted in cool season species (planted in early fall with forage available during winter stress periods) and at least one-half of the food plots be planted in warm season species (planted in spring with forage available during the summer stress period), and 3) the plots be between 1/2 to 5 acres in size, long and narrow, and well distributed over the entire area adjacent to escape cover. Food plots should be planted on the deepest soils available.

Cool season plantings (planted in October) are generally more successful than warm season plantings because rainfall is somewhat more dependable during the fall and winter and there is less competition from weeds. To provide a safe-guard against complete failure, it is recommended that a mixture of species be planted rather than planting a single species. A recommended cool season mixture is a combination of at least two of the following cereal grains: wheat, oats, and rye. All are annuals and will have to be replanted annually. Adding a cool season legume to the seed mixture, or planting separately, will increase the protein content. There are some legumes that can be incorporated into supplemental plantings that are well adapted to this region. Recommended cool season legumes are: Austrian winter peas, yuchi arrowleaf clover, Louisiana S-1 white clover, and crimson clover.

Although they are usually the most important, warm season supplemental plantings are generally less successful than cool season plantings. Typically, during drought conditions when native vegetation is in poor condition and supplemental plantings are most needed, there is not enough moisture for production of food plots. However, forage cowpeas (Iron-clay or Chinese red) and soybeans have proven to increase fawn survival and are strongly recommended during normal rainfall years. Other recommended warm season annual species are: American joint-vetch, Lab-Lab, alyce clover, common sunflower, grain sorghum, and spanish peanuts for the western blackland prairie. Most species of "improved" livestock forage grasses are not highly preferred by deer.

An NRCS recommended seed mix for permanent food plots in the western blackland prairie is: bush sunflower, Engelmann daisy, maximillian sunflower, and Illinois bundleflower. All are perennials and native to central Texas. Engelmann daisy is a cool season species, the rest are warm season. This would be a good seed mixture to use to "reclaim" improved grass pastures, i.e. convert them from a non-native species back to native species. This mixture could also be used on other deep soil sites.

Supplemental food plots should be fenced to control livestock grazing so that the maximum amount of production is available for wildlife. It may also be necessary to control deer access into planted areas until the plants are well established (the perennial mix species may need protection for a full growing season), unless sufficiently large areas are planted so deer grazing pressure can be distributed.

Appendix G

Specific Management Recommendations for Bobwhite Quail

Before entering into a discussion on bobwhite quail, it should be noted that the Post Oak Savannah Ecological region of western east Texas is not known as a good quail producing area of the state. Although, prior to about the 1970's, quail populations were usually good enough for quail hunters to keep a bird dog and look forward to the quail season each year, however that is not the case now. In earlier years, there were more native pastures, rural family gardens, disking and soil disturbance that created early plant succession, and other situations that benefited quail. As more acreage was planted to dense monoculture tame pasture, less quail habitat was available. In the 1970's, the imported red fire ant began its move into the region, steadily moving northward. Studies indicate that they have made an impact on quail and other ground dwelling/nesting wildlife. Besides their direct impact on animals by stinging (one to two fire ant stings can kill a few days-old quail-D. Wilson study), their reduction of the insect food base probably is the most detrimental to quail populations.

In relative terms, the overall habitat types occurring in the region are not as suitable for quail as those found in south Texas or north-central Texas. Also, quail population densities tend to vary greatly from year to year, even in the best quail producing regions of the state. The timing and amount of fall and winter rainfall are thought to be the most critical factors that determine quail breeding success and survivability during the next year (adequate amounts of fall/winter rains improve soil moisture and promotes the early growth of herbaceous plants).

<u>Basic Habitat Requirements:</u>

Bobwhite quail must have a year-round adequate supply of food and reasonable protection from hazards. This includes protection from predators while feeding, resting, loafing, roosting, traveling, and nesting, as well as protection from inclement weather conditions. Both food and cover supply must be stable or continuously renewed during the entire year. It is not enough that food and cover be adequate for 11 months, if either is lacking during a single month.

Food and cover must occur in a well-arranged pattern if they are to comprise quail habitat. The distance between a source of ample food and adequate cover must not be

greater than what a quail can negotiate with safety. As a rule of thumb, bobwhites venture no further than 200 yards from patches of cover. Ideally, escape cover should be linked to food supplies with more or less continuous screening cover. Overgrazed pastures do not provide adequate screening cover. However, the screening cover must not be dense enough to create an obstacle to the quail's short-legged gait. Dense stands of thick grass (tame pasture monocultures) cannot be easily negotiated. Without a suitable space relationship, a range will not be habitable for quail regardless of the quality or amount of food and cover present. In fact, ideal quail habitat consists of 30 - 60 percent bare ground interspersed with cover, forbs, and seed producing plants. This permits ease of movement and location of seeds and insects, especially for newly hatched quail.

Food:

Food supplies are usually most abundant during the spring and summer; seeds are ripening and insects and green plant material are available. The food supply begins to diminish at the time of the first killing frost in the fall, and continues to decline throughout the winter due to competition from other animals and from weathering. Seeds from forbs such as croton (doveweed), ragweed, sunflower, partridge pea, tick clover, and many others are staple winter foods. A number of woody plants provide winter quail food. Fruits and mast such as small acorns, sumac berries, hackberries, and gum elastic berries supplement quail diets. Most grasses, except for paspalums and panic grasses, do not produce seeds large enough to be worthwhile quail food. In general, forbs are the most important and most widely distributed sources of winter quail food. Green material from cool season forbs and grasses that germinate in the late winter if rainfall is adequate are essential to get quail in good body condition for the upcoming breeding season.

Cover:

Bobwhite quail need several types of cover: screening overhead cover for security while feeding and traveling, "tangled" woody cover to retreat into to escape enemies, a "living room" type of cover for dusting or resting, and nesting cover. Roosting cover is also needed, but if other types of cover are present, the roosting cover requirement is usually adequately met.

Cover can take many forms and a patch of cover can meet several of the cover requirements.

A stand of broomweed, or similar tall plants with bushy canopies and an open understory at ground level, can provide screening overhead cover.

Thickets of low brush, trees, and vines can provide escape and loafing cover. In general, a habitat with between 5% and 15% canopy coverage of good woody cover is adequate, if it occurs in small, well distributed patches (no more than 200 yards between patches as discussed above).

Patches of residual grasses left over from the previous growing season can provide nesting cover. Individual patches should be at least 8 inches tall and 12 inches in diameter (the size of a cake pan). Ideally, there should be more than 250 well distributed clumps of suitable nesting cover per acre, or 1 clump every 15 to 20 steps. Too little nesting cover makes it easier for predators to find and destroy nests.

Habitat Management Recommendations:

A primary quail management objective is to maintain or create the mosaic of small thickets of low growing woody brush throughout a ranch, as described above in woody cover requirements. Thickets of sumac, briers, plums, blackberries, etc. should be retained and encouraged to form. Although not as desirable, small clumps of low growing cedars could have some value as cover where other species do not grow or are in short supply. Where vines have grown up into a tree leaving ground too open to serve as quail cover, the tree can be cut half through a few feet above ground and pushed over, bringing the living vines closer to the ground. In the western portion of the area, the trunks of multi-stemmed mesquites can be half-cut and pushed over so that the limbs touch the ground but continue to grow, forming small areas protected from cattle grazing/deer browsing. Half-cutting mesquite should be done during the early and middle parts of the growing season, not during the dormant season. The individual "skeletons" of large cut cedars can also form small areas protected from grazing/browsing where patches of herbaceous and woody plants suitable for cover can become established. The number of browsing animals on the range (combination of wildlife and domestic livestock) needs to be maintained at a level where browsing pressure on low growing woody cover is not excessive.

Another objective is to improve the amount and quality of herbaceous cover. A well-planned deferred-rotation livestock grazing system (as described in the Livestock Recommendations section) can be used to create the patchy pattern of lightly grazed areas interspersed among more heavily grazed areas needed for nesting cover.

Most good seed producing forbs are early successional stage annuals that respond to soil disturbance that sets back plant succession. Discing the soil is a good practice that encourages the growth of forbs and other annual plants. Disced strips should be long and meandering and 1 or 2 disc widths wide. The same strips can be disced annually, or side-by-side strips can be disced on an alternating basis every other year to create adjacent strips in various stages of succession. The best plant response will occur in areas of deeper sandy, sandy-loam soils. It is important that disced strips be located near escape cover so they are useable by quail. Discing can be done anytime between the first killing frost in the fall and the last frost in the spring, but the optimum time is near the end of winter (January, February) shortly before spring growth gets underway.

Heavy spot grazing by cattle, such as occurs around salt blocks, feed areas, and water, causes soil disturbance that encourages forb growth. Salt blocks and feeding areas should be moved around the ranch to create small patches of disturbed ground.

Managing the habitat for the production of native food plants and cover should be the primary management goal. Supplemental feeding and/or the planting of food plots are not a substitute for good habitat management. These practices should only be considered as "supplements" to the native habitat, not as "cure-alls" for low quality and/or poorly managed habitats. Food plots and feeders alone will not increase the number of quail a range can support if the supplies of other required habitat elements such as cover are limited.

Small food plots of seed producing plants including but not limited to millets, sorghum alum, and sorghum planted on deeper soils near cover can provide supplemental food sources during periods of extreme weather conditions. A limiting factor of supplemental food plots is sometimes an insufficient amount of rainfall received in western east Texas during the summer. During dry years when the production of native foods is limited and supplemental foods are most needed, supplemental plantings will also be failures. During good years when the production of native foods is adequate, supplemental plantings may do well, but are not as necessary. Also, these seeds do not normally last long into the fall and winter, due to normal fall rainfall. Another limiting factor is that most types of supplemental plantings will have to be protected from livestock grazing by fencing the plot or deferring the pasture.

Feeding can provide supplemental food during extreme weather conditions and help hold quail in an area. Broadcasting corn or sorghum by hand is one method of distributing supplemental feed. It can also be distributed from fixed feeders. An intensive feeding program would be one that provides 1 feeder per every 40 to 60 acres of quail habitat (feeders placed 440 to 540 yards apart in a grid pattern) so that every quail covey has access to several feeders. One feeder per 75 acres may be sufficient. As with all other types of food sources, feeders need to be located near escape and screening cover to be useable by quail. Some limitations of supplemental feeding are: they can be expensive and labor intensive, diseases and parasites can be spread at heavily used sites, predators learn to key on sites regularly used by quail, and, depending on the type of feeder used, they may have to be fenced from livestock.

Prescribed burning is a very effective, low-cost habitat management tool that can be used to enhance plant diversity by stimulating production of a variety of woody plants, forbs, and grasses. Burning can be used to remove rank stands of herbaceous vegetation and plant litter that hinder quail movements. Also, studies have shown that up to seven times more protein rich insects are present in burned areas compared to unburned areas.

In summary, food and all the different types of cover must be available year around and suitably arranged to have a good quail habitat. The number of quail a range can produce and support will be dependent on the habitat element that is most limited. In other words, if cover is the limiting factor, increasing the amount of food beyond that needed for the number of quail that can be supported by the cover will not increase the range's quail carrying capacity, and vice versa.

See TPWD brochure 7000-37, Bobwhite Quail in Texas, Habitat Needs & Management Suggestions by A.S. Jackson, C. Holt, and D. W. Lay.

Notes: The same types of cover and seed producing forbs and supplemental food plants utilized by quail are also utilized by many other species of birds and mammals.

Appendix H

Specific Management Recommendations for Rio Grande Wild Turkeys

Rio Grande Turkey - southwest portion of Post Oak Savannah Ecoregion and western portions of the Blackland Prairies, with Eastern Turkey - remaining portion of Post Oak Savannah

Rio Grande turkeys are present in some of the southwestern counties of the Post Oak area and some bottoms in the western Blackland Prairies, generally where annual rainfall is below 35 inches. Fairly stable populations have been established in these counties due to suitable habitat and restocking programs by the TPWD. These populations are presently subjected to hunting during the regular fall and/or spring turkey season.

Eastern wild turkeys are currently being restocked in most of the remainder of the Post Oak Savannah and the Pineywoods. Beginning in 1987, using wild-trapped birds from wild eastern turkey populations in the Eastern United States, an intensive restoration effort was begun to restore these native birds to eastern Texas where there was suitable habitat and annual rainfall exceeds 35 inches. This restocking program has been completed, and huntable populations of eastern turkeys in the Post Oak Savannah and Blackland Prairie have been established in several counties, and others may be opened based on annual census activities.

Both of these subspecies of turkeys generally have similar habitat requirements and have similar seasonal habits. Although turkeys are non-migratory resident species, they have large home ranges that change with the season of the year. Turkeys tend to be widely dispersed during the spring and summer nesting/brood-rearing period. Nesting and brood-rearing habitat is similar to that required for quail, but on a larger scale: scattered thickets of low growing brush, patchy residual herbaceous vegetation, a moderately grazed, diverse grass/forb plant community that produces seeds and insects.

After the breeding season, numerous smaller flocks that were widely dispersed during the summer tend to congregate into large winter flocks. The ranges of winter flocks are centered around riparian areas (the flood plains of large creeks and rivers) that have

moderately dense stands of tall, full canopied trees. These winter flocks will disperse several miles from their riparian area roost sites on daily feeding forays. Turkeys are attracted to feeders (not recommended for eastern turkey) and supplemental food plantings provided for deer and quail. The nearness of a ranch to a winter roost site(s), and the availability of a food source, would determine to what extent turkeys are present during the winter months.

Habitat management for the wild turkey concerns the availability of water, food, and cover. The distribution of these key components of the range is of major importance. Turkeys require water daily and can obtain water from foods or free water (ponds, creeks, rivers, etc.) Grassy or brushy nesting and brood-rearing cover is probably the most important cover requirement. Food availability of the native range can be increased by the following activities: (1) Moderately stock the range with domestic animals. (2) Utilize a deferred rotation system of grazing. (3) Control total deer numbers by harvesting does. (4) Prescribed burns can be utilized to retain openings and control regrowth elm, locust, hackberry, pine, and cedar as well as increase production of forbs, grasses and fruit or mast producing browse plants. In summary, range management activities that increase the diversity of grasses, forbs, shrubs, trees, and vines improves the habitat for the wild turkey. These same management practices are also beneficial to deer, quail, and many other wildlife species.

Preservation of roosting sites is a key factor to maintain a turkey population on a sustained basis. Turkey also need escape cover to travel to and from roosting sites. Mature trees utilized as roosting sites include pine, pecan, cypress, sycamore, cottonwood, most large oaks, elm, hackberry, western soapberry, and large mesquite. Dense brush thickets or solid block clearing both furnish poor habitat for the turkey. Clearing programs that leave brush strips between cleared areas are advantageous. Avoid removing hardwood trees such as the various species of oaks, hackberry, elm, or large mesquite. If clearing is needed to improve the range, irregular shaped cleared strips that follow topography are best.

Appendix I

Comments Concerning Federally Listed Endangered Species

The Houston Toad and Southern Bald Eagle are Federally listed endangered and threatened species, respectively, which are found in some areas of the Post Oak Savannah and Blackland Prairie ecological areas. The following information and management guidelines are from the 130 page book "Endangered and Threatened Animals of Texas - Their Life History and Management", by Linda Campbell. Published by the Texas Parks and Wildlife Press, Austin, Texas in 1995. Distributed by the University of Texas Press, Austin, Texas, and revised in 2003 as an electronic book available on the TPWD website at www.tpwd.state.tx.us.

Houston Toad

Scientific Name: *Bufo houstonensis*
Federal Status: Endangered, 10/13/70 • State Status: Endangered

Description

The Houston Toad is 2 to 3.5 inches long and similar in appearance to Woodhouse's Toad (*Bufo woodhousei*), but smaller. General coloration varies from tan to brownish-black. The pale ventral surfaces often have small, dark spots. Males have a dark throat, which appears bluish when distended.

Habitat

The Houston Toad is a terrestrial amphibian associated with deep sandy soils within the Post Oak Savannah vegetational area of east central Texas. Since Houston Toads are poor burrowers, loose friable soils are required for burrowing. The toads burrow into the sand for protection from cold weather in the winter (hibernation) and hot, dry conditions in the summer (aestivation). Large areas of predominantly sandy soils greater than 40 inches deep are characteristic of habitat. The vegetation type of currently known Houston Toad sites can typically be described as pine or oak woodland or savannah, with native bunchgrasses and forbs (flowering plants) present in open areas. Plants that are often present in Houston Toad habitat include loblolly pine, post oak, bluejack or sandjack oak, yaupon, curly threeawn and little bluestem.

For breeding, including egg and tadpole development, Houston Toads also require still or slow-flowing bodies of water that persist for at least 30 days. These water sources may include ephemeral (temporary) rain pools, flooded fields, blocked drainages of upper creek reaches, wet areas associated with seeps or springs, or more permanent ponds containing shallow water. Shallow areas of deep water, such as the coves and inflow to Bastrop State Park Lake, are also used. The source of ephemeral or permanent water should be located within one-half to three-quarters mile of the toad's hibernation/foraging habitat (deep sands supporting

woodland or savannah). Recent research indicates that mortality in toadlets is 100% if their ponds are in open pastures more than 55 yards from woodland habitat. The toads do best in ponds without predatory fish.

Life History

The Houston Toad is a year-round resident where found, although its presence can most easily be detected during the breeding season, when males may be heard calling. Males usually call in or near shallow water, from small mounds of soil or grass surrounded by water, or from floating objects such as logs or algae mats. Males occasionally call from wooded habitat located within about a 100-yard radius of breeding ponds. The call is a high clear trill that lasts an average of 14 seconds. The call is much like that of the American Toad (*Bufo americanus*), but usually slightly higher in pitch. The American Toad occurs in Texas, but north of the range of the Houston Toad.

Houston Toads may call from December through June. Most breeding activity takes place in February and March, and is stimulated by warm evenings and high humidity. Toads emerge from hibernation to breed only if moisture and temperature conditions are favorable. Females, responding to calling males, move toward the water to mate. The female lays her eggs as long strings in the water, where they are fertilized by the male as they are laid. The eggs hatch within seven days and tadpoles metamorphose (turn into toadlets) between 15 and 100 days, depending on the water temperature.

Young toadlets are about the size of one's pinkie fingernail when they complete metamorphosis. They then leave the pond and spend their time feeding and growing in preparation for the next breeding season. Males generally breed when they are a year old, but females may not breed until they are two years old. Houston Toads, especially first-year toadlets and juveniles, are active year round under suitable temperature and moisture conditions. Their diet consists mainly of insects and other invertebrates.

Threats and Reasons for Decline

Habitat loss and alteration are the most serious threats facing the Houston Toad. Alteration of ephemeral and permanent natural wetlands for urban and agricultural uses eliminates breeding sites. Draining a wetland, or converting an ephemeral wetland to a permanent pond, can eventually cause the Houston toad to decline or be eliminated entirely. Conversion to permanent water not only makes them more vulnerable to predation by snakes, fish, and other predators; but also increases competition and hybridization with closely related species of toads.

Periodic drought is also a threat, particularly long-term drought such as that experienced during the 1950s. Drought may result in the loss or reduction of breeding sites as well as enhanced mortality of toadlets and adults.

Extensive clearing of native vegetation near breeding ponds and on the uplands adjacent to these ponds reduces the quality of breeding, foraging, and resting habitat, and increases the chances of predation and hybridization. Conversion of native grassland and woodland savannah to sod-forming introduced grasses, such as bermudagrass and bahiagrass, eliminates habitat because grass growth is generally too dense for the toad to move freely. Dense sod also inhibits burrowing.

High traffic roads are a barrier to Houston Toad movement, and toads are sometimes killed on

roads. Other linear features such as pipelines and transmission lines can create barriers between foraging, hibernating, and breeding sites, especially if native vegetation has been removed.

Continuous grazing (not rotating cattle), heavy stocking rates, and long term fire suppression have caused loss of habitat in a significant part of the toad's range. Historically, periodic fire played an important role in maintaining native bunchgrass communities in loblolly pine and post oak savannah. Due to poor grazing management practices and fire suppression since the arrival of European man, much of the former savannah grasslands of the Post Oak region have grown into brush thickets devoid of herbaceous vegetation. Houston Toads need the herbaceous layer of bunchgrasses for cover and foraging habitat.

Although the toad is believed to be adapted to fire regimes, prescribed burning may result in toad mortality. Frequent and/or severe burns may be detrimental to the toad, particularly for small, fragmented populations. However, increased fuel loads due to prolonged periods of fire prevention may result in very hot wildfires. Additional research is needed to determine the effects of various prescribed burning programs.

The invasion of the Red Imported Fire Ant makes it harder to ensure the long-term survival of the Houston Toad. These toads occur in small, scattered populations, and may be more seriously affected by fire ants than species that are more common and widespread. Fire ants kill young toadlets (less than 7-10 days old) moving out of the breeding pond into the surrounding land habitat. Current research shows that fire ants have a devastating impact on local arthropod communities, and thus may also limit the toad's food supply.

There is no specific information on the effects of various chemicals on the Houston Toad, but it is known that amphibians in general are very sensitive to many pollutants, including pesticides and other organic compounds. These chemicals may affect the toad directly, particularly in the tadpole stage, or indirectly by lowering the abundance and diversity of its food supply. Widespread use of pesticides and herbicides from about 1950 to 1975 may also have contributed to declining populations. During this period, DDT and similar non-specific chemicals accumulated in the environment, affecting a wide variety of animal life. Although threats from persistent, non-specific chemicals are not as serious today as in the past, the use of pesticides and herbicides for agricultural and residential purposes may still pose a danger for the Houston Toad.

Although Houston Toad populations are inherently separated because they exist only in areas of deep sandy soil, further fragmentation of habitat due to human activity can be a problem. Widely scattered parcels of habitat may not easily be re-colonized by toads from nearby populations if extensive areas of unsuitable habitat exist between them, or human impacts eliminate a population.

Recovery Efforts

Research is continuing into the life history, habitat requirements, and land management practices affecting the Houston Toad. Population surveys are being conducted in areas where toads have been found and in potential habitat areas. Efforts to provide information and educational opportunities to the general public and landowners regarding life history and habitat requirements of the toad are a vital part of the recovery process.

Where To See The Houston Toad

The best place to visit if you want to see and learn about the Houston Toad is Bastrop State Park near Bastrop, Texas. The largest known population of the toad exists in the park and surrounding areas. For more information, contact Bastrop State Park at (512) 321-2101.

How You Can Help

You can help by protecting pond habitat. Conservation and wise management of native vegetation is important in preserving Houston Toad habitat. You can also help by landscaping with native plants to reduce water and pesticide use, and by proper storage and disposal of household, gardening, and agricultural chemicals. Hopefully, thoughtful and effective between human resource needs and habitat management will allow for the continued survival and recovery of the Houston Toad. You can be involved with the conservation of Texas' nongame wildlife resources by supporting the Special Nongame and Endangered Species Conservation Fund. Special nongame stamps and decals are available at Texas Parks and Wildlife Department (TPWD) field offices, most state parks, and the License Branch of TPWD headquarters in Austin. Conservation organizations in Texas also welcome your participation and support.

For More Information Contact

Texas Parks and Wildlife Department
Wildlife Diversity Branch
4200 Smith School Road
Austin, Texas 78744
(512) 912-7011 or (800) 792-1112
or
U.S. Fish and Wildlife Service
Ecological Services Field Office
10711 Burnet Road, Suite 200
Austin, Texas 78758
(512) 490-0057

Management guidelines are available from the Texas Parks and Wildlife Department and U.S. Fish and Wildlife Service for landowners and managers wishing to protect and improve habitat for the Houston Toad.

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Management Guidelines for the Houston Toad

The following guidelines address land management practices that can be used to maintain existing Houston Toad habitat or enhance degraded habitat. They are intended primarily to serve as general guidance for landowners and managers in Texas. The guidelines are based on our current understanding of the biology of this species.

Protect Pond Habitat

Avoid modification or disturbance of temporary wet-weather ponds and other small natural ponds located within one-half mile of deep sandy soils supporting post oak or loblolly pine woodland or savannah. These small ephemeral wetlands are prime breeding habitat for the Houston Toad. Extensive clearing of native vegetation and alteration of drainage patterns should be avoided in and around these ponds.

Because predators and other toad species live in and near permanent ponds, it is important that these ponds be located away from breeding ponds. To reduce predation and hybridization between Houston Toads and other toads, permanent ponds for livestock water should be located as far as possible from any existing temporary or natural pond. Also, permanent ponds should not impound ephemeral ponds or wetlands, in order to discourage predation and hybridization. Alternatives for livestock water, such as pipelines and windmills, should be considered in lieu of disturbing natural ponds and seeps that could serve as breeding habitat.

Since predation can be an important factor in reducing Houston Toad populations, predatory fish should not be introduced into breeding ponds. In addition, a fungus commonly found in hatchery raised fish has been shown to be harmful to the eggs of other toad species and could be a potential problem.

Conserve and Manage Existing Post Oak or Loblolly Pine Woodland and Savannah and the Associated Native Plant Communities

Conservation and wise management of rangeland and native grassland pasture in the Post Oak Savannah region are the keys to preserving Houston Toad habitat. Preventing overuse by livestock is important. Maintaining and improving range condition through moderate stocking, rotational grazing, and prescribed burning, will help restore the plant communities with which the Houston Toad evolved and upon which it is dependent. Good range management practices such as these will also benefit livestock, deer, and other wildlife.

Prescribed burning is an important management tool for maintaining the open woodland savannah preferred by the Houston Toad. Periodic burning (every 3 to 5 years) will stimulate native bunchgrasses, improve plant diversity, and reduce excessive mulch buildup. Prescribed burning also improves forage quality and availability for livestock and enhances habitat for deer, quail, turkey and other wildlife. At this time, little is known concerning the effects of prescribed burning on Houston Toads. Studies are being conducted to address questions concerning how prescribed burning affects Houston Toads and their habitat. Because prescribed burning could

result in the death or injury of individual toads, landowners are advised to contact the Texas Parks and Wildlife Department or U.S. Fish and Wildlife Service for further information concerning prescribed burning in Houston Toad habitat.

Clearing of trees and brush should be limited to reducing woody canopy enough to allow sufficient sunlight to reach the ground for herbaceous plant production. Initial brush management can then be followed by prescribed burning to maintain more open savannah grassland.

Reduce Loss of Habitat Due to Pasture Establishment

The introduction of sod-forming grasses, such as bermudagrass and bahiagrass, on deep sandy soils has reduced habitat for the Houston Toad in the Post Oak Savannah region. Ideally, areas of potential habitat should be managed as native rangeland pasture for the production of native bunchgrasses and forbs. If improved forage production through pasture establishment is an objective, it is better to plant high quality native bunchgrasses that are adapted to local conditions and sandy soils, such as Indiangrass and little bluestem.

Use Safe, Effective Alternatives to Chemicals Whenever Possible

Amphibians such as the Houston Toad are susceptible to chemical contamination. The toads can be affected either directly, or through reduction in their food supply. Some pesticides can impact water quality and adversely affect the Houston Toad and other species. Alternatives, such as integrated pest management, organic gardening, and the use and proper management of native vegetation reduce reliance on chemicals and can improve cost effectiveness.

When insecticide or herbicide treatments must be used, label directions should be carefully followed. Avoid contamination of temporary ponds and other natural wetlands by limiting use of these products near them. Dispose of rinse water and empty containers in strict accordance with label directions. Contact the Texas Department of Agriculture or the USDA Natural Resources Conservation Service for guidance on ways to minimize the environmental effects of agricultural chemicals.

Control Fire Ants

Although the full impact of fire ants on the Houston Toad is not known, fire ants are believed to be a serious and increasingly important threat. You can help control fire ant infestations by limiting soil disturbance, inspecting imported soil and nursery products thoroughly for fire ants, and properly disposing of trash. Controlling heavy fire ant infestations in Houston Toad habitat may help minimize their impact. Where fire ant control is needed, the U.S. Fish and Wildlife Service recommend treatment of individual fire ant mounds with commercial fire ant bait. Bait should be placed only near fire ant mounds and not near the mounds of native ant species. To avoid affects on non-target species apply bait when ants are actively foraging and prevent accumulations of excess bait.

For More Information

Technical assistance in range and wildlife management, including management for endangered species, is available to landowners and managers by contacting the Texas Parks and Wildlife Department, USDA Natural Resources Conservation Service, or Texas Cooperative Extension. Further guidance and specific questions concerning landowner responsibilities under the Endangered Species Act, should be directed to the U.S. Fish and Wildlife Service.

Bald Eagle

Scientific Name: *Haliaeetus leucocephalus*
Federal Status: Threatened • State Status: Threatened

Description

The Bald Eagle is one of nature's most impressive birds of prey. Males generally measure 3 feet from head to tail, weigh 7 to 10 pounds, and have a wingspan of 6 to 7 feet. Females are larger, some reaching 14 pounds with a wingspan of up to 8 feet. Adults have a white head, neck, and tail and a large yellow bill. First year birds are mostly dark and can be confused with immature Golden Eagles. Immature Bald Eagles have blotchy white on the under wing and tail, compared with the more sharply defined white pattern of Golden Eagles. While gliding or soaring, Bald Eagles keep their wings flat, and their wing beats are slow and smooth. In contrast, Turkey Vultures soar with uplifted wings, and they fly with quick, choppy wing beats. Bald Eagles require 4 or 5 years to reach full adult plumage, with distinctive white head and tail feathers.

Distribution and Habitat

The Bald Eagle, our National Symbol, occurs throughout the United States, Canada, and northern Mexico. Bald Eagles are present year-round throughout Texas as spring and fall migrants, breeders, or winter residents. The Bald Eagle population in Texas is divided into two populations; breeding birds and nonbreeding or wintering birds. Breeding populations occur primarily in the eastern half of the state and along coastal counties from Rockport to Houston. Nonbreeding or wintering populations are located primarily in the Panhandle, Central, and East Texas, and in other areas of suitable habitat throughout the state.

The Bald Eagle in Texas formerly nested in the Panhandle, throughout East Texas, and at localized sites in central Texas. Populations declined throughout the lower 48 states during the 1900's with habitat destruction and use of pesticides detrimental to the species. Nesting populations are now increasing in most areas of the country. Active nests in Texas increased from 13 in 1982 to 117 in 2003. Breeding territories are located mostly along rivers and near reservoirs in East Texas, the Post Oak region, and the Gulf Coast. The nesting near reservoirs by Bald Eagles is a rather recent event, since this habitat type was not available to eagles historically. As of 2003, Bald Eagle nests are known to occur in Angelina, Austin, Bastrop, Bell, Bosque, Brazoria, Burleson, Calhoun, Cass, Chambers, Colorado, Fayette, Fort Bend, Freestone, Goliad, Grimes, Harris, Henderson, Jackson, Jasper, Kaufman, Lavaca, Liberty, Limestone, Llano, Marion, Matagorda, Montgomery, Nacogdoches, Navarro, Navasota, Newton, Panola, Polk, Refugio, Robertson, Rusk, Sabine, San Augustine, San Jacinto, Shelby, Smith, Trinity, Victoria, Walker, Wharton, and Wood counties.

In Texas, Bald Eagles nest in areas along river systems, reservoirs or lake shores with large, tall (40- 120 ft.) trees for nesting and roosting. Nests are usually located within 1 mile of water, such as lakes, reservoirs, creeks or rivers, and are often located in the ecotone or edge between forest and marsh or water. Bald Eagles often build their nests in the tallest trees in an area, providing an unobstructed view and flight path to the nest. Nests are built in a variety of tree species. Eagles nest primarily in loblolly pine in East Texas.

Throughout the rest of it's Texas breeding range, nests are found in a variety of trees, including bald cypress, water oak, live oak, American elm, cottonwood, sycamore, and pecan. Open water or wetland areas located within approximately 1 mile of nesting habitat are needed to provide feeding areas.

Most of the Bald Eagles seen in Texas breed in the northern states and spend the winter (December through March) in Texas. Wintering populations may occur statewide, but generally are found near large lakes and reservoirs, such as Lake Meredith, Buffalo Lake, Lake Texoma, Wright-Patman Lake, Lake O' the Pines, Lake Fork, Lake Tawakoni, Lake Whitney, Lake Fairfield, Toledo Bend Reservoir, Sam Rayburn Reservoir, Lake Livingston, Lake Conroe, Lake Buchanan, Lake Cooper, Lake Palestine, Lake Pat Mayse, Lake Warren, and Palo Duro Lake, or in the rice growing region hunting waterfowl.

Bald Eagle wintering habitat is characterized by abundant, readily available food sources. Most wintering areas are associated with open water or waterfowl concentration areas, where eagles feed on fish or waterfowl. Wintering populations are also found on rangelands of the Davis Mountains, western Edwards Plateau, and the Panhandle, where eagles may take rabbits and feed on carrion.

The availability of night roost sites is often an important characteristic of wintering habitat. Bald Eagles may roost singly or in groups, and the same roosts are used from year to year. Roost trees are usually the oldest and largest trees in an area, and most have large horizontal limbs and open branching that allows plenty of room for takeoff and landing. Eagles generally choose roosts that allow unobstructed visibility to the surrounding areas, with a minimum of human activity in the immediate vicinity. Roost sites are often located near water, but eagles also roost on windbreaks and in secluded canyons well away from water.

Life History

Bald Eagles are opportunistic predators. They feed primarily on fish, but also eat a variety of waterfowl and other birds, small mammals, and turtles, when these foods are readily available. Carrion is also common in the diet, particularly in younger birds. Bottom-dwelling fish tend to occur more frequently in the diet. It is thought that the downward visual orientation of bottom-feeding fish makes them more vulnerable to eagle attacks than surface sight-feeders, which are more aware of movements from above. Eagles capture fish by extending their talons a few inches below the water's surface. Therefore, live fish are vulnerable only when near the surface or in shallows. Studies in Texas have shown that eagles commonly eat coots, catfish, rough fish, and soft-shell turtles.

In Texas, Bald Eagles nest from October to July. Nests are constructed primarily by the female, with the male assisting. The typical nest is constructed of large sticks, with softer materials such as leaves, grass, and Spanish moss used as nest lining. Nests are typically used for a number of years, with the birds adding nest material every year. Bald Eagle nests are often very large,

measuring up to 6 feet in width and weighing hundreds of pounds. Eagles often have one or more alternative nests within their territories.

Peak egg-laying occurs in December, with hatching primarily in January. The female lays a clutch of 1 to 3 eggs, but the usual clutch is 2 eggs. A second clutch may be laid if the first is lost. Incubation begins when the first egg is laid and usually lasts 34 to 36 days. The young generally fledge (fly from the nest) in 11 to 12 weeks, but the adults continue to feed them for another 4 to 6 weeks while they learn to hunt. When they are on their own, young Bald Eagles migrate northward out of Texas, returning by September or October.

Nest surveys in Texas from 1981-2003 have shown that greater than 80% of the active nesting territories successfully produced young, with production averaging greater than 1 young per active nest found. Studies show that at least 70% of the juveniles survive their first year. Causes of first year mortality include disease, lack of food, inclement weather, and human interference. Bald Eagles reach sexual maturity at 4 to 6 years of age; however, they have been known to successfully breed at 3 years. They are monogamous and are believed to mate for life; however, if one of the pair dies, the surviving bird will accept another mate. Bald Eagles are believed to live up to 30 years or more in the wild.

Threats and Reasons for Decline

Habitat loss over the past 200 years is the factor most consistently associated with declines in Bald Eagle populations. Unfortunately for eagles, people also like to live and spend their leisure time near water. In recent decades, the accelerated pace of development along the coast and near inland rivers and waterways is a primary cause of habitat loss. There are, however, encouraging signs in Texas that a significant amount of new habitat has been created in the form of man-made reservoirs. Most reservoirs in eastern Texas, especially those bordered by national forests, are used by nesting eagles, and are also used to some degree by wintering birds. Hopefully, if human disturbance is kept to a minimum, a redistribution of nesting to reservoirs may offset some habitat loss in other areas. Shooting has long been recognized as a major human-caused factor in the decline of Bald Eagles. Although primarily fish and carrion eaters, eagles were thought to be a major threat to chickens, livestock, and game animals. As a consequence, many were killed by farmers, ranchers, and hunters. In 1940, Congress passed the Bald Eagle Protection Act, which made it illegal to shoot or harass eagles. In 1969, Bald Eagles gained further legal protection under federal endangered species laws. With heightened public awareness and sensitivity to the plight of the Bald Eagle, coupled with strict laws, shooting mortality has declined from 62% of total reported deaths from 1961-1965 to 18% from 1975-1981. Although this downward trend is encouraging, shooting mortality could still be a limiting factor, particularly in remote areas.

Human disturbance can also be a cause of population decline. Activities such as logging, oil exploration and extraction, construction, and recreational activity certainly do disturb eagles in some instances. However, the impact of these disturbances is highly variable, depending on the activity, its frequency and duration, its proximity to areas used by eagles, the extent to which the activity modifies the habitat or its use, and timing in relation to the reproductive cycle. Also, some birds are more tolerant of disturbance than others, with adults generally less tolerant than immature birds. Despite this variability, disturbance near nests has caused nesting failures.

Finally, the most dramatic declines in Bald Eagle populations nationwide resulted from environmental contaminants. Beginning in 1947, reproductive success in many areas of the

country declined sharply, and remained at very low levels through the early 1970's. After several years of study, the low reproduction of Bald Eagles and many other birds was linked to widespread use of the insecticides DDT and Dieldren. These insecticides were used extensively in agriculture and forestry beginning in 1947. As DDT entered watersheds, it became part of the aquatic food chain, and was stored as DDE in the fatty tissue of fish and waterfowl. As eagles and other birds of prey fed on these animals, they accumulated DDE in their systems. Although occasionally causing death, DDE mainly affected reproduction. Some birds affected by the chemical failed to lay eggs, and many produced thin eggshells that broke during incubation. Eggs that did not break were often addled or contained dead embryos, and the young that hatched often died. Dieldren killed eagles directly rather than causing thin eggshells, but compared to DDT, Dieldren was probably not as important in overall Bald Eagle declines. In 1972, the EPA banned the use of DDT in the United States. Since the ban, DDE residues in Bald Eagle eggshells have dropped significantly, and a slow recovery of eagle productivity has occurred. Most populations appear to be producing chicks at the expected rate.

Of more recent concern is evidence that lead poisoning may be a significant cause of death in eagles. Chronic low levels of lead can produce nervous system disorders, affect behavior and learning, cause anemia, and increase susceptibility to disease. As laws requiring the use of steel shot to hunt waterfowl become effective, accumulation of lead in the food chain is expected to decline.

Since 1981, Texas Parks and Wildlife Department has conducted extensive aerial surveys to monitor Bald Eagle nesting activity. The 2003 survey identified 117 active nests which fledged at least 144 young. This compares with only 7 known nest sites in 1971. Midwinter Bald Eagle counts coordinated by TPWD and conducted by birding enthusiasts throughout the state reported 325 eagles in 2002. From 1986-1989, midwinter counts averaged less than 15 Bald Eagles per survey site. Since 1990, the average number of eagles per survey site has increased to 18. These numbers show encouraging trends for Texas. With continued vigilance, protection, and informed management, today's Texans can insure that future generations will have the opportunity to enjoy the sight of our majestic national symbol – the only eagle unique to North America.

Recovery Efforts

During the 1970's and 1980's, major efforts were directed toward captive breeding and reintroducing young birds into the wild. A total of 124 Bald Eagles were hatched at the Patuxent Wildlife Research Center in Maryland from 1976-1988. These captive-hatched eaglets were an important source for restocking wild populations. One successful reintroduction program placed young eaglets in the nests of adults whose own eggs were infertile or failed to hatch. The "foster" parents readily adopted the chicks and raised them as their own.

Another method, called "hacking" places young birds on man-made towers in suitable habitat where populations are low. The nestlings are kept in an enclosure and fed by humans that stay out of sight. When they are able to fly, the enclosure is opened and the birds are free to leave. Food is still provided at the release site until no longer used or needed by the young birds. Hacking has been used very successfully in at least 11 states.

In Texas, the greatest challenge for the future will be to prevent further destruction of habitat and retention of sufficient creek and river flows to support a food base for breeding and wintering eagles. The Texas Parks and Wildlife Department, in cooperation with landowners,

other agencies and conservation groups, is continuing to monitor breeding and wintering Bald Eagle populations. Monitoring of nesting success is particularly important in detecting any problems associated with contaminants in the environment. Finally, appropriate management of nesting, feeding, loafing, and wintering habitat must be a priority if we are to maintain the current upward trend in Bald Eagle numbers in Texas.

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Where To See Bald Eagles

There are a number of State Parks where visitors have the opportunity to see and learn more about Bald Eagles. These include Lake Brownwood, Lake Livingston, Lake Texana, Lake Whitney, and Possum Kingdom State Parks. The Vanishing Texas Rivers Cruise, a privately operated excursion boat, also provides visitors with excellent opportunities to see wintering eagles on Lake Buchanan in Burnet and Llano Counties. Because the Bald Eagle is a protected species and sensitive to human disturbance, birders and other observers should carefully follow certain viewing ethics. Recorded calls of prey species should not be used to attract birds. Also, observers should be careful not to approach too closely or otherwise disturb or stress birds.

How You Can Help

If you see a Bald Eagle nest, remember that eagles are vulnerable to disturbance throughout the nesting period (October to July in Texas), and are easily disturbed particularly during the first 12 weeks of nesting activity. Observers should remain a safe distance away from the nest (at least 750 feet) and keep noise and other human impacts to a minimum. Private landowners are encouraged to report new Bald Eagle nests to Texas Parks and Wildlife Department.

You can be involved in the conservation of Texas’ nongame wildlife resources by supporting the Special Nongame and Endangered Species Conservation Fund. Special nongame stamps and decals are available at Texas Parks and Wildlife Department (TPWD) Field Offices, most State

Parks, and the License Branch of TPWD headquarters in Austin. Conservation organizations in Texas also welcome your participation and support. Finally, you can encourage and support private landowners who are minimizing nest disturbance and managing their land to protect Bald Eagle habitat.

For More Information Contact

Texas Parks and Wildlife Department
Wildlife Diversity Branch
4200 Smith School Road
Austin, Texas 78744
(512) 912-7011 or (800) 792-1112
or
U.S. Fish and Wildlife Service
Ecological Services Field Office
10711 Burnet Road, Suite 200
Austin, Texas 78758
(512) 490-0057

Management guidelines are available from Texas Parks and Wildlife Department or the U.S. Fish and Wildlife Service for landowners wishing to protect and manage Bald Eagle habitat.

Habitat Management Guidelines for Bald Eagles in Texas

The following guidelines were developed to help landowners and managers maintain or improve their land for the benefit of the Bald Eagle. Information is also provided so that landowners may recognize and avoid or minimize human-related disturbance to eagles, particularly nesting pairs.

Nesting Habitat

The protection of an actual nest is important, but so is protection of the nest area and all the surrounding habitat factors that attracted the nesting pair to the area. Once the eagles establish a suitable breeding territory, they will return to the same area year after year, often using several nests within the territory during different years. When a given nest or the tree that it is in falls, a pair generally returns to the same territory to begin another nest. If one member of a pair dies, the nest may go unused for several years and then be recolonized by the surviving member returning with a new mate. Nesting territories can even be inherited by offspring. Therefore, protection of nesting territories should apply to “abandoned” nests for at least five consecutive years of documented nonuse.

The following habitat management guidelines are based on two management zones surrounding each nest site, with certain restrictions recommended for each zone.

Primary Management Zone For Nest Sites

This zone includes an area extending 750 to 1,500 feet outward in all directions from the nest site. It is recommended that the following activities not occur within this zone:

1. Habitat alteration or change in land use, such as would result from residential, commercial, or industrial development; construction projects; or mining operations.
2. Tree cutting, logging, or removal of trees, either living or dead.
3. Use of chemicals labeled as toxic to fish and wildlife.
4. Placement of above-ground electrical transmission or distribution lines. Since collision with powerlines and electrocution on powerline structures remain an important cause of death, placement of underground lines is recommended near Bald Eagle nests and winter concentration sites.
5. Helicopter or fixed-wing aircraft operation within 500 feet vertical distance or 1,000 feet horizontal distance of the nest site during the nesting season (October-July).
6. Activities which create minimal disturbance, such as hiking, fishing, camping, and bird-watching can be carried out safely during the nonnesting season if there is no physical alteration of the habitat within the zone. Traditional farming, ranching, and hunting activites which are existing practices and have occurred historically on the site can be carried out safely during the non-nesting season as long as habitat alteration is avoided.

Human presence within this zone should be minimized during the nesting season, especially during the early nesting period from October- April. Traditional agricultural activities and low impact recreational activities are generally not a problem even during the nesting season as long as they do not appear to be adversely affecting nesting success, there is no increase in the level of disturbance from historic levels, and physical alteration of the habitat is avoided. However, activities of any kind should be stopped if it becomes apparent that the birds are suffering from disturbance. The key point is whether the activities keep the breeding birds away from the nest, eggs, or young for extended periods of time. If they do, they are harmful. In general, it is important to protect the nest from human disturbance during very hot or very cold weather, since the parents' absence at these times can be particularly deadly for the eggs or young.

Secondary Management Zone For Nest Sites

This zone encompasses an area extending outward from the primary zone an additional 750 feet to 1 mile. Recommended restrictions in this zone are intended to protect the integrity of the primary zone and to protect important feeding areas, including the eagle's access to these areas. The following activities are likely to be detrimental to Bald Eagles at any time, and in most cases should be avoided within the secondary zone:

1. Development of new commercial or industrial sites.
2. Construction of multi-story buildings or high-density housing developments between the nest and the eagle's feeding area.
3. Placement of electrical transmission or distribution lines between the nest site and the eagle's feeding area.
4. Construction of new roads, trails, canals, or rights-of-way which would tend to facilitate human access to the eagle nest.
5. Use of chemicals labeled as toxic to wildlife.

Certain activities that involve only minimal alteration or disturbance to the habitat can be carried out safely in the secondary zone during the non-nesting season. Examples of these activities include: minor logging or land clearing, minor construction, seismographic exploration employing explosives, oil well drilling, and low-level aircraft operation. However, these activites should avoid major alteration or loss of Bald Eagle habitat as much as possible. If logging is done, it is best to retain as many large trees as possible for roost and perch trees. Retention of at least 10 to 15 live trees per acre is suggested. Ideally, the trees left uncut should be the largest in the stand, preferably those with open crowns and stout lateral limbs. Selective forestry practices such as seedtree, shelterwood, and single tree selection are recommended over clear-cutting.

Minimal disturbance recreational activities (hiking, fishing, camping, picnicking, bird-watching, hunting) and everyday farming and ranching activities that cause no new alteration of habitat can be safely carried out in the secondary zone at any time.

Feeding Areas

The use of toxic chemicals in watersheds and rivers where Bald Eagles feed should be avoided as much as possible. Where agricultural herbicides and pesticides are used within the watershed, label directions should be strictly followed, including those describing proper disposal of rinse water and containers. Alteration of natural shorelines where Bald Eagles feed should be avoided or minimized as much as possible. Degraded or eroded shorelines should be revegetated whenever possible.

Winter Roost Concentration Areas

Logging or land clearing activity should be avoided within 1,500 feet of a roosting concentration area. Disruptive, noisy, or out-of-the-ordinary land use activities should be avoided near communal roost sites. Normal agricultural activites which have occurred traditionally on the land are generally acceptable near these roost sites as long as they do not appear to be affecting roosting eagles. However, it is best to avoid even normal activities during evening, night, and early morning hours.

For More Information

Landowners and managers can contact the Texas Parks and Wildlife Department, U.S. Fish and Wildlife Service, U.S. Natural Resources Conservation Service (formerly Soil Conservation Service), or Texas Agricultural Extension Service for technical assistance in managing habitat and protecting Bald Eagle nest sites.

Appendix J

Nongame Wildlife Management Recommendations

by
Matt Wagner and David Rideout
Texas Parks & Wildlife Department

Follow guidelines provided through TPWD's Texas Wildscapes Program for specific practices to provide food, water and cover requirements for various nongame species. Following is a list and brief description of habitats and various management practices that are beneficial to nongame species of wildlife in the Post Oak Savannah. It should be noted that many of the practices are also beneficial to and recommended for game species (eg.,, deer, dove, turkey, quail, etc.). Conversely, most management practices directed at managing game species will also be beneficial to many species of nongame wildlife.

HABITAT CONTROL

Prairie/grassland restoration -Establishing a mixture of native grasses and forbs on disturbed range or farm land to provide habitat for wildlife diversity. Use the TPWD wildscape plant list. Restore and maintain mid and tall grass prairie by planting native seed stock, using species such as Indiangrass, Little bluestem, Big bluestem, Switchgrass, and Sideoats grama. Follow guidelines in Appendix K. Reduce woody plants near restored blocks of prairie to reduce incidence of predators and cowbirds. Use prescribed burning or apply selective herbicides in late summer or early fall using individual plant treatments according to recommendations provided by Texas A&M University Extension Service, Natural Resource Conservation Service and local Fire Department protocols. Summer burns are more effective at woody plant control but avoid burning during June and early July. Use rest-rotation grazing whereby one pasture in a multiple pasture system receives one year of rest on a rotational basis at least every third or fourth growing season. Pasture deferment should coincide with nesting season and seed set. Grass height of 4-12 inches is desirable for feeding and nesting cover of ground-besting birds. Delay haying until July to avoid destruction of ground-nesting birds. Avoid fragmenting large blocks of habitat. Area sensitive prairie species benefit from tracts of 125 - 250 acres or more in size. Minimize edge by restoring square rather than irregular shaped blocks. Connect scattered plots of prairie by restoring connecting corridors. If this is not possible, create restoration plots of 15-20 acres located within a mile of each other. Incorporate hayfields, improved pastures or CRP lands to minimize edge.

Forest/woodland restoration - Establishing native trees and shrubs where appropriate to restore native habitats for wildlife diversity. Use the TPWD Wildscapes plant list.

Maintain larger tracts of 100 acres or more of late successional woodland for area - sensitive species. Allow regeneration of seedlings to develop sapling/small-sized trees

for well-developed understory.

Shrubland restoration - Establishing native shrubs or small trees where appropriate to restore native habitats for wildlife diversity. Use TPWD the Wildscapes plant list. Early-successional habitats can be provided by establishing hedgerows or plots of fruit-bearing native shrubs. Maintain brush along fencelines or shelterbelts with saplings and dense thickets of shrubs and vines for nongame birds such as Loggerhead shrike and Blue grosbeak.

Wetland restoration - Establishing water flows and native vegetation in former wetlands to provide wildlife habitat.

Riparian area management - Provide alternate livestock feeding and watering sites, exclude pastures with riparian areas from livestock grazing or fence out livestock. Defer grazing in riparian areas during April - October.

Prescribed burning - The use of fire to restore, enhance or maintain native habitats for wildlife diversity. Prescribed burns should be conducted according to TPWD, USDA Natural Resource Conservation Service, Texas Agricultural Extension Service and Texas Natural Resource Conservation Commission protocols in coordination with local Fire Department.

Mowing - Used to manage invading woody plants and maintain desirable herbaceous vegetation for wildlife food and cover. Mow before or after nesting season to avoid grassland nesting birds (most nesting occurs generally April-June).

Exotic or "weedy" plant control - Use of fire, selective herbicides, and mechanical methods to control invasive plants in important habitat types to maintain or restore wildlife populations.

Conversion of exotic vegetation - Removal and replacement of exotic vegetation with native plants for wildlife habitat.

Restore and maintain oak savannah/grassland - Prescribed burns should only be conducted according to TPWD, USDA Natural Resources Conservation Services, Texas Forest Service, Texas Agricultural Extension Service, and Texas Natural Resource Conservation Commission protocols in coordination with local Fire Department. Most prescribed burns are conducted during December-March. Late winter-early spring burns will not impact cool season forbs as much as mid-winter burns. Summer burns are more risky, but could be more effective at woody plant control. If mechanical brush control is used leave brush piles for small mammals. Reseed areas with native grass/forb mixtures as necessary. Avoid fragmentation of large blocks of habitat or maintain shrubs and small trees in savannah habitat for song posts, and perch sites.

Maintain oak woodlands with dense understory - Exclude livestock from woodlands, especially during the early spring green-up, and the late summer-fall and

winter peak stress periods for wildlife. This allows for understory regeneration, and berry and mast production, and keeps livestock from reducing evergreen browse during periods of reduced forage availability. Maintain dense horizontal layers of understory vegetation for nesting warblers, vireos and other songbirds. Connect fragmented blocks of habitat by planting a diversity of native, fruit-bearing trees and shrubs.

Protect/restore oak woodlands - Maintain areas with hardwoods, the broad - leaved species (post oak, red oak, water oak, white oak, etc.) with at least 50% canopy cover. Control overbrowsing by white-tailed deer, exotic game and livestock.

Enhance mid-succession brush habitat - Promote brush regeneration with prescribed fire and/or mechanical methods that remove the top-growth of woody plants but encourage root sprouting. Use proper grazing management.

EROSION CONTROL

Riparian area management - Provide alternate livestock feeding and watering sites, exclude pastures with riparian areas from livestock grazing or fence out livestock. Defer grazing in riparian areas during April - October. Control erosion using water structures and native plants.

Prairie/grassland restoration - Establishing a mixture of native grasses and forbs on disturbed range or farm land to provide habitat for wildlife diversity. Use the TPWD Wildscapes plant list.

Forest/woodland restoration - Establishing native trees and shrubs where appropriate to restore native habitats for wildlife diversity. Use the TPWD Wildscapes plant list.

Trails and signs - Create walkways or paths to manage human impact and reduce erosion in sensitive areas.

PREDATOR CONTROL

Avian predator and nest parasitecontrol – Selected avian predators (grackles, starlings, and brown-headed cowbirds) may be controlled as a part of a PLANNED PROGRAM to reduce impacts on nesting neotropical and resident songbirds through shooting and trapping, grazing management, and maintenance of large blocks of wildlife habitat. A planned trapping program, that minimizes capture of non-target species in cowbird traps, is being tested and developed for use by landowners. All non-target species are protected by state and federal law, and must be released unharmed following developing protocol.

Carnivore-furbearer control - Reduce the impact of coyotes, raccoons and other carnivores on colonial nesting birds. Control of feral dogs and cats by humane methods can enhance grassland bird nesting success and survival.

Fire ant control - Control fire ants using bait (such as Logic) or other approved product during spring-fall.

PROVIDING SUPPLEMENTAL WATER

Wetland restoration - Establishing water flows and native vegetation in altered coastal and inland wetlands.

Well/trough/pond with overflows - Establish additional shallow water supplies through construction of ground-level wildlife ponds, or adding overflow systems on existing wells and troughs. Protect these areas from livestock use. Follow TPWD Wildscapes Program guidelines and guidelines in Appendix O.

PROVIDING SUPPLEMENTAL FOOD

Establish food plots ½ to 1 acre in size by shallow discing and/or sowing native seed-producing food plants for birds (i.e., sunflower, millet, partridge pea, sesame).

Butterfly and hummingbird gardens - Establish native wildflowers, trees, shrubs, vines, or cultivated flowers as food sources for butterflies and hummingbirds. Follow the TPWD Wildscapes Program plant list.

Feeding stations - Set up liquid, seed and free-choice feeding stations for resident and migratory birds. Especially critical during migration and winter months when natural food sources are scarce. Follow TPWD Wildscapes Program guidelines.

Reduction of broadcast insecticides - Increases the amount of insects available as a wildlife food source for birds, reptiles and amphibians.

PROVIDING SUPPLEMENTAL SHELTER

Brush piles/rock piles - Leaving or stacking cleared brush and rock to create denning and escape cover for birds, small mammals, reptiles and amphibians. Follow TPWD Wildscapes Program guidelines.

Thickets of native brush - Create or maintain thickets of native shrubs/trees for refuge.

Snag maintenance and creation - Protect snags and deadfall for cavity-dwelling species. Create snags using selective herbicides or girdling undesirable woody plants.

Nest boxes and perching platforms/poles - Provide nest structures for songbirds, owls, small mammals, bats, raptors, herons, and other nongame species. Where suitable nest cavities are in short supply due to lack of dead timber snags that provide cavities or natural timber hollows, artificial nest/roost boxes can be erected to help

alleviate these shortages for particular species. Some of the birds and mammals that can benefit from these structures are: bluebirds, chickadees, titmice, prothonotary warbler, wrens, woodpeckers, screech owls, kestrels, wood ducks, black-bellied whistling ducks, squirrels, and bats. The TPWD Wildscapes Program can furnish additional information regarding number, specifications, placement, and maintenance of these structures for specific species.

CENSUS

Time area counts - The number of individual species seen or heard during a fixed time frame per unit area (eg, point counts for birds, squirrels).

Drift fences/pit fall traps - A system of flashing or similar material arranged on the ground to funnel small wildlife species into buried buckets or other pitfall trap. (used primarily for reptiles and amphibians).

Small mammal traps - Small live traps arranged along a trapline to sample small mammals.

Neotropical Migratory Birds: These are birds that breed in the United States and Canada, and migrate to the Neotropical regions of Mexico, Central and South America, and the Caribbean during the nonbreeding season. As mentioned in the General Habitat Management section at the beginning of this example plan, loss and fragmentation of woodland and native grassland habitat has reduced populations of many neotropical populations. Neotropicals include the following groups of birds: kites, hawks, cuckoos, nightjars, hummingbirds, flycatchers, swallows, thrushes, vireos, warblers, tanagers, grosbeaks, buntings, orioles, and blackbirds. For more information regarding neotropical status, surveys, and possible management strategies, contact the Partners in Flight Program Coordinator at TPWD Headquarters in Austin.

Birds of management concern for Post oak and Blackland Prairie region include:

White-breasted nuthatch
Chuck-will's-widow
Kentucky warbler
Yellow-throated vireo
Harris' sparrow
Loggerhead shrike
Eastern meadowlark
Blue-gray gnatcatcher
Blue grosbeak
Smith's longspur

Waterfowl/Wading Birds: To improve the habitat for dabbling ducks and wading birds, construction of 3 - 4 foot high levees with a drop-board water control structure in suitable low areas could back up and hold water during the fall, winter, spring, summer

months, depending on water management strategy. This could provide shallow (6 to 24 inches) water feeding areas for migrant ducks, wading birds, and spring-nesting wood ducks. Exclude livestock from this area with installation of an electric or barbed wire fence around the perimeter, at least 50 yards away from the maximum flooded area. Contact the local Natural Resources Conservation Service or TPWD waterfowl biologist for assistance in location and construction of the levee.

Installation of wood duck nest boxes in and around the edge of shallow water areas can increase nesting sites for wood ducks that are normally present in the summer, but lack suitable nesting sites due to lack of natural cavities in older, damaged trees or lack of these type of trees. One nest box (not within view of other nest boxes) per acre of brood-rearing wetland habitat is usually sufficient. These should be erected on 10 foot metal or treated wooden posts in or at the edge of wetlands.

Feral Hogs should be controlled by shooting and live trapping whenever possible. Most success at this usually occurs during the winter when feral hogs are having to travel more to find food. Besides rooting up pastures, feral hogs compete directly with deer, turkey and most other wildlife species that rely heavily on acorns and other hard and soft mast for winter food. Deer also tend to avoid areas when feral hogs are present.

Other Comments: The development of a Landowner Wildlife Management Association with adjacent and neighboring landowners will greatly enhance any management that you apply to your ranch, and is strongly encouraged. TPWD and TCE personnel are available to assist in this endeavor.

Appendix K

Guidelines for Native Grassland Restoration Projects

by
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Texas Parks and Wildlife Department, Mineral Wells

INTRODUCTION

Native grasslands and prairies, with their ecologically complex plant and animal communities, were an important component on the landscape of early Texas. They were dominant features on the landscape in the Edwards Plateau, Cross Timbers and Prairies, Coastal Plains, High Plains, and Lower Rolling Plains. They contributed significantly to forage production for livestock grazing and habitat for a wide variety of wildlife species. Most of the native prairies found in the Blackland Prairie and Coastal Prairie Regions of Texas have been depleted. Only isolated relic native prairies sites remain. Native prairies were also found within most of the other ecological regions of the state where adaptable soils site occurred. Soil that once supported these vast plant communities of native perennial grasses and forbs now maintain a thriving farming economy. Most of these lands are now devoted to the production of wheat, milo, corn, cotton, hay, improved pastures, and an array of other cash crops to meet our demands for food and fiber.

It is not possible to totally replicate the native grasslands and prairies that once existed in the different ecological regions of Texas. These guidelines, however, represent basic and fundamental techniques and procedures that should be addressed when attempting to restore or reconstruct range sites to resemble native prairie plant communities in Texas. Only with time can land truly evolve through the stages of natural plant succession to replicate the diverse flora and fauna characteristic of climax native prairies. There are land management steps that can be taken to speed up this process by reintroducing native plants or their cultivars on those lands that once supported native grasslands and prairies. Texas Parks and Wildlife Department recognizes the importance of native prairies and grasslands and their function as habitat for many wildlife species including native and migratory birds, small and large mammals, reptiles and amphibians, insects, and invertebrates. Each ecological region will require different techniques, planting procedures, species selections, and site preparations to be successful. It will be imperative that a coordinated effort be made to draw upon the expertise of other agencies and groups with knowledge and training on native grassland and prairie restoration before undertaking a restoration project. Agencies such as the United States Department of Agriculture Natural Resources Conservation Service (NRCS), Texas Agricultural Extension Service, Soil and Water Conservation Districts, Native Prairies Association of Texas, Texas Parks and Wildlife Department, United States Forest Service, and universities are logical sources of information concerning the specifics to formulate grassland and prairie restoration plans. Many of these organizations have identified successful techniques and procedures through research and demonstration projects in different parts of Texas. No plan should be considered

complete that has not taken into consideration the experience and knowledge already available from such sources.

The following outline covers most of the major elements that should be addressed in a grassland restoration plan. Many variables in techniques are possible and may be considered adequate if supporting evidence is presented to justify the approach to grassland and prairie restoration. As each site will be different, every effort should be made to identify specific techniques or steps that are applicable to each site.

GRASS SPECIES

Native grasslands/prairies are diverse plant communities where 50 to 90 percent of the vegetation is grasses. They are the basic framework of the site and are associated with a wide variety of forbs or other plants. The more individual grass species planted, the better. However, initiation of a restoration project can include the initial planting of as few as four species for the site. Grasses planted, if from commercial seed sources, should be climax grass species for the ecological region of the state being considered and adapted to the soils found on the site. Sites may be suited to tall, mid-, or short grass species, depending on individual site classification or soil type. It may be necessary to plant different grass species on different locations of the site due to differences in soil type, moisture retention properties of the soil, PH considerations, or other microhabitat factors.

Selection of individual grass species to plant should be based on information obtained from the local NRCS or Soil and Water Conservation District (SWCD) office or other recognized source with knowledge about climax grass species of the area. Their range site descriptions will also be useful. Seed sources should be from within 300 miles of the site or nearer to assure adaptability and improve success of initial establishment. Grass seed will have a PLS (pure live seed) or germination rating which should be checked - the higher the better. Many commercial seed companies also will mix seed on request when ordering. Seed should be clean to improve flow through grass seed drills during planting. Soil type is also a factor to be considered when selecting grass species to plant.

FORB SPECIES

Forbs or broadleaf herbaceous plants represent a major component of native grasslands/prairies and may be seasonally co-dominant. Annual and perennial species are found in native prairies and are responsible for the majority of species diversity. Planning native grassland/prairie projects should also incorporate initial introduction of a selected number of forb species. A plan should provide for the planting of at least four perennial species from the ecological region and adapted to the site. Range site descriptions and climax vegetation check list from the local NRCS or other recognized source should be reviewed. The planting of additional species of annual and perennial species is encouraged as the site develops over time.

Annual forb species should not be introduced on the site until planted grass species become established. Establishment of grasses may require periodic mowing, at least initially, and will make establishment of annual forbs difficult. Most sites will produce annual forbs and some perennials from existing seed banks in the soil. Annual forb diversity will increase over time. Annual forbs should not be planted during the first two years of the project.

A listing of seed sources for native grasses and forbs is also available from the National Wildflower Research Center in Austin. When ordering seed from any commercial seed dealer, always ask about the source of the seed you want. Be selective and shop around for seed availability when you will need it and the price you are willing to pay.

Native grasslands/prairies may also be reestablished using cut seed hay from an existing native prairie site. Seed can also be combined from an existing stand of native grassland. Techniques for planting seed obtained by these methods will be discussed. Annual forb seeds may also be collected by hand, stored to dry, and planted on selected sites throughout the life of the restoration project to improve plant diversity.

SITE PREPARATION

Site preparation is perhaps the most important element to be addressed in planning a native grassland/prairie restoration project. The initial success of plantings will often be dependent on those steps taken to reduce weed competition, provide a suitable seedbed, and promote growth of seedlings. Competition by cool-season grasses and weeds will make initial establishment of native grass plants difficult and require site management. Many of these plants are alien species and are undesirable in the completed project.

As each site will be different, an evaluation should be made to determine what existing vegetation complex is present and what steps will be necessary to set back plant succession so species planted can germinate and grow. It is important to determine the history of the site including past land use, crops grown, species of improved grasses planted, cultivation or other mechanical soil disturbances, herbicides used, etc. A check with the local NRCS or Farm Service Agency (FSA) office will be helpful. Aerial and topographic maps will help you evaluate the site to determine important features such as drainages, slope, or other physical features important in planning the restoration project. County soil maps should be closely reviewed during the early planning stages to determine soil types and adaptability of grass and forb species to be planted on the site.

One approach to grassland/prairie restoration is to plant forbs initially during the first fall period of the project and grasses during the late winter months of the following year. For a fall planting of forbs during October, the site must be prepared well in advance. Mowing and periodic light disking during the spring and summer months prior to planting will help set back germination and establishment of existing weeds and grasses. Shallow disking is recommended to avoid stimulating the existing dormant weed seed

bank in the soil. Several diskings will be required initially and again just prior to planting. Application of an approved herbicide such as Roundup may be necessary on some sites prior to planting to control vegetation regrowth or undesirable species such as Johnsongrass, coastal bermudagrass, or cockleburs. A year's lead time is preferred for initial site preparation. Fire may also be used in initial site preparation to reduce rank vegetation.

A cover crop such as Haygrazer or other sorghum varieties may be planted on some sites to be restored during the summer, harvested in the fall, and the remaining stubble used to stabilize the soil surface for planting with grass seed drills. Not all sites require such plantings, depending on the individual site and strategy being used to establish grass and forbs. This technique reduces soil erosion by wind and water and may be necessary on some sites. Stubble should be left to a height of at least four inches.

Soil preparation specifications and guidelines for specific soil types and range classifications have been developed by the NRCS and are available at local SWCD offices.

PLANTING

Preferred planting dates for perennial forb seed is during the fall, particularly the October-November period. Although most perennial forb species will not germinate until the spring, it is necessary that they undergo the chilling and softening process in the soil. Forb seeds may be planted with mechanical seed drills or broadcast spreaders, hand-carried seeders, broadcast by hand, or be mixed and incorporated with grass seeds during the grass planting process. Most forb seeds require shallow planting depths into a firm seed bed. Forbs should not be planted earlier than the first freeze of the fall. Planting date information is also available from commercial seed dealers who provide recommendations for seed they sell. Planting dates will also vary, depending on what part of the state the site is located in. Native grass seed should be planted in Texas between January and April. Dry conditions during this period may substantially influence germination and growth of grass seedlings.

Seeding rates of commercial seed are available from the dealer. Seeding rate information for soil and range sites is also available from the local Natural Resources Conservation Service office. Seeding rate recommendations for pure stands of individual grass species may require adjustment to allow for planting of multiple species or mixes. Generally, a generous seeding rate for native grass species will improve the odds for a good stand the first year. Seeding rates will depend on the number of individual species being planted, type of equipment, and proportion of species desired in the final stand.

There are several types of equipment that are effective for planting grass seed. Grass drills are probably the best equipment and have greater reliability in establishing a stand. Grass drills are often available for use from local SWCD offices. Also, commercial contract farmers who specialize in grass plantings normally have this type

of equipment. Common brand names are Tye, Nesbitt, John Deere, and Turax. Cultipackers are also used and consist of a seed box and roller system to pack seed into the ground. Seeds may also be planted by a fertilizer spreader followed by a harrow to work seed into the soil. Hand-held broadcast spreaders or those operated by small all terrain vehicles may also be used.

Seed hay taken from a native prairie site can be scattered over prepared ground by hand from a trailer, followed by a light harrowing to incorporate it into the soil. Prairie hay bales may be available and are easily stored. Such plantings should be done in the fall following the harvest of native seed hay. This method is not reliable because there is no guarantee that viable seeds have been produced and that germination will occur. Although native grasses may appear to have good seed production, only by conducting a germination test will you know if live seed are present and establishment of seedlings is likely.

Fertilization is optional during the initial planting of native grasses and forbs. It may serve to promote the growth of undesirable forbs and annual grasses and slow establishment of the desired species planted. Fertilization rates can be determined by soil analysis tests or based on recommendations from the NRCS or Texas Agricultural Extension Service.

Forb seed purchased from seed dealers should be specified as native, not domesticated seed. Mixes are generally not recommended unless they contain a desired species composition adapted to the region and are those species you want. Individual species plantings are preferred. One approach to seeding forbs is to mass plant a variety of adaptable species and let the site, through the process of natural selection, determine where certain species will do best. A continuing effort should be made by the landowner to introduce additional forb species to the site as the project progresses over time.

SITE MANAGEMENT

During the first year, growth of grass seedlings and perennial forbs may not appear impressive. Most growth of these plants will be below ground in the development of root systems. Annual weeds and other on-site grasses will respond to soil disturbances associated with initial planting operations. Mowing will be necessary during the first two years. Restoration sites should be mowed to a height of no less than 4 inches to reduce competition from annual weeds and undesirable grasses. It will also serve to reduce moisture loss from the soil. It may take 2 to 3 years growing time for native grasses to dominate the site vegetatively. Perennial forbs should respond sooner and become established along with annuals. Timing for mowing will have to be determined on-site and will require regular attention by the landowner.

Grazing is not recommended during the first three years. If vigorous growth of planted grass species does occur during this time, limited grazing during the dormant season may be possible. After three years, grazing may be incorporated into the management

plan for the site by grazing during the growing season under a rest and rotation system. Grazing is not required for grassland/native prairie restoration projects, rather it should be used as a tool in their management.

Control burning is also a tool that can be used for site management. No burning should be conducted during the first three years after grasses have been planted. After that time, if the site has developed sufficiently and forage and thatch becomes excessive, burning on a 3 to 4 year rotation can be initiated. Fire is a natural event for grasslands and prairies that benefit from its occurrence. Burning will stimulate growth of dormant forb seed, promote growth of above ground vegetation, improve soil fertility, and help control the invasion of undesirable woody plant species found in the area. Fire releases nutrients back into the soil and reduces shading of new grass and forb seedlings. Many new species will also germinate from the existing soil seed bank. Winter burns benefit warm-season dominant plants, whereas summer burns promote growth of cool-season plants. Depending on individual site management strategies, the use of prescribed burning, mowing, and grazing will be the primary tools available for site management of grassland/prairie restoration projects.

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Native Plant and Seed Sources of Texas and Oklahoma. National Wildflower Research Center, Austin, Texas.

SUGGESTED INFORMATION SOURCES

USDA Natural Resources Conservation Service (local)
Soil and Water Conservation Districts (local)
Native Prairies Association of Texas
3503 Lafayette Avenue, Austin, TX 78722-1807
Texas Parks and Wildlife Department
4200 Smith School Rd., Austin, TX 78744
National Wildflower Research Center
2600 FM 973 North, Austin, TX 78725
Plant Materials Center, NRCS, Knox City, TX
The Nature Conservancy of Texas
P.O. Box 1440, San Antonio, TX 78295
Texas Agricultural Extension Service (local)
Native Plant Society
USDA Farm Service Agency (FSA) (local)
USDA US Forest Service

USDA US Fish and Wildlife Service
Texas A&M University/College Station
Texas Tech University/Lubbock
Texas A&M University/Kingsville
Southwest Texas State University/San Marcos
Sul Ross State University/Alpine
East Texas State University/Nacogdoches
Other Universities

Appendix L

Conducting White-tailed Deer Spotlight Surveys in Central Texas

by
Steve Jester, Wildlife Biologist, Decatur
Jim Dillard, Technical Guidance Biologist, Mineral Wells

This brief overview of the **deer spotlight survey** is designed to answer some of the most commonly asked questions about this method for censusing white-tailed deer and its application in central. A deer spotlight survey is only one part of a comprehensive deer management program that must also include proper habitat management, harvest management, and record keeping. Why a deer census is needed, what it will and will not tell you, the type of equipment necessary for conducting spotlight surveys, and how to interpret data collected will be discussed.

There are some limitations to using spotlight census for estimating densities of white-tailed deer in central Texas. Spotlight surveys have limited application on small tracts of land or where dense vegetation such as juniper or oaks greatly reduces visibility. Land holdings of 1,000 acres or greater offer better potential for application of this sampling technique. Spotlight surveys are not designed to observe a total deer population, rather to sample a representative portion of habitat and the number of deer found there.

What is a deer spotlight survey? A deer spotlight survey is a method of sampling a given area of land and the density of deer found there. Area is expressed as the number of **visible acres** which is determined by taking a series of visibility readings along the designated route at 10th mile intervals. Data collected on a deer spotlight survey is express as the number of **acres per deer**. Multiple counts are required on the repeatable route for reliable information on deer density.

Why do I need to know about estimated deer density and herd composition? Estimates of deer density and habitat surveys can help determine whether your deer herd is at, above or below carrying capacity of the habitat. Deer **carrying capacity** is the density of healthy and productive deer the land can support without causing habitat damage. A knowledge of the deer density and herd composition is necessary to regulate annual deer harvest (how many bucks or does to harvest). Daylight herd composition counts may be used in conjunction with spotlight census data to more accurately estimate percentages of bucks, does, and fawns in the deer herd. The spotlight census also enables landowners to monitor progress of habitat and harvest strategies in reaching specific deer management goals and objectives.

Where do I set up my deer census line? Select all-weather roads that go through a variety of habitat types. Avoid roads that frequently wash out or become impassable following heavy rain. The transect should sample different habitat types in proportion to number of acres they represent on the property. Avoid roads by feeders or food plots where deer may be concentrated. Spotlight surveys conducted during August and September are less likely to be influenced by seasonal environmental factors, food

distribution, acorn-drop, or other biological events affecting deer. On large tracts, more than one route may be required to adequately sample a ranch. **Make a map of the route(s) for future reference.**

How do I set up my line and determine visible acres? Once a route has been selected, an estimate of the number of visible acres along the route must be determined. During the summer months and prior to the first official count, drive the route at night with two observers on the back of the vehicle. Using the same type of spotlight you will use to count deer, have the driver stop every **1/10 mile**. The observers estimate how far they can see a deer (or where the brush becomes too thick to see deer) in a straight line perpendicular to the truck **(left 150 yards and right 50 yards, etc.)** up to maximum of 250 yards from the road. A visibility estimate is also needed at the start point of the line. Visibility estimates made on census routes 12 miles long or greater can be taken ever **2/10 mile.** Visibility readings may be recorded on a form or tape recorded for later tabulation. This process is repeated for the length of the route. On dead-end roads, record visibilities only going down the road and resume taking visibilities when a new portion of the route is begun. When conducting additional counts on the same census route, it is **not** necessary to retake visibilities. Visibility estimates may be used for several years unless significant changes in vegetation have occurred along the route. The following formula is used to convert 1/10 mile visibility estimates into **acres of visibility:**

Total yards of visibilities / number of 1/10mile stops +1 X Number of miles X 1,760 / 4,840 = Visible Acres

For a 7.7 mile line with 4,744 total yards of visibility the formula would be:

4,744 / 77 + 1 X 7.7 X 1,760 / 4,840 = 170.29 ac.

When do I conduct deer spotlight counts? In central Texas, spotlight surveys should be conducted during the months of August, September and early October. Deer are generally well distributed in their home ranges during this period of the year and are more easily identified by sex and age-class (fawns). Each route should be counted 3-4 times to improve reliability of the data. Do not conduct surveys during rain, high wind or following significant disturbance along the route during the day of the count (working cattle, construction, seismograph work, etc.) Begin all counts one hour after official sunset. Contact the local Texas Parks and Wildlife Department game warden prior to conducting spotlight surveys. Also, notify neighbors or adjoining landowners who might see the lights to alert them about your activity.

What equipment do I need to make a deer survey? Pickup trucks (4-wheel drive may be required) are preferred over sport utility vehicles or cars. Use a 25 ft. piece of 12 gauge insulated woven wire with two "alligator" clips on one end and a two-plug outdoor type outlet box on the other. Replace the cigarette lighter plug on the spotlight cords with a standard male plug. Attach the alligator clips to the positive and negative poles of the vehicle battery and plug the light into the outlet box. Other wiring systems

can also be used. Use 100,000 candlepower tractor or utility bulbs and avoid using Q-beam-type lights, which are heavy, produce excessive glare, and can quickly drain a battery. Other necessary equipment includes clipboard or tape recorder, **binoculars,** and a pencil.

How do I conduct the survey? Drive the route 5 to 8 mph. In open terrain where visibility permits, speed may be increased to 10-12 mph. Stop only to identify deer or determine the number of deer in a group. Unless all deer observed in a group can be identified by sex and age-class, record **ALL** these deer as unidentified. Recording only bucks from a group will bias data and reflect a better buck to doe ratio than may be present. Record deer as **bucks, does, fawns,** or **unidentified.** Deer are usually first spotted by their reflective eyes. Deer eye reflection is greenish-white. Other wildlife, birds, fence posts, and livestock are often mistaken for deer. It is **imperative** that binoculars be used to identify **all** deer observed. Keep the lights moving as the truck moves, checking both ahead of and behind the vehicle. The observer on each side of the vehicle shines only his/her side to prevent blinding the other observer. Deer observed over 250 yds. from the vehicle should **not** be recorded.

How do I interpret the spotlight census data? Divide the **total number of deer** into the **total number of visible acres** observed to determine the number of **acres per deer** on the route. For example: **1,260 acres** (one spotlight survey route counted 3 times with 420 acres of visibility) divided by **90** (total number of deer observed on one spotlight survey route counted 3 times) = **one deer per 14.00 acres.** The estimated deer population for the ranch can then be estimated by dividing the total acres of the ranch by the estimated acres per deer figure. For example, the deer **population estimate** for a **5,000** acres ranch with a deer density of one deer per **14.00** acres is **357 total deer.** An **estimate** of the number of bucks, does, and fawns in the population may then be determined by multiplying the **total number of deer** by the **percent** of all deer identified that were bucks, does, and fawns. For example:

357 Deer	X 0.20 (% identified as bucks) =	71 bucks
357 Deer	X 0.50 (% identified as does) =	179 does
357 Deer	X 0.30 (% identified as fawns) =	107 fawns
	TOTAL =	**357 deer**

In addition, deer identified as bucks, does, and fawns from spotlight surveys combined with daylight herd composition counts will provide important information on the buck to doe and fawn to doe ratios. These ratios are important population parameters of you deer herd that allow you to measure the success of your management program.

For example: 179 does / 71 bucks = 2.52 does per buck

107 fawns / 179 does = 0.59 fawns per doe

How can Texas Parks and Wildlife Department help me? On written request, department wildlife biologists and technicians provide technical assistance to

landowners on wildlife and habitat management planning, including establishing deer management programs and deer spotlight surveys. Under the Private Lands Enhancement Program, department personnel are available to assist landowners with setting up and conducting an initial spotlight survey. In addition, assistance is available for interpreting census data collected by landowners and with formulating harvest recommendations based on that information. Literature and data forms are available on request. For assistance, contact Texas Parks and Wildlife Department, Wildlife Division, 301 Main Street, Suite D, Brownwood, TX 76801 or your local Texas Parks and Wildlife Department wildlife biologist.

Appendix M

Herd Composition: An Essential Element of White-tailed Deer Population and Harvest Management in Central Texas

By Jim Dillard, Technical Guidance Biologist, TPWD, Mineral Wells

INTRODUCTION

White-tailed deer management consists of a series of strategies, practices, and other actions taken on the part of landowners and land managers to produce and sustain populations of this important game animal. **Habitat management**, **population management**, and **harvest management** are all essential ingredients for accomplishing a successful white-tailed deer management program. It is the degree of importance that landowners or wildlife managers place on these different stages of management that will determine long term results. Knowledge of the composition of a deer herd is fundamental to making sound management decisions.

Herd Composition - What Is It?

Herd composition refers to the **ratio of bucks, does, and fawns in the population.** In addition, the ratio of does to bucks and fawns to does are also key population relationships used to implement and evaluate management and harvest strategies. An estimate of the **percent bucks, does, and fawns** in the total population is one of the most important factors that must be known before harvest rates can be formulated.

Deer are born at approximately a one-to-one sex ratio; however, few free ranging populations reflect this ratio. Herd composition is not static but changes throughout the year due to the cumulative influences of hunting pressure, reproduction, natural mortality (diseases, accidents, predation, etc.), range conditions and land use, and environmental factors such as rainfall patterns, temperatures, drought, or floods.

Although the exact number of deer living on most ranches is impossible to determine, various techniques are available that estimate their numbers. Techniques such as spotlight surveys, walking Hahn transects, mobile daytime census, and aerial counts are common methods used to estimate the relative density of deer. With each of these techniques, deer are counted on a given area of space or acreage. The number of deer observed divided by the number of acres sampled is expressed as **acres per deer.** An estimate of the total population can then be determined by expanding this figure to the total ranch acreage. For example, a 5,000 acre ranch with an estimated density of 25 acres per deer has an estimated total deer population of 200 deer. Unless a significant number of observed deer are identified as to sex and age class, estimated herd composition is unknown. In most situations, not enough deer are identified while conducting these types of surveys which must be supplemented by additional **herd composition counts.**

When Do You Conduct Herd Composition Counts?

Deer herd composition counts should be made during that time of the year when bucks, does, and fawns are most easily identifiable. The exact time of the year may vary across the state due to differences in fawning dates and antler formation on bucks. Counts initiated before peak fawning has occurred or prior to advanced antler formation will not provide data reflective of the population sex or age composition. Also, fawns are not actively up and moving with does until they are 6-8 weeks of age. It is recommended that herd composition counts in central Texas be conducted during **August and September**. The differential size between fawns and adult deer is most evident during this period. The spotted hair coat on fawns begins to disappear during late September when molt occurs, making identification difficult unless a mature size deer is nearby. Fawns also begin to grow rapidly by this time, making positive identification difficult. Early fawns may be misidentified as yearlings on counts made after this time. Antler development on bucks has also progressed during this period so that they too are readily identifiable.

Herd composition counts should also be completed by the end of September to allow time for harvest rates to be calculated and preparations made for the upcoming archery and general gun seasons.

How Do You Make Herd Composition Counts?

Herd compositions counts can be made any time of the day or night. However, since deer are most active during the **early morning and late evening**, efforts to observe deer during these periods are most productive. Identification of deer during daylight hour is also easier than night observations with spotlights and a higher percentage of deer can be identified. Most counts can be made from a slow moving vehicle along ranch roads. Counts can be made at random, along a systematic route, or at specific locations where deer are feeding or congregating. Grain fields, food plots, water sources, natural crossings, or tree lines are good places to observe deer. Counts may also be made from hunting blinds or other stationary structures where deer are known to occur. **The use of binoculars or spotting scopes is a must!**

Record **only** deer that can be identified as a buck, a doe, or a fawn. When a group of deer is observed, **do not** record **any** of the deer unless **all individuals** can be positively identified. If you see a deer but can not identify it - don't record it. Do not assume the identity of deer or counts will become biased. Fawns and mature bucks are usually easy to identify. Yearling bucks or spikes are often mistaken as does. Every effort must be made to be sure you properly identify all deer. Avoid recording the same individual deer on different dates if possible. Your objective is to observe a representative cross section of deer throughout the total population on your ranch.

Remember, many deer during this time of the year will still be in small family groups that may consist of a doe with this year's fawn or fawns, and her doe or buck yearling from the previous year. Other groups may consist of several does and their collective fawns. And, during August, bucks are often observed in groups away from the does. As September progresses, buck become less tolerant of each other and begin to be observed more as singles.

Take your time when you see a deer. Often, there are other deer standing nearby that you won't see unless the group begins to move or run. Fawns may be hidden in tall grass and not seen until the doe begins to move away. Be patient!

Data should be recorded on a simple form that has columns for the date, bucks, does, fawns, and total. When all herd composition observations are completed, simply add to total number of bucks, does, and fawns observed together. It is recommended that a minimum of **100** individual deer be identified if possible. **The more the better!**

How Do You Determine Herd Composition from the Data?
From your data sheet, **total** the columns for **bucks, does, and fawns** and **add them together**. This figure represents **total deer identified**. To determine estimated herd composition, **divide** each individual group (bucks, does, and fawns) by the **total identified deer figure**. For example, if a total of 100 deer were identified and 20 were bucks, 50 were does, and 30 were fawns, calculate herd composition as follows:

20 (# of identified Bucks) divided by 100 (total identified Deer) = .20 *x* 00 = **20% Bucks**
50 (# of identified Does) divided by 100 (total identified Deer) = .50 *x* 100 = **50% Does**
30 (# of identified Fawns) divided by 100 (total identified Deer) =.30 *x*100= **30% Fawns**
100 Total Identified Deer **100%**

In addition, **doe to buck** and **fawn to doe** ratios can also be determined. To determine the **doe to buck ratio**, **divide the number of identified does** *by* **the number of identified bucks**. To determine the **fawn to doe ratio, divide the number of identified fawns** *by* **the number of identified does:** For example:

Divide 50 (# identified Does) *by* 20 (# identified Bucks) = **2.50 Does per Buck**
Divide 30 (# identified Fawns) *by* 50 (# identified Does) = **0.60 Fawns per Doe**

How Do You Use Herd Composition Data?
Once you have estimated what your deer herd composition is and expressed it as **percent bucks, does, and fawns,** you may now apply these figures to your total estimated deer population. For example, a ranch containing 2,000 acres with an estimated deer density of one deer per 20 acres has an estimated population of 100 deer. Calculate herd composition as follows:

100 Total Deer ***X*** .20 percent (% identified Bucks) = **20 Bucks**
100 Total Deer ***X*** .50 percent (% identified Does) = **50 Does**
100 Total Deer ***X*** .30 percent (% identified Fawns) = **30 Fawns**
100 Total Deer

With the knowledge of approximately how many bucks, does, and fawns are present on your ranch, you may now make important decisions about how many deer should be harvested during the upcoming deer season. Buck to doe ratios and fawns to doe ratio also are good indicators of your progress toward obtaining your goals and objectives.

Appendix N

Supplemental Forage Management for East Texas White-tailed Deer

By Billy Higginbotham and James C. Kroll

The white-tailed deer is the most popular big game species in Texas. Our large deer population has generated a tremendous sport hunting demand, which has developed into more than a billion-dollar-a-year industry.

Landowners are becoming more interested in intensive deer management strategies in order to conserve deer management strategies in order to conserve deer populations in the face of decreasing deer habitat. Existing habitat is threatened by the growing human population in East Texas, as well as by land use changes, urbanization, highway and road construction, water development and certain cattle management, timber management and farming methods.

The establishment of supplemental food plots is an important deer management strategy which is becoming widely accepted throughout eastern Texas and much of the southeastern U. S. However, most plantings are not aimed at improving the nutrition of white-tails. This is critical since much of the southeastern deer range (including East Texas) provides substandard nutrition for desirable deer production. The use of supplemental food plots as an intensive management tool evolved from hunters' efforts to concentrate deer in one area for harvest. It is just as important to use plots to improve the nutrition of white-tails and add critical minerals (particularly calcium and phosphorus) to the diet of a deer herd.

Description of the region

East Texas is composed of two major ecological regions - the northern part of the Post Oak Savannah and the Pineywoods (Figure 1). The Post Oak Savannah lies northeast to southwest between the Blackland Prairie of Central Texas and the Pineywoods in eastern Texas. The upland soils of East Texas are light-colored sandy loams and sands, while bottomlands are typically light-brown to dark gray sandy loams, clay loams and some clays. Soils throughout East Texas are generally acid (pH below 7.0). Annual rainfall is usually the highest of any region in the state - 35 inches on the western edge of the region up to 55 inches along the eastern boundary.

Abundant rainfall is a mixed blessing when managing deer habitat. It quickly leaches nutrients from the soil, which lowers the quality of food supplies. It also results in the rapid succession of vegetation, and causes native food supplies to grow beyond the reach of deer. On the other hand, the amount of rainfall East Texas receives annually is generally sufficient to product consistent crops of supplemental forages. For these reasons, planting supplemental forage is a sound strategy for managing white-tailed deer in East Texas.

Planning the food plot

Well-planned food plots can increase forage availability and at least partially compensate for decreases in suitable deer habitat. However, maximum benefits can be obtained only if forages complement the diet available from native vegetation and if forages are available when native vegetation is lacking or low in nutritional value. In East Texas these stress periods occur in late summer and late winter (Fig. 2).

In addition to timing the availability of supplemental forage properly, landowners also must plant appropriate species in the best available sites, use correct planting techniques and ensure soil fertility.

Site selection and preparation

These are selected for planting will depend on the plant species to be established (warm-versus cool-season) and the goals of the landowner/deer manager. The landowner may want to plant both types to supplement the usual lack of nutritious native forage in both late summer and late winter.

Warm-season species are more reliable when planted in bottomland soils that retain moisture during the drier summer months. However, care should be taken to select a site that is not prone to flooding from nearby streams and rivers. Droughty upland soils are not good sites for warm-season species. Warm-season species should be selected for their ability to grow quickly and compete with native weeds.

Cool-season species are not as susceptible to drought or weed competition as warm-season species. One exception may be legumes, which may require delayed planting if rainfall is deficient in the early fall months (September and October). Cool-season species can be planted on either upland or bottomland sites.

Whenever possible, food plots should be planted in existing openings to reduce costs. Examples include fallow fields, pipeline and transmission line rights-of-way, logging roads, firelanes and interior road rights-of-way. Areas adjacent to public roads or areas of public access are poor planting sites since they may encourage poaching.

With either warm- or cool-season supplemental forages, soil samples should be taken to determine lime and fertilizer requirements. Failure to properly amend the soil may result in drastically reduced yield or excessive weed competition. Your county Extension agent can help with soil testing.

If soil testing is not possible, food plots should be:
1) limed every 3 years at the rate of 2 tons per acre;
2) fertilized after germination with 200 pounds per acre of 6-24-24 (cool season plots) or 0-24-24 (warm-season plots); and
3) 3) top-dressed with 200 pounds per acre of 34-0-0 fertilizer in mid-December (cool-season small grains).

The site should be shredded and disked to prepare a clean seedbed. Agricultural limestone (if needed to correct pH) should be applied prior to disking and worked into the soil. Planting sites should not be shaded by nearby trees, but should be adjacent to adequate escape cover. Since cool-season plantings are often established in hunting areas, particular care should be given to placing these plots near adequate escape cover, travel corridors and other types of habitat frequented by deer.

All legumes should be inoculated to increase nitrogen fixation. This will lower fertilizer needs and improve soil quality over time. Planting depth is also critical for successful establishment. Failure to plant species (especially legumes) at the recommended depth may result in poor stands.

Food plot size and shape

The sizes and shapes of supplemental food plots vary tremendously. Most plots are from 0.5 to 3.0 acres in size. Since deer are more apt to feed along the edges of plots than in the center, several small plots are more effective than one large plot. Larger food plots can be established, especially if the shape is long and narrow instead of square. Long, narrow food plots maximize the edge available and can cut across more home ranges of deer. However, plots must be wide enough to prevent excessive shading from nearby trees.

Properly established food plots are expensive, and this may limit the acreage that can be established. Therefore, it is important to maximize productivity and carefully select planting sites. A good rule of thumb is to plant 1 to 3 percent of the total habitat in both warm- and cool-season forages. For instance, 1 to 3 acres of food plots should be established for every 100 acres of habitat present. Food plots should be distributed at the rate of at least one plot per 160 acres of habitat.

Species selection

Unfortunately, there is no one forage species that can satisfy all the nutritional requirements of the white-tailed deer throughout the year. For this reason, warm- and cool-season forage combinations are recommended over the establishment of individual species.

In choosing a species or combination, keep in mind that the forage should: 1) increase the nutrition available to deer; 2) be readily accepted by deer; 3) be available at times when native forage is lacking in quality and quantity; and 4) be adapted to both the region (Post Oak Savannah or Pineywoods) and the site (bottomland or upland). In other words, if a forage species does not improve nutrition, if deer won't eat it, if it's not available during periods of stress or if it won't yield sufficient quantities to justify establishment, DON'T PLANT IT! Furthermore, since most plant species are commercially available in several varieties, care should be taken to plant a variety adapted to a particular area.

Warm-season forages supplement the deer diet throughout the important summer and early fall months when doe lactation, fawn growth and antler development occur. Alyceclover and forage cowpeas has proven to be an excellent combination planting for the warm season, producing 3 to 4 tons of forage per acre in performance trials. "Iron and clay" cowpeas produced higher yields and matured later than other forage cowpea varieties in recent trials in East Texas. Other forage combination recommendations are given in Table 1.

Cool-season forages provide additional nutrition during the hunting season as well as during the critical stress period in January and February prior to spring green-up. Cool season combinations can extend forage availability into early summer, about the time warm-season plots become useable by deer.

Rye is an excellent cereal grain to include in a cool-season forage combination because of its cold hardiness. Grains that can supplement rye in a combination plot include oats and wheat; however, rye should constitute at least two-thirds of the small grain component Arrowleaf clover, a legume, is also a valuable component of cool-season forage plots. It provides forage through late spring and early summer. Once established, arrowleaf clover should not have to be replanted. An annual program of shredding in late summer, followed by light disking or late summer burning of the clover, will result in sufficient seed to develop a stand the following year. Since the arrowleaf clover component of the stand requires slightly different management than the cereal grains, the clover should be planted with the arrowleaf clover since it will also reseed itself and responds favorably to the same management. Cool-season forage combinations of small grains, arrowleaf clover and ryegrass have yielded as much as 4 to 5 tons of forage per acre per year.

Other good cool-season forage species include subterranean clover, sweetclover and Austrian winter peas. Subterranean clover and sweetclover varieties should be selected to produce in the spring and early summer months. Austria winter peas provide some early growth and may be established alone or in combination with cereal grains (Table 2).

Whenever possible, livestock should be excluded from food plots established for deer. Failure to exclude livestock may result in stand failure and certainly will limit the forage available for deer. Fence wires should be spaced to permit deer easy access to plots (i.e., the bottom wire should be 18 inches from the ground).

Supplemental forages versus corn

Hunters commonly use shelled corn as a "supplemental" deer feed. Commercial producers even market "deer corn" or "apple flavored corn" to take advantage of the popularity of this grain. Deer are attracted to corn because its relatively high carbohydrate content makes it sweet. Unfortunately, however, corn is low in crude protein (only 7 to 9 percent) and deficient in certain important amino acids.

Does corn have a place in supplemental feeding? The answer is *perhaps*. Corn can be

used to increase energy availability during extremely cold periods. When offered as a high energy supplement to a well planned forage management of supplemental feeding program, corn can increase the winter survival of white-tailed deer. Corn also can be used as a bait to aid in hunting, especially for antlerless deer.

Conclusions

Supplemental forages are not cure-alls for poor deer management practices. Without proper habitat management and population control, food plot establishment is a waste of time and money for the hunter, landowner and deer manager. However, food plots can be an important part of the overall management of deer in East Texas. Properly established food plots can increase the production capacity of deer habitat by enhancing the nutritional level of white-tails throughout the year.

Appendix O

Wildlife Watering Facilities

By

Jerry Turrentine, NRCS Biologist

USDA – Natural Resources Conservation Service

WILDLIFE WATERING FACILITIES DESIGNS AND DRAWINGS

Designs for wildlife watering facilities can be simple or very complex. A simple facility works well in many situations by more complex facilities are needed in some situations. Each situation needs to be evalluated and the proper facility recommended to the landuser. To assist in making recommendations and designing these facilities and to supplement the standard and specifications, this technical note outlines specific criteria for a number of facilities.

GENERAL GUIDELINES

1. Where livestock or larger wildlife species are present, the facilities should be fenced to provide proper protection. One example is shown in drawing number 16.
2. Plastic and PVC materials can be damaged by rodents and ultraviolet light. As little as possible of this material should be left accessible to rodents or sunlight.
3. In areas with hard winter freezes, some facilities can be damaged by hard freezes. Provisions should be made to drain or shut off water supply during these periods.
4. Proper maintenance of equipment will ensure adequate wildlife water and increase life of facilities. As with all equipment, facilities should be checked on a regular basis.
5. Algae growth can be a problem in many facilities. The less sunlight, the less algae growth problems will be encountered. As much as possible, the facility should be shaded. If algae growth becomes too bad, the facility may have to be drained and cleaned.

NON COST SHARE FACILITIES

A. PVC (over other flexible type) Pipe Facility (Drawing #1)

1. Materials:
   7 feet of 2 inch or larger PVC pipe
   1 end plug to fit PVC pipe
   1 sink trap to fit PVC pipe
   1 six foot steel T post
   2 four inch hose clamps.
2. Construction and Installation:
   Cut off I inch of the open end of sink trap. Glue end plug and sink trap to PVC pipe. To fill, turn upside down and fill through sink trap. After filling, use hose clamps to fasten PVC pipe to T post. If larger PVC pipe is used, it can be necked down to 2 inch sink trap. A s inch PVC will hold 1 gallon, and a 4 inch will hold 4 gallons.

B. Drum with facet or Float (Drawing #2 and #3)

1. Materials:
   1 drum (can use metal or plastic).
   1 facet or float valve
   1 stand (metal or wood)
   18 inches of ¼ inch hose
   1 metal or concrete trough (Should be at least 6” x 6” x 4” deep)

2. Construction and Installation:
   Stand should be constructed so as to hold weight of filled drum. Stand should be leveled when installed. Insure that drum did not contain toxic material or is rusted wither inside or outside. If float valve is used, insure that trough is firmly installed and leveled. Most drums hold about 50 gallons.

B. Small Game Guzzler (Drawing #4)

1. Materials:
   3 sheets corrugated galvanized metal (at least 10 feet long)
   8 feet minimum of 6 inch PVC (over other flexible) pipe
   2 six inch PVC caps or end plugs
   11 feet of 4 inch post
   11 feet of 2x4 inch lumber
   30 one inch sheet metal screws
   30 sixteen penny nails

2. Construction and Installation:
   Three posts should be cut 2.5 feet in length and 3 posts cut 1.5 feet in length. Set post level in ground at 1 foot depth. The front post should be 6 inches lower than back post. Nail a 2x4 to top of back post and one to top of front post. Attach sheet metal together, making sure it is square, and attach to 2x4's. Cut a slot 1 inch wide, the same length as width of assembled sheet metal, out of PVC. Make sure the slot is centered in PVC. Six inches from each end of PVC, cut a 6 inch by 3 inch wide slot on the opposite side of the long slot. Install end plugs or caps.

   Dig out soil at lower end of sheet metal. Install and level PVC in dug out area with sheet metal inserted into 1 inch slot. Metal should extend into PVC at least 2 inches. Put enough soil around PVC to ensure that it is stable.

   A 0.3 inch rain will fill the PVC, and PVC will hold 12.5 gallons.

C. Windmill Supply Pie Dripper (Drawing #6)

1. Materials:
   3 feet of metal or PVC (over other flexible) pipe (should be ½ inch larger in diameter than water supply pipe)
   1 cloth or sponge bushing
   1 metal or concrete trough

2. Construction and Installation:
   Slip metal or PVC pipe sleeve over water supply line. Wedge cloth or sponge bushing between the two pipes. Make sure water discharge will enter trough. The rate of water flow can be regulated by sliding sleeve up or down water supply pipe. Area of pipe and trough should be protected from livestock.

D. Plastic Container (Drawing #13)

1. Materials:
   1 plastic or metal container (smallest size should be 5 gallons)
   1 commercial spring operated chicken watering bowl
   2 cement blocks or 6 bricks

2. Construction and Installation:
   Install watering bowl to bottom of watering container. Set facility on blocks or bricks at a height that allows target wildlife species to utilize. Make sure facility is level.

COST SHAREABLE FACILITIES

A. In Ground Bowl Trough (Drawings #7, #8, #12, #14, and #16)
Storage Trough:

1. Trough Material: Concrete will be at least 5 sack cement mix. Concrete will be reinforced using 6" x 6" welded wire. Metal trough using pipe should meet criteria for pipe material listed below under heading "Pipe Material". If the trough is constructed of sheet metal it should be new and at least 12 gauge.

2. Trough Size: Concrete troughs for upland game birds should be at least 1 foot by 4 inches deep at the center (will hold 2 gallons). Concrete troughs for big game should be at least 1.5 foot by 6 inches deep at the center (will hold 6.5 gallons). Metal troughs for upland game birds should be at least 4 inch pipe, 3 feet long (will hold 2 gallons). Metal troughs for big game should be at least 6 inch pipe, 5 feet long (will hold 6.5 gallons).

Pipe and Pipeline:

1. Pipe Material: May use existing pipeline or new pipeline and either used shall be at least ¾ inch diameter and can be galvanized steel, aluminum or plastic complying with the following specifications:

Steel A-120 (galvanized)
ABS D-1527 (sch. 40 or 80)
PE D-2239 (SIRD-PR)
PE D-3035 (SRD-PR)
PVC D-2241 (SDR-PR)
PE D-2247 (Sch. 40 or 80)
ABS D-2282 (SDR-PR)
PE D-2104 (Sch. 40)
PE D-2737 (PE Tubing-PR)
PVC D-1785 (Sch. 40, 80, or 120)
PVC D-2740 (PVC Tubing – PR)

Additional Requirements:
If a facet is used it shall be new and shall meet or exceed pipe used. After water volume is set the handle should be removed. If a float is used it should be new and of good quality. If a drip emitter is used it should have the capability of being cleaned out.

Metal pipe trough will be anchored by use of concrete or metal legs buried in the ground at least 18 inches.

B. Big Game Guzzler (Drawing #9)

For specifications to big game guzzler, see supplement to standard and specifications for wildlife watering facility.

C. Inverted Umbrella Guzzler (Drawing #10)

This facility is commercially produced. It is available in 2000 to 5000 gallon sizes. The basin diameters are 16 to 32 feet. It takes 8 inches annual rainfall for 2000 to 3000 gallon size and 10 inches for the 5000 gallon size. No float needed if trough and tank set at same level.

D. Flying Saucer Guzzler (Drawing #11)

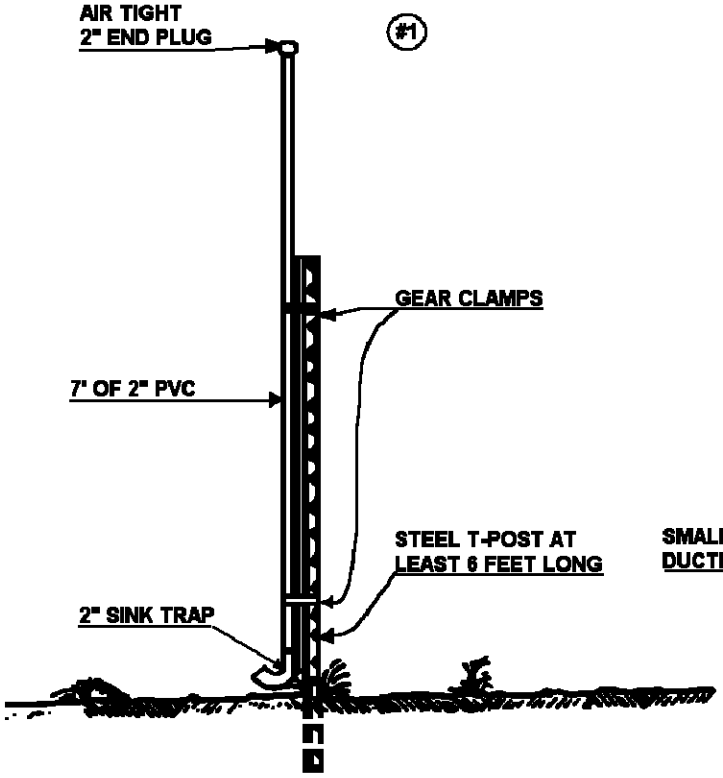
This facility is commercially produced. It is available in 200 to 2100 gallon sizes. It takes 6 inches annual rainfall for 200 gallon size, 8 inches for 1000 gallon size and 17 inches for 2100 gallon size. No float needed if trough and tank set at same level.

E. Ranch Specialties Wildlife Waterer (Drawing #15)

This facility is commercially produced. It holds 9.5 gallons of water. The float is built into the facility. The facility is 42 inches by 42 inches and 7.5 inches deep with a 3 foot diameter bowl. To be eligible for cost share, the facility must be connected to a permanent water source.

WILDLIFE WATERING FACILITIES

SCALE: 3/8" = 1'



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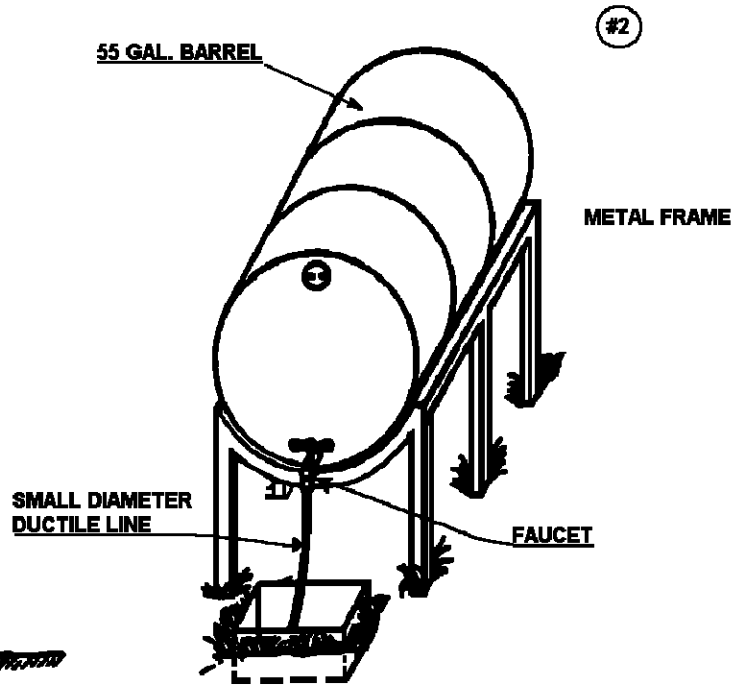

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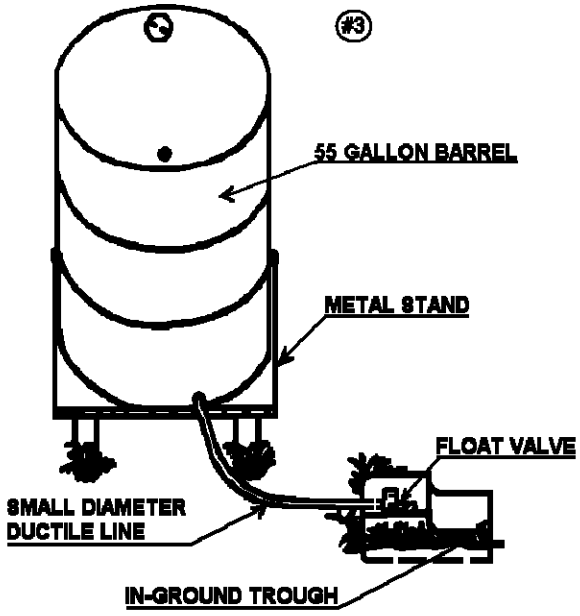
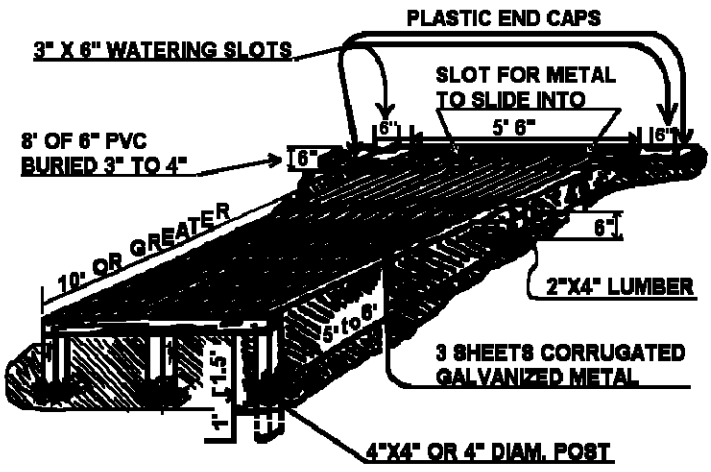


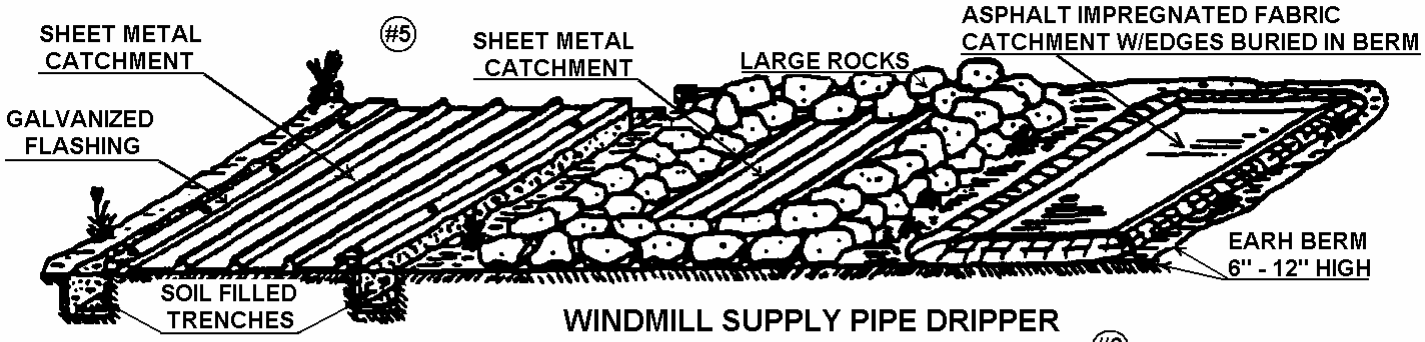
#4 SCALE: 1/4" = 1'



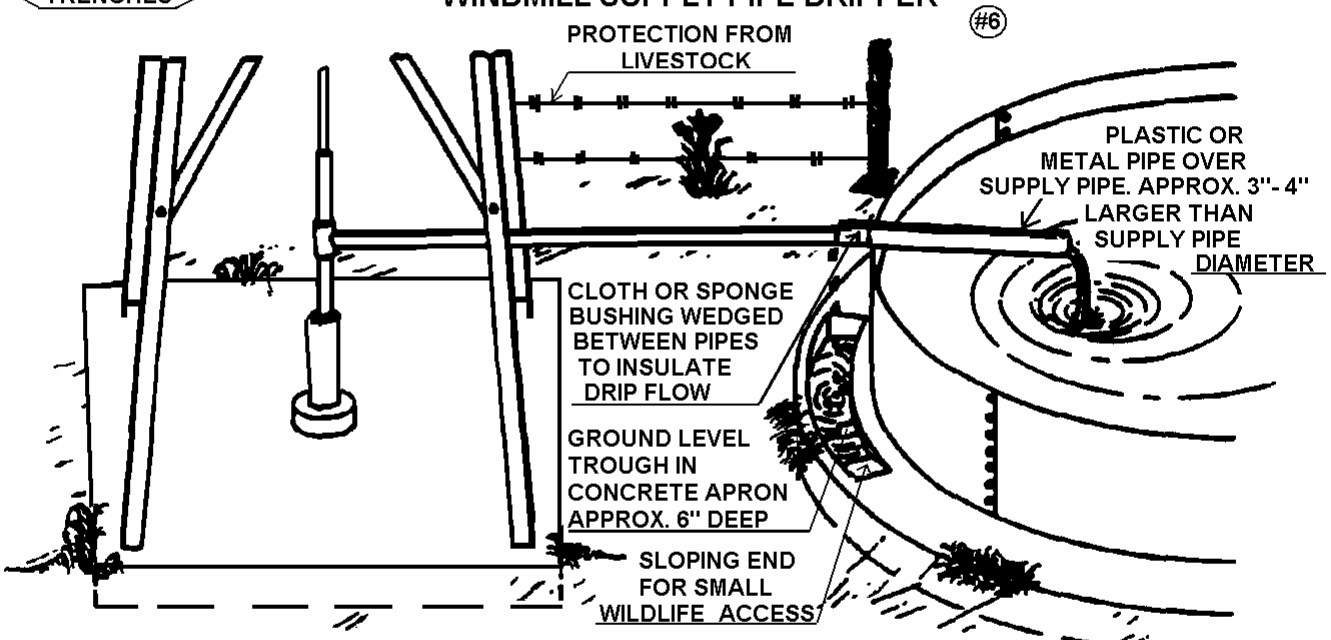
DRAWINGS BY TODD A. MAREK
SEPT. 1991

WILDLIFE WATERING FACILITIES

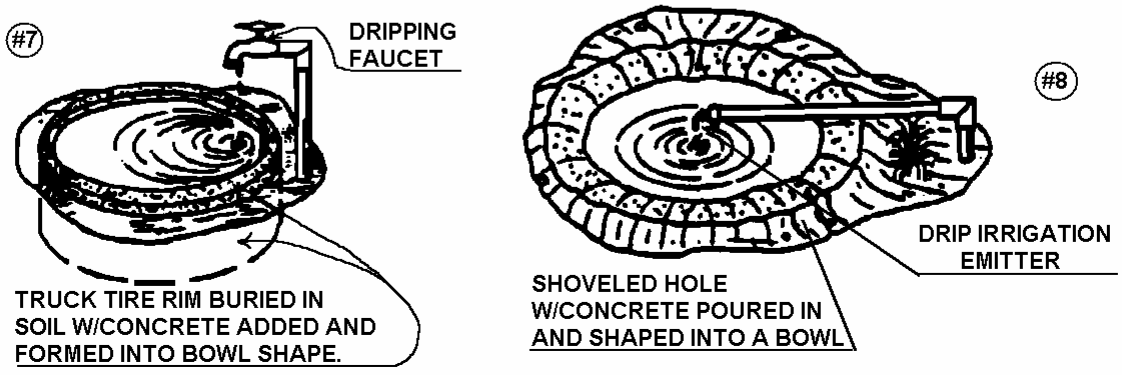
3 METHODS OF ANCHORING ON-THE-GROUND CATCHMENTS



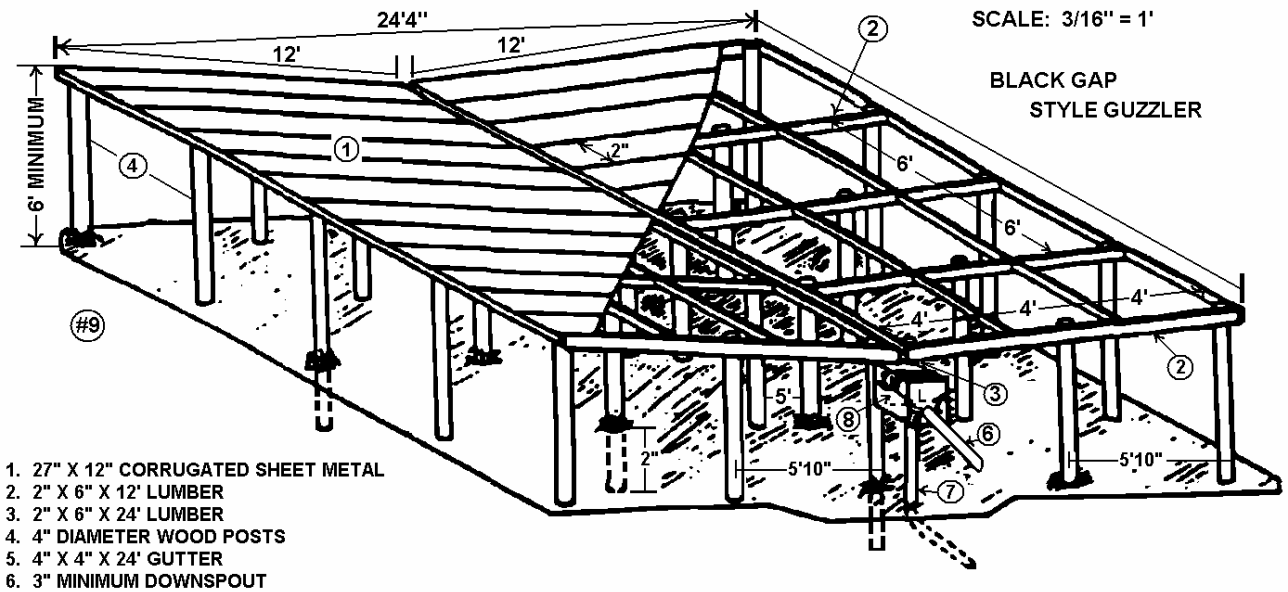
WINDMILL SUPPLY PIPE DRIPPER



IN-GROUND BOWL TROUGHS

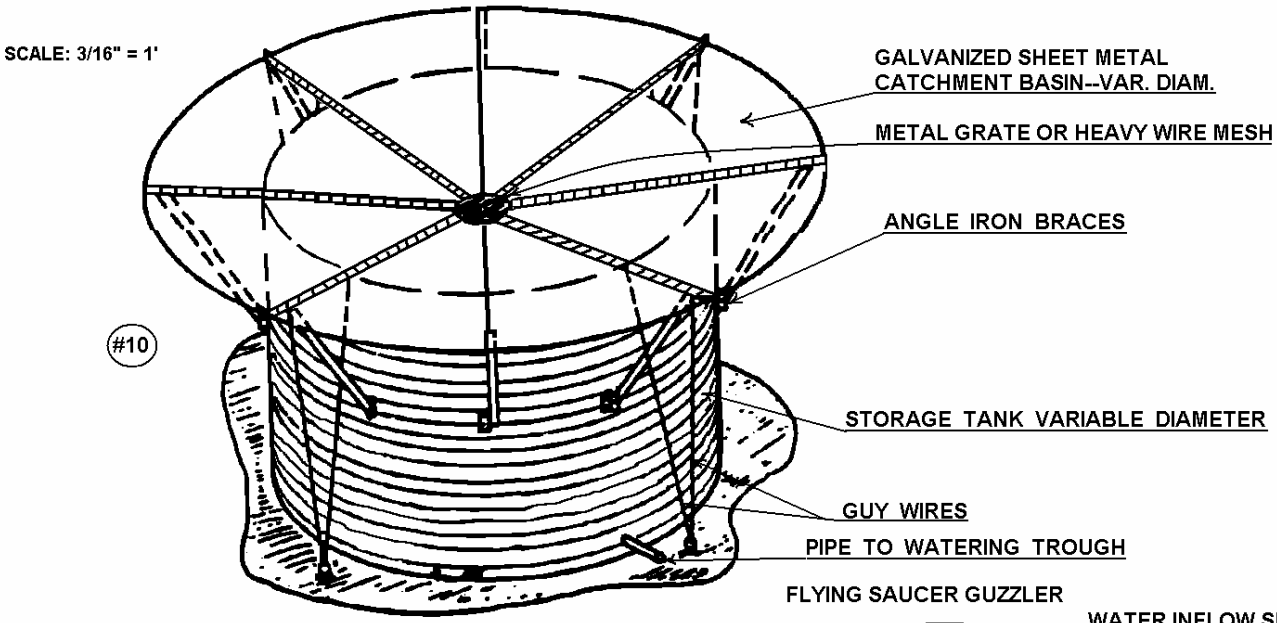


WILDLIFE WATERING FACILITIES

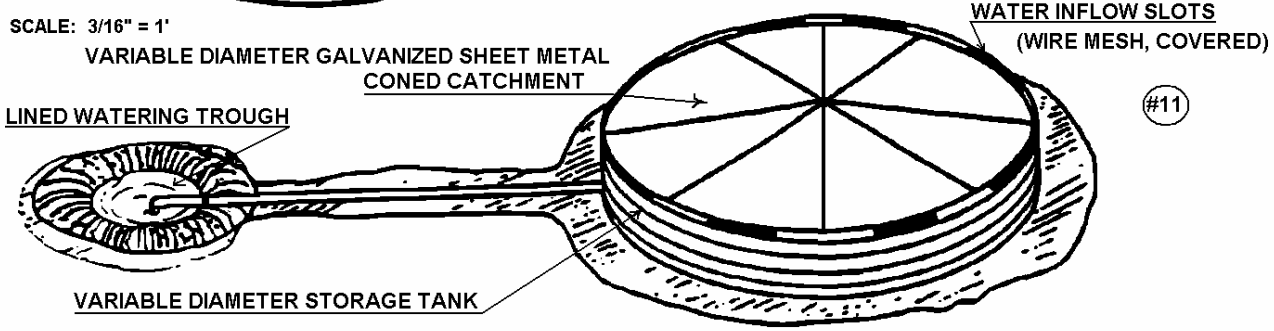


1. 27" X 12" CORRUGATED SHEET METAL
2. 2" X 6" X 12' LUMBER
3. 2" X 6" X 24' LUMBER
4. 4" DIAMETER WOOD POSTS
5. 4" X 4" X 24' GUTTER
6. 3" MINIMUM DOWNSPOUT
7. ALTERNATE DIRECTION FOR DOWNSPOUT
8. 1'6" X 1'6" X 1' SUMP COVERED WITH 1/4" - 1/2" HARDWARE CLOTH

INVERTED UMBRELLA GUZZLER

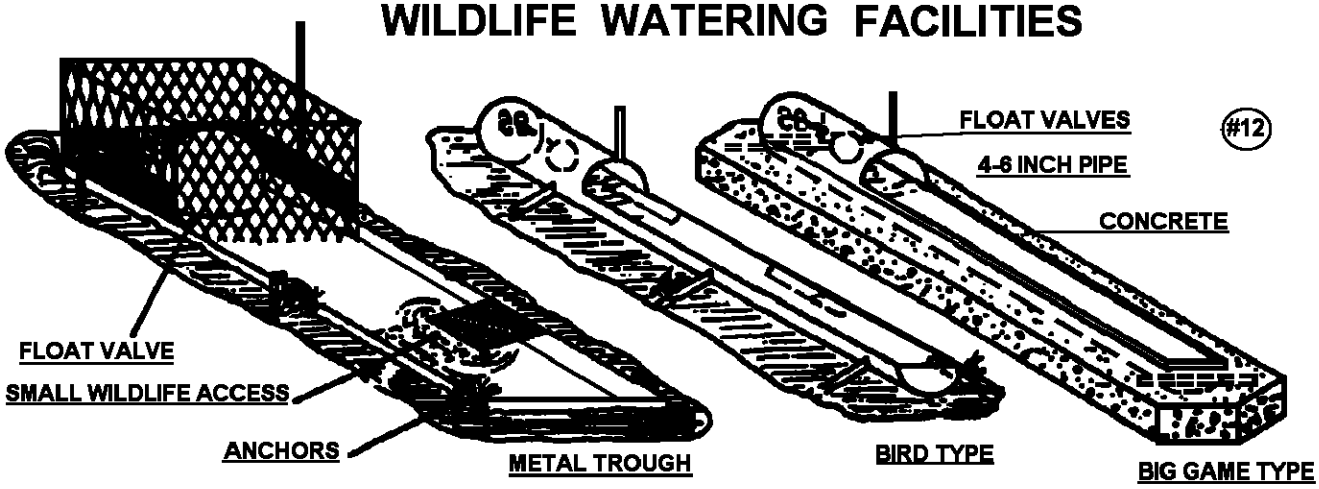


FLYING SAUCER GUZZLER



DRAWINGS BY TODD MAREK SEPT. 1991

WILDLIFE WATERING FACILITIES



#12

SCALE: 1 1/2 " = 1'

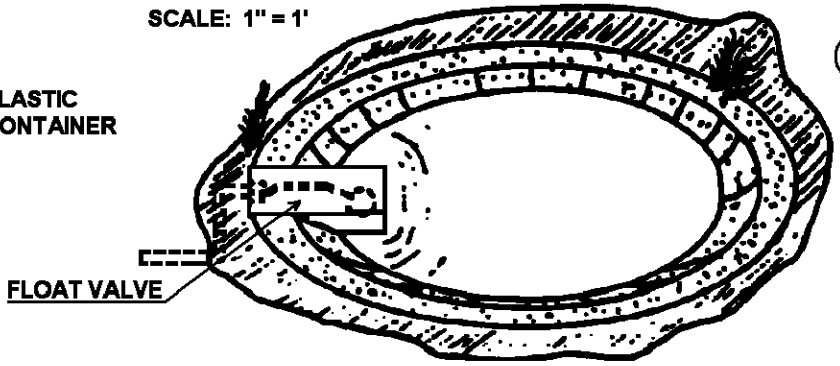
#13

PLASTIC CONTAINER

DRINKING BOWL

SCALE: 1" = 1'

#14

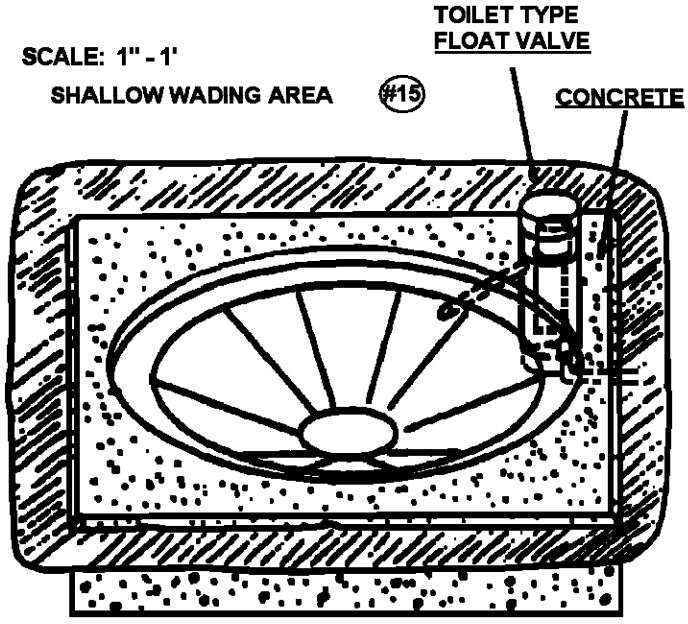


3 FT. DIAMETER BOWL APPROX. 8 IN. DEEP

SCALE: 1" - 1'

SHALLOW WADING AREA

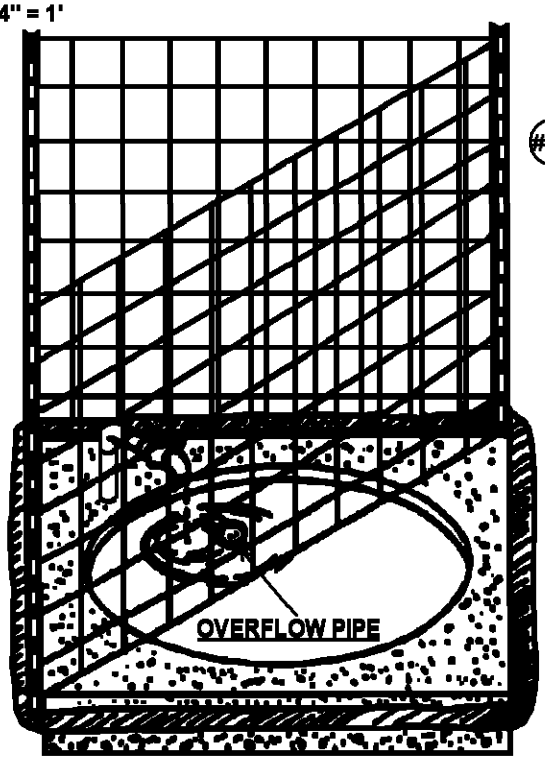
#15



RANCH SPECIALTIES

SCALE 3/4" = 1'

#16



3 FT. DIAM. BOWL APPROX 8 IN. DEEP

DRAWINGS BY TODD A. MAREK

Appendix P

Managing Red Imported Fire Ants in Wildlife Areas

by Bastian Drees, Extension Entomologist and Fire Ant Project Coordinator
Texas A&M University

The red imported fire ant, *Solenopsis invicta* (Buren), is an introduced species that arrived in Mobile, Alabama from South America around the 1920s. This species has had an enormous impact in the southeastern United States, and continues to spread into areas of North America with mild climates and adequate moisture and food. About two thirds of eastern Texas is currently infested.

Biology of the red imported fire ant: Like other ants, the fire ant is a social insect and colonies reside in mounds of dirt that may exceed 18 inches in height. Mounds commonly occur in open, sunny areas. Periodically, winged reproductive male and female ants leave colonies on mating flights. Mated females (queens) can fly for miles, land and start a new colony. Development from egg to adult occurs in about 30 days, progressing though four larval stages and a pupal stage. Worker ants (sterile female ants capable of stinging) can number in the hundreds of thousands in a mature colony. Two forms of fire ants occur: single queen and multiple queen colonies. Multiple queen colony infested land can harbor 200 to 800 or more colonies per acre since worker ants are not territorial and move freely from mound to mound.

Fire ant mounds can rapidly become numerous on lands disturbed by mechanical methods, pesticide use or flooding. The ants disperse naturally through mating flights, mass movement of colonies or by floating to new locations in flood water. Fire ants can travel long distances when newly-mated queens land in cars, trucks or trains. Shipments of hay, nursery stock or soil from an infested area may relocate entire colonies or nests. Quarantine regulations, enforced by the Texas Department of Agriculture, prevent movement of infested articles from infested (quarantined) to non-infested areas.

Fire ants feed primarily on other insects and arthropods (ticks, chiggers), although they "tend" some species of sucking insects (aphids) which provide them with a sugary solution (honeydew) upon contact. This imported species has displaced many native ant species and eliminated food used by some wildlife. Fire ants recruit to newborn livestock and wildlife on the ground or those nesting in low trees, causing medical problems associated with multiple stings and, occasionally, death. Populations of some wildlife species may be dramatically reduced.

Impact on wildlife: Certain forms of wildlife, such as deer, ground-nesting birds, and reptiles, are especially affected by ants during and soon after birth or hatching. The risk is greatest during the warm months. Fawns are vulnerable because they are born in June and because they instinctively remain motionless in their hiding places. Hatching quail and ground-nesting waterfowl chicks are also attacked. However, the impact of fire

ants on area-wide populations of wildlife remains controversial and largely undocumented with data from scientific studies. In Texas, no endangered species has been reported lost because of fire ants. ***Insecticide-based fire ant control programs in wildlife areas are discouraged unless the benefits from such treatments have been documented***. Many pesticides are toxic to non-target organisms (particularly to aquatic organisms) and may directly or indirectly affect game species if not used properly. Below are some considerations when selecting management options:

1. If wildlife breeding areas are considered non-agricultural lands, fire ants on these lands can be treated with insecticide products registered for this kind of usage site, *e.g.,* non-agricultural lands, ornamental turfgrass, way-side areas). However, if these lands are claimed to be agricultural lands, or if the game/wildlife or other livestock is being produced to be harvested and consumed, insecticide products selected to treat ants on these lands must be registered for use on those sites, *e.g.,* wildlife or livestock areas, pastures, rangeland, etc.

2. Exotic game ranches are considered commercial agriculture areas. Breeding areas may be treated with products registered for use in wildlife or livestock areas, pastures, rangeland, etc.

Management Strategies: Non-chemical or cultural approaches to avioding fire ant problems can reduce various problems caused by fire ants while maintaining a stable ant population that will help suppress lone star ticks, filth breeding flies and other pests, while also deterring the multiple queen form. These include:

1. In operations where wildlife breeding is being managed, try to schedule breeding to assure that young are born during cooler months of the year when fire ants are less active (soil temperature below 65 degrees F). This will reduce the probability of ant attacks.
2. Use shallow discing or drag heavy objects such as railroad ties across pastures particularly after rotating livestock out of a pasture to temporarily flatten tall, hardened mounds (although this practice seldom eliminates fire ants) and scatter manure. Manure can breed fly larvae upon which fire ants feed.
3. Use disc-type (Kountz) cutters to cut hay. These machines are designed and promoted to withstand the impact of fire ant mounds, to reduce equipment damage.
4. Use mechanized balers and bale movers characteristic of round bale production to reduce human contact with potentially infested bales.
5. Remove hay bales from the field immediately to prevent ants from invading them, particularly when rain is anticipated.
6. Store bales off the ground or in an area around which the ants have been treated (Note: A quarantine is in effect which prohibits the shipment of hay from infested to non-infested counties without certificates. Call Texas Department of Agriculture personnel to certify that hay shipments are ant-free).

Insecticide-based management program: Fire ant populations can be suppressed in

pastureland using currently available methods for $10 to $15 per acre per year. Current methods are not capable of eradicating this species and treatments need to be periodically re-applied. Applications of some bait-formulated insecticides also affect native ant species that compete with fire ants. However, in "fully-infested areas" (20 or more mounds per acre), implementation of the “Two-Step Method” of fire ant management may be justified. This program relies on the periodic (annual, semi-annual) broadcast application of an effective fire ant bait product. These treatments can reduce mound numbers by up to 90 percent, but reduction requires several weeks to months to achieve, depending upon the product chosen, *e.g.*, Amdro® (hyrdamethylnon), the only bait product currently registered for use in cattle pastures takes 3 to 6 weeks; Logic® (fenoxycarb), currently registered for non-agricultural lands and horse pastures usually requires 2 to 6 months but suppresses ants for over a year). Individual mound treatments registered for use in livestock pastures (*i.e.*, Sevin® (carbaryl) formulations applied as individual mound drench cost about $0.10 per mound) can be used to treat "nuisance colonies" between bait applications. Additional insecticides being promoted for fire ant control in pastures include Organic Plus? Crop Insecticide (0.2% pyrethrins, 97.9% silicon dioxide from diatomaceous earth, and 1.1% piperonyl dioxide) and True Stop? Fire Ant Insecticide (0.21 percent rotenone and 0.41% cube root extract). **Always follow closely the instructions provided for pesticide use on the product’s label.**

In the future, there is great hope that research entomologists will be able to successfully import and release natural enemies of the fire ant from the native habitats in South America to permanently suppress the red imported fire ant. One potential parasite being investigated is a phorid fly which develops inside the heads of ants. In theory, adult phorid flies looking for worker fire ant hosts suppress ant foraging activities during the day, thereby allowing native ant species time to look for food and better compete with the fire ant. Support for fire ant research may allow other sustainable solutions to be developed.

Appendix Q

Trapping Brown-headed Cowbirds to Control Songbird Nest Parasitism

Trapping Brown-headed Cowbirds

The purpose of this guide is to assist landowners that wish to help songbird reproduction by building and operating a cowbird trap. Please note that all persons wishing to trap cowbirds must be certified through an approved training program before the trap is put into operation. This training is offered at no cost by **Texas Parks and Wildlife (TPW)** and affords the landowner with permit coverage to handle and release non-target birds that may inadvertently enter the trap. All applicable state and federal laws must be observed during the duration of trapping. If questions arise, contact your closest **TPW** office for assistance.

Why Trap Cowbirds?

Throughout North America songbird numbers are declining. While there is no one single reason for this decline, one major contributing factor is the spread of the brown-headed cowbird. These birds were once limited to the short-grass prairies, where they followed the herds of buffalo, feeding on the insects stirred up by the movement of herds as they moved from place to place. Today however, this highly adaptive bird is found throughout North America. This is a problem because of the reproductive strategies the species employs. The cowbird is what is referred to as a brood parasite. This means the female lays her eggs in the nests of other birds, abandoning them to the care of foster parents. The foster birds raise the cowbird chick to the detriment of their own young. Because the female cowbird can lay as many as 70 eggs per season, susceptible species of songbirds, such as the black-capped vireo and the golden-cheeked warbler, that are already endangered, are particularly at risk.

One of the most effective ways of controlling cowbirds is through trapping. Traps are operated from March 1 through May 31 only. During this time they are checked frequently, preferably every day, and data is collected. Any birds that are not cowbirds that have accidentally been trapped must be released as soon as possible. Female cowbirds are humanely euthanized through cervical dislocation. Males may be released, often after being banded for study purposes. Cowbird parasitism on vulnerable species cannot be systematically brought under control without the help of trapping.

Collecting Data

As with any scientific endeavor, cowbird trapping requires that data be collected in order to determine how effective it is. Collecting data also allows scientists to track the movements of banded birds, and hopefully to find new ways to reduce the parasitism rate that has caused many songbird populations to decline. By participating in this project landowners have the opportunity to help songbirds, and make a genuine contribution to the threatened and endangered wildlife in Texas.

Once the data has been collected, landowners should keep a copy, and forward a copy to **Texas Parks and Wildlife**. This allows **TPW** to monitor the total numbers of birds being trapped and the locations of the traps. ***All data and information submitted is strictly confidential.*** Data to be collected should include the date, the number and type of non-target species that might get into the trap, the number of males,

the number of females, and the numbers off any banded birds that might be caught. *Banded birds are to be released* after the data is collected. While any data sheet will do, a data page is included in this material that may be copied and used immediately.

Selecting a Trapping Location

The location of the trap is critical to maximize cowbird capture and to minimize non-target birds being caught. The idea is to put the trap in a place that is as attractive to cowbirds as possible, without being disruptive to other species. Ideally the trap should be located in areas that include the following:

- Close to where cattle or other livestock graze.
- In open pasture, away from any brush, and in low grass.
- The trap should be readily accessible to vehicles, even after heavy rain.
- Water and some perching snag (dead trees) nearby.

Site Precautions

Even on a perfect location site there are precautions that should be taken to insure the safety of landowners and others participating in cowbird trapping.

One of the hazards to be aware of is that of predators. Any mammal, bird, or reptile that eats birds will be attracted to the traps in search of an easy meal. Keep the grass around the trap short. This will not only make it easier to spot snakes, but it will also make it more attractive to cowbirds. Raccoons and skunks will dig under the traps if precautions are not taken to keep them out. Owls and hawks also try to swoop down on the birds inside the trap. Fire ants can pose an additional hazard. Before using fire ant bait, check with your local Extension Service office for application recommendations. Always be sure to read and follow pesticide label directions. Never use any insecticides in the trap itself.

TRAP OPERATION: Traps are permitted to operate from March 1 to May 31 ONLY. This is to avoid incidental catch of non-target species. After May 31, fledglings of beneficial species such as cardinals, mockingbirds, buntings, and finches are most abundant and are more likely to be accidentally trapped.

Setting up the Trap

Erect the trap on a level site with no gaps between the frame and the ground. Use a shovel to fill in any gaps, if necessary.

Place a one gallon poultry waterer on level ground inside the trap. Scatter about a half a coffee can of cleaned milo (grain sorghum) on the ground, being careful to avoid getting it in the water. Do not feed milo during rainy weather because the birds do not like soggy grain. Wait until the ground has dried up before scattering it out again.

Since cowbirds are gregarious birds, the traps work best if about 10-15 live cowbirds are present to act as decoys. When first starting a trap without decoys, be patient. If cowbirds are in the area, they'll find and enter the trap.

Use a large minnow dip or trout net to catch birds in the trap. You must **immediately release** any non-target bird species. Any bird not a cowbird is a non-

target bird. Always remove and dispose of any dead or injured birds (usually a result of avian predator attack on the trap). The most common species of non-target birds that have been found in traps are mockingbirds, cardinals, various sparrows, grackles, blackbirds, and loggerhead shrikes. Consult a bird field guide to help you identify these species. Non-target birds will enter the traps for a variety of reasons. Some are attracted to the grain, some for company, and still others just out of curiosity. Putting a board across one side at the top to provide shade to trapped birds is recommended. Humanely treating birds while in the trap and humanely euthanizing birds is important.

Euthanizing Cowbirds

This is the real job of protecting songbirds from nest parasitism. Whichever method is used to kill cowbirds, it must be humane, fast, and certain*. The recommended method is cervical dislocation, or separating the vertebra.*

Cervical dislocation: Hold top of neck between thumb and forefinger, grab head with other hand, turn and lift until you feel the cervical vertebrae detach from the head – HINT: hold the bird away from you when you do this the first few times until you have the "touch". A catch box, net, gloves, and a light for night time are useful items to have on hand.

Alternative Dispatch Methods: Carbon dioxide (CO_2) gas in a 5-gallon bucket may be used to euthanize brown-headed cowbirds. Use dry ice as the source of carbon dioxide. Cut a hole in the top of the bucket, cover opening with a piece of inner tube, or similar material, that has a slash in it to facilitate putting birds inside. Birds must not be touching the dry ice! Birds should be dead within 20 seconds.

Taking Traps out of Operation

Because cowbirds are a native species in North America, they are protected under the Migratory Bird Treaty Act. However, there are exceptions to this law for acts of depredation by a few select species. Under the **Texas Parks and Wildlife** Code, Section 64.002(c) brown-headed cowbirds are included among this small group of eight non-protected bird species that "may be killed at any time and their nests or eggs may be destroyed." State regulations may not supersede federal regulations, so it is important that all participants in this project follow the protocols outlined here in this module. Again, remember that no traps are to be in operation either before March 1, or after May 31.

If it is not possible to remove the trap to a location where it can be stored under cover, then certain precautions must be taken because birds, including non-target species, will tend to enter the trap. The traps may be taken out of operation by placing boards over the entry slots or by securing the door in an open position. Be sure to remove all cowbirds, and release any banded birds, disposing of any dead or injured birds.

Reporting the Data

Be sure to record all data on birds captured on an approved data form and forward copies to Texas Parks and Wildlife in Austin. This is a necessary part of your

permit requirements. Landowners who are certified through Parks and Wildlife and actively participating in trapping brown-headed cowbirds will be provided with self-addressed envelopes and data forms on a weekly basis. ***ALL information submitted to TPW is strictly confidential.*** Submit data to:

Texas Parks and Wildlife
Private Lands and Habitat Program
4200 Smith School Road
Austin, TX 78744

COWBIRD TRAPPING DATA SHEET

NAME*: ____

***Optional, but desired. Information provided is strictly confidential.**

TRAP # ___________ **LOCATION: _____________________**

Date: ______________

Females	
Males	
Band Numbers (If Any)	
Non-Targets (record # and species)	_______ _______ _______ _______
Comments	

Date: ______________

Females	
Males	
Band Numbers (If Any)	
Non-Targets (record # and species)	_______ _______ _______ _______
Comments	

Date: ______________

Females	
Males	
Band Numbers (If Any)	
Non-Targets (record # and species)	_______ _______ _______ _______
Comments	

Date: ______________

Females	
Males	
Band Numbers (If Any)	
Non-Targets (record # and species)	_______ _______ _______ _______
Comments	

Date: ______________

Females	
Males	
Band Numbers (If Any)	
Non-Targets (record # and species)	_______ _______ _______ _______
Comments	

Date: ______________

Females	
Males	
Band Numbers (If Any)	
Non-Targets (record # and species)	_______ _______ _______ _______
Comments	

Submit Data to: Texas Parks and Wildlife, Private Lands & Habitat Program, 4200 Smith School Rd., Austin, TX 78744

Materials List for 6x8 Portable Wood Cowbird Trap

Number	Description	Comments
16	2x4x8 (treated)	Rip 2x4 into 2x2
2 Sheets	½" CDX plywood	1 sheet is for slot assembly, 1 sheet is to cut up for gussets.
64 linear ft	½" mesh hailscreen	Bought in 100 ft. rolls
1 pair	Tight pin hinges (3")	Door hinges
1	Screen door-handle	Outside of door
1	Galvanized hasp (4½")	Use with padlock for security
1	Screen door latch	Used on inside of door
14	10"x12" shelf brackets	Used to square panels (2 per panel)
125 (approx)	1" drywall screws	Field assembly of slot assembly, attaching shelf brackets to panels.
50 (approx)	3" galvanized deck screws	Field assembly (panel to panel)
300 (approx)	1½" pneumatic staples	Used attach gussets
600 (approx)	1 pneumatic staples	Used to attach screen to panels
300 (approx)	½" staples	Used to attach screen to slot assembly

Recommended Tools For Construction

Shop Assembly of Panels

Table saw – for ripping 2x2
Chop saw – for cutting boards to length
Electric hand saw – for cutting out gussets and slot assembly
Retractable rule – for measuring dimensions
Electric or cordless drill/driver – for driving screws
Pneumatic or electric nibbler – for cutting hail screen
Pneumatic stapler – for attaching gussets and wire
Pneumatic nailer – for assembly of panels
(optional but helpful – Panels can be assembled with 3" deck screws if nailer is not available.)

Field Assembly

Cordless drill/driver – for driving screws
Bar of soap – to lubricate screw threads
Hand stapler – to secure wire to ends of drop entrance
Step ladder – for attaching top panels

Construction Tips

- Use treated lumber throughout. Added initial cost is compensated for by longer field life and reduced maintenance.

- Don't rip lumber until you are ready to start construction. Ripped lumber will bow and twist if allowed to sit for several days.

- Use a shelf bracket on diagonal corners to square each panel before attaching gussets. To cut gussets, lay out sheet of plywood in 12" squares, then draw diagonals across the square. A sheet of plywood will make 64 gussets.

- Gussets go on one side of panel, hailscreen attaches to the other side. For side and top panels, wire will end up being on the inside on the panel. This prevents birds from roosting on framework next to wire where they are prone to predation. **Exception:** End panels are constructed the same way, but during final trap assembly, the wire goes on the outside, because the drop entrance attaches to horizontal members for structural stability.

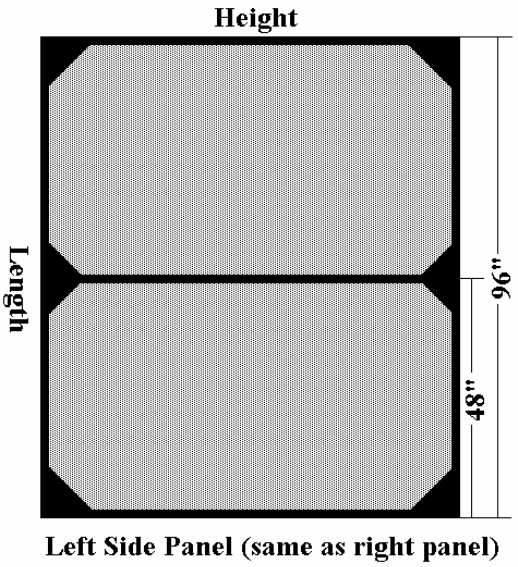
- This pattern is designed to use 48" wide hailscreen to maximize efficiency. Internal cross members are placed to allow for slight overlap. Wide hailscreen will probably not be readily available in stock, but any building supply can order it. Use of narrower hailscreen requires repositioning of tack strips, and results in higher lumber use.

- To maximize shop efficiency: cut gussets; rip lumber; pre-cut lengths; cut out slot assembly; assemble side, top, and end panels; attach hailscreen; final assembly. When building multiple units, performing similar actions for several traps at the same time will allow you to develop an assembly line process that cuts construction time per unit.

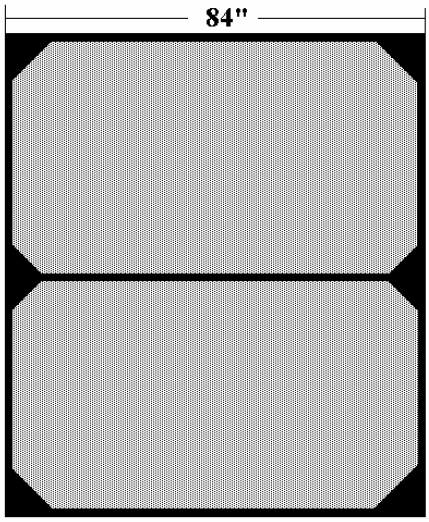
- ***Slot width of 1.25 inches in slot assembly is critical***. Wider slots will increase non-target captures, including small raptors, which will feed on your decoy birds. Escapes by females may also increase with wider slots.

- Side panels attach to the outside of end panels. Nothing else will fit if you attach ends outside.

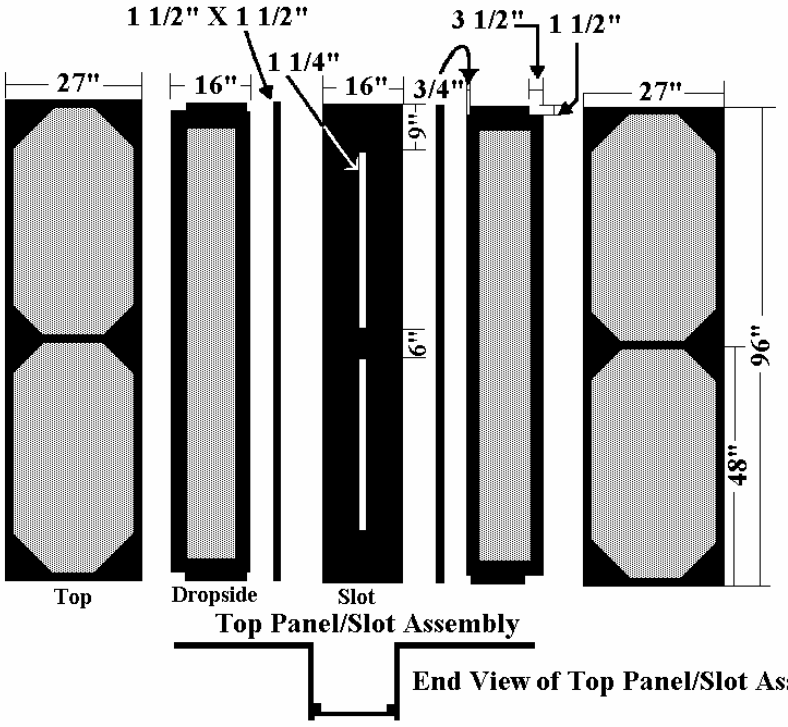
- During final assembly assemble in this order: end, side, side, top, top, dropping slot assembly (3 pieces), then finish with the other end.



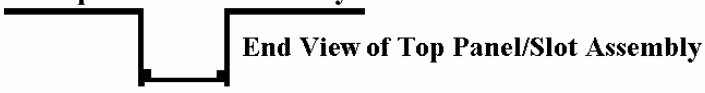
Left Side Panel (same as right panel)



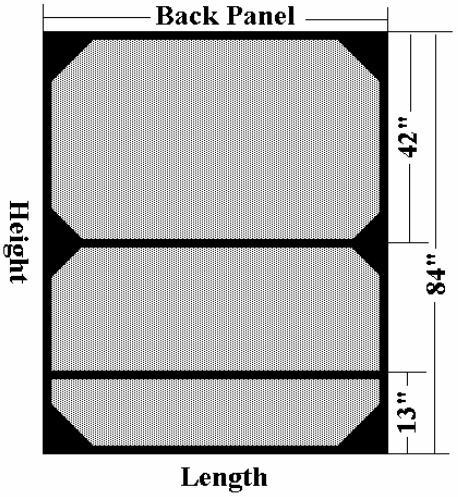
Right Side Panel



Top Panel/Slot Assembly

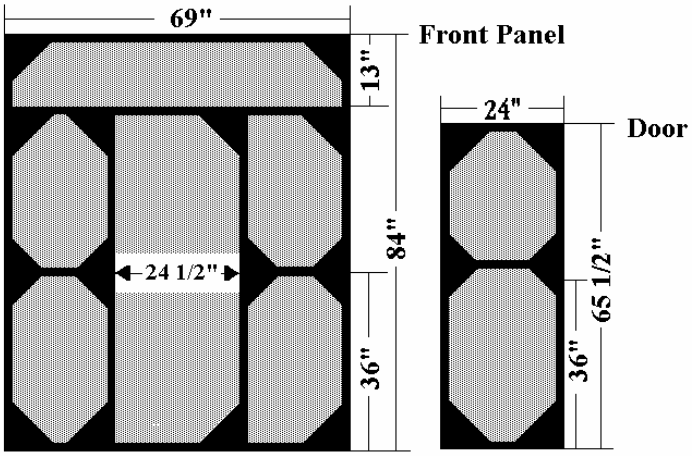


End View of Top Panel/Slot Assembly



Cowbird Trap Plans

Plans developed by Fort Hood Environmental Division.



Materials List for 6x8 Portable Metal Cowbird Trap

Number	Description	Comments
300	1 ½” fender washers*	attach wire to the trap frame
210 ft.	1 ½” 14 gauge square tubing	frame
16 ft.	1 ½” x 1 ½” x ⅛” angle iron	trap funnel base
15” w x 94 ½” lg	⅛” plate*	funnel entrance floor
2	2” weld-on hinges*	door hinge
1	weld-on door latch*	used to keep door secured
50 ft. of 48”	½” hardware cloth	bought in 100 ft. rolls
40 ft. of 36”	½” hardware cloth	bought in 100 ft. rolls

Recommended Tools:

220 amp electric wire feed welding machine	Vise-grip pliers
Oxyacetylene cutting torch or pipe saw	6 3 or 4 inch C-clamps
Electric drill and metal bits	Metal measuring tape
Driver for self-tapping metal screws	Wire brush
Hacksaw	Wire shears or tin snips
Hammer	Metal dirt rake

Order of Construction: *(Refer to diagram for placement before welding)*

Sides (Cuts necessary for both sides)
2 cuts 96” of 1 ½” x 1 ½” 14 gauge square tubing (top of side panels).
2 cuts 96” of 1 ½” x 1 ½” heavy gauge square tubing (base of side panels).
4 cuts 81” of 1 ½” x 1 ½” 14 gauge square tubing (vertical corner posts).
2 cuts 93” of 1 ½” x 1 ½” 14 gauge square tubing (center braces).

Front
2 cuts 72” of 1 ½” x 1 ½” 14 gauge square tubing (door headers).
1 cut 72” of 1 ½” x 1 ½” heavy gauge square tubing (base piece).
2 cuts 11” of 1 ½” x 1 ½” 14 gauge square tubing (bracing over the door).
2 cuts 22 ¼” of 1 ½” x 1 ½” 14 gauge square tubing (mid-section bracing by door).
2 cuts 68 ½” of 1 ½” x 1 ½” 14 gauge square tubing (doorframe).

Door
3 cuts 21” of 1 ½” x 1 ½” 14 gauge square tubing (top, middle, bottom bracing).
2 cuts 68” of 1 ½” x 1 ½” 14 gauge square tubing (sides of door).

Back
3 cuts 72” of 1 ½” x 1 ½” 14 gauge square tubing (top, center frame pieces).
1 cut 72” of 1 ½” x 1 ½” heavy gauge square tubing (base piece).
2 cuts 11” of 1 ½” x 1 ½” 14 gauge square tubing (top bracing pieces).

Top
2 cuts 93” of 1 ½” x 1 ½” 14 gauge square tubing (upper frame for trap funnel).
2 cuts 93” of 1 ½” x 1 ½” x ⅛” angle iron. (lower trap entrance plate supports).
15” wide x 94 ½” long ⅛” plate (trap entrance plate). Cut two openings 36 ¼” x 1 ¼” as shown in the diagram. *The exact 1 ¼” width of each opening is critical. (Note: If desired, this plate can be made of wood, rather than metal.)*

Wire Mesh covering

Center the wire at the door and wrap it around the entire trap, using a dirt rake to pull the wire tight. Don’t forget to cover the floor of the trap (this will help keep predators out). Attach the wire to the frame with fender washers and self-tapping screws placed every 12 inches apart.

Door: 1 piece 67 ¾" x 23 ½". Trim to fit.

Placement Notes:
A. ¼” gap on hinge side of door between door and frame.
B. Hinge starts 10” from the top.
C. Hinge starts 10” from the bottom.

***ALTERNATE CONSTRUCTION METHODS**

Attaching Wire Mesh (Alternate Method)
If desired, the screen mesh can be attached to the trap using 130 feet of 1” x 1/8” strap, and 275 self-tapping metal screws. Make the following cuts if this method is used:

Front:	2 – 74 ½”	Both Sides:	6 – 95 ¾”
	2 – 23 ½”		4 – 6”
	2 – 27 ½”		
	2 – 11”	Rear:	3 – 74 ½”
			2 – 11 ½”
Door:	3 – 23 ½”		1 – 19”
	2 – 21” (upper sides)		
	2 – 42 ¾” (lower sides)	Center Trap Angle:	2 – 93”

Hold all screen in place with 1" x ⅛" plate with screws placed every 6 inches.

Alternate Door Hinges and Latch Construction:
Note: Put door latch on first, then install frame latch to fit.

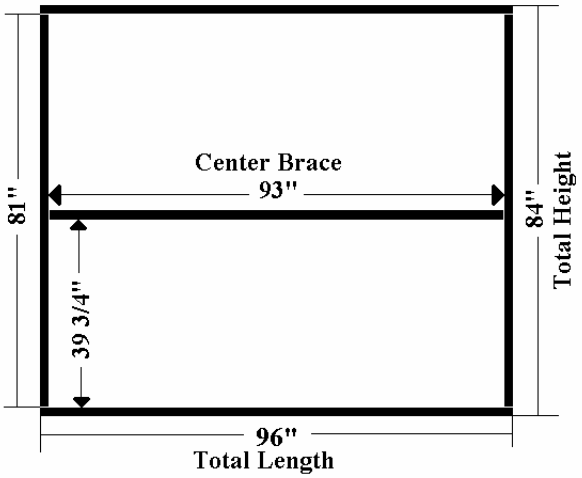
1 ft. of 1” x ¼” strap
2 ft. of ⅜” tubing
2 ft. of 7/16” rod

Make the following cuts:

4 cuts 2” of 3/8” tubing (door hinge part)
2 cuts 5” of 7/16” rod (door hinge part)
1 cut 7” of 1” x ¼” strap (door latch)
1 cut 5” of 1” x ¼” strap (on door)
1 cut 2” of 3/8” tubing (on door)
1 cut 3 ¼” 7/16” rod

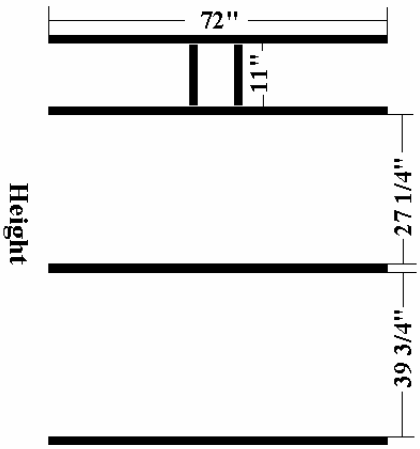
Alternate Trap Entrance Plate:
2 pieces of plate 7” wide x 94 ½” long, separated by 1 ¼” inches that will form the opening. *The exact 1 ¼” width of the opening is critical.*

Side Panels (Make 2)



(Heavy gauge tubing on bottom)

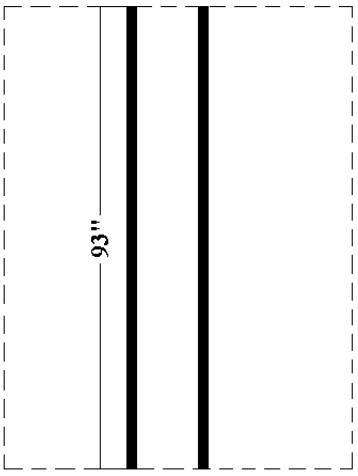
Back Panel

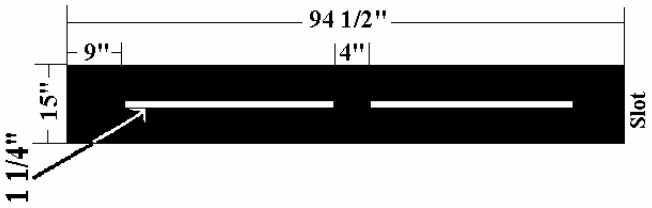


(Heavy gauge tubing on bottom)

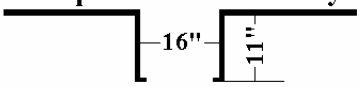
Top

93" Top Center Upper Pieces





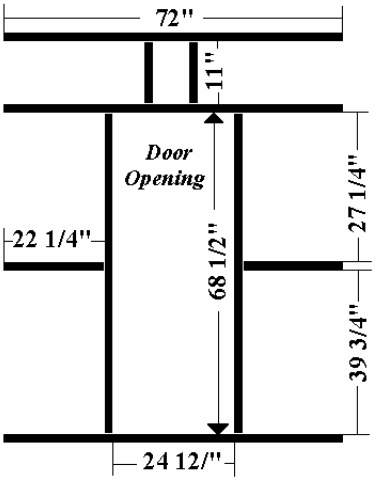
Top Panel/Slot Assembly



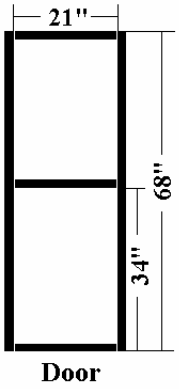
End View of Top Panel/Slot Assembly

Lower Cross pieces 93" angle iron

Front Panel

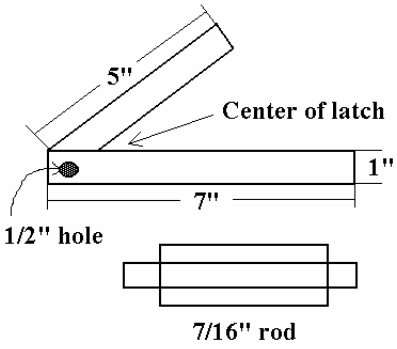


(Heavy gauge tubing on bottom)

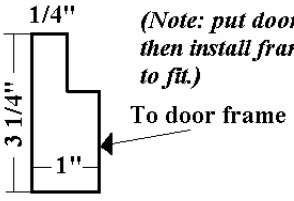


Door

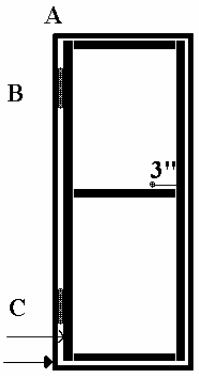
Door Latch Assembly



Weld rod to both sides of latch



(Note: put door latch on then install frame latch to fit.)



A. 1/4" gap between hinge side of door between door and frame.

B. Hinge starts 10" from top.

C. Hinge starts 10' from bottom.

Metal Cowbird Trap Plans

Resources

The following organizations and their web-sites are recommended as sources of further information on cowbird parasitism, cowbird trapping, and other wildlife information.

Central Texas Cattlemen's Association. Steve Manning, Vice President. 4125 FM 116, Gatesville, TX 76528.

Kerr Wildlife Management Area. Route 1, Box 180, Hunt, TX 78024. Ph. 830-238-4483.

The Nature Conservancy of Texas. P.O. Box 1440, San Antonio, TX 78295-1440. www.tnctexas.org

Texas Department of Agriculture. P.O. Box 12847, Austin, TX 78711. Ph. (512) 463-7476. www.agr.state.tx.us.

Texas Farm Bureau. P.O. Box 2689, Waco, TX 76702-2689. Ph. (254) 772-3030. www.txfb.com.

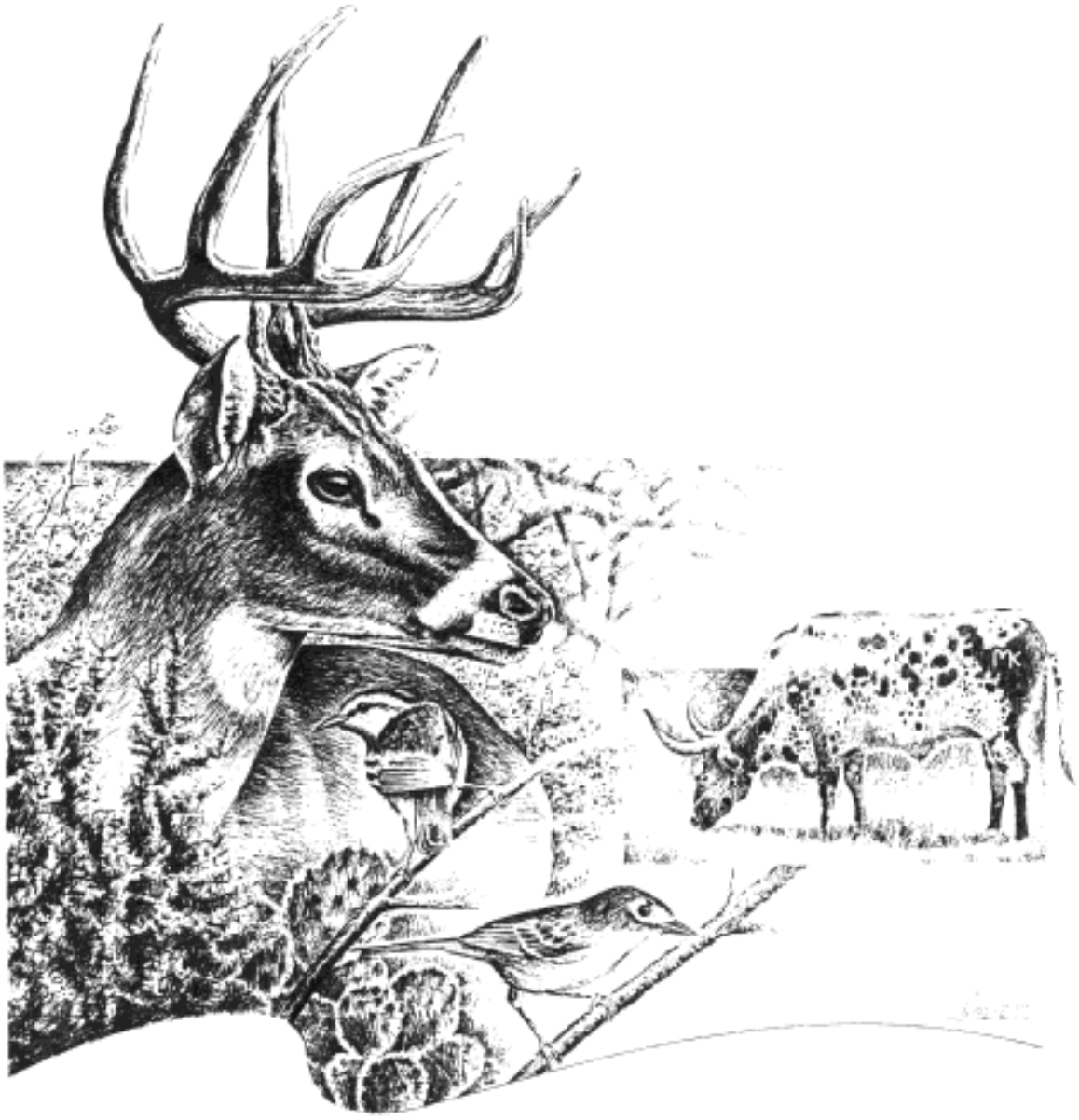
Texas Parks and Wildlife Department. 4200 Smith School Rd., Austin, TX 78744. Ph. (800) 792-1112. www.tpwd.state.tx.us.

Texas Wildlife Association. 401 Isom Rd., Suite 237, San Antonio, TX 78216. Ph. (210) 826-2904. www.texas-wildlife.com.

Appendix R

Small Acreage Management Techniques

(Abridged)



By

Trey Carpenter

Texas Parks and Wildlife Department

Small Acreage Management Techniques

By Trey Carpenter

The goal of this publication is to present wildlife habitat improvement projects to landowners with the least amount of narration as possible. The workbook describes the three necessary ingredients for wildlife habitat. Habitat is where wildlife lives, and they require food, water, and cover. The abundance and diversity of these three elements are directly proportional to the number of plant and animal species one can expect to attract.

Projects described in this workbook are intended to be as useful to an urban backyard wildlife enthusiast or a manager of a large ranch. The booklet will be most attractive to owners of small properties that want to attract wildlife and develop habitats for it. Incorporating the FOOD, WATER, and COVER projects laid out in this booklet will ensure good wildlife habitat. Managing properties for wildlife should be a holistic (big picture) practice, therefore much overlapping and duplication of the sections will occur.

FOOD

Providing food is an obvious and simple wildlife enhancement concept. There are many ways of supplying food to wildlife ranging from simple bird feeders to fenced food plots. It is a common misconception that an area knee-high in grass or a mature, closed-canopy forest is good wildlife habitat. There is little diversity in these situations and consequently these type habitats produce poor food sources for wildlife. Diversity is the key to quality wildlife habitat. This booklet will show how to create more edge effect to enhance wildlife habitat. The edge effect is the result of tow adjoining plant communities coming together. The **Food** section describes how to put “food on the table” for wildlife. Supplemental feeding is not a replacement for good habitat. Corn, milo, etc. are good attractants and can help hold wildlife in a given area; however, they are low in protein and do not meet the nutritional requirements for most wildlife. Periodic moving of feeders is necessary to

prevent disease transmission among wildlife species. In addition, washing with a 10% bleach solution is a safe way to keep structures germ-free.

WATER

Water is a necessity for most wildlife. If the property is question has an existing stream, creek, or pond, most of a wildlife manager's problems are solved. This booklet will show how to improve these riparian habitats for wildlife and how to more evenly distribute wildlife by creating new watering situations and improving existing structures. The more diverse the watering situations are, the greater the number of species that will benefit. The ideal situation is to have many watering type areas ranging from fast moving water to pools. A small dam on a creek is a good way to change and diversify an existing water system. Wet marshy areas, excluded from livestock, will benefit many wildlife species. These water projects also produce many unseen creatures that provide food for other animals along the food chain.

COVER

Cover can be broken down into three categories: nesting, escape, and feeding, with some overlapping of the three. Nesting boxes for birds are some of the most visible and enjoyable COVER projects. Cavity nesters such as bluebirds, and wrens are delightful to watch and easy to attract. Leaving snags, dead or dying trees may seem unattractive, but many birds depend upon them for their "natural" shelters.

Snags can be created by girdling a live tree. This entails ringing a tree's bark below the cambium level with a chain saw or axe. On small properties or around a house, a less drastic approach such as building a structure from limber products should be considered. Basic designs and dimensions for such structures have been included in the Nesting Cover portion of this workbook.

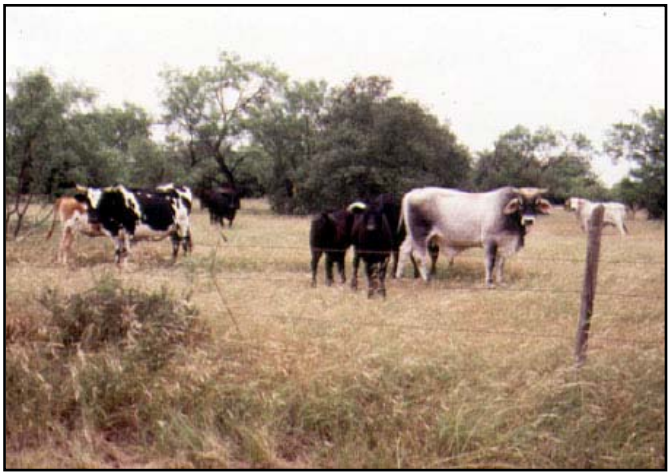
Escape cover can include brush piles, half-cut trees, and shrub plantings. These happen to be among some of the most popular wildlife enhancement projects. Most wildlife species are edge dwellers, and escape cover is necessary to provide protection from predators. Wildlife is not comfortable

out in the wide open, and foods that they search out are not always readily available in dense wooded situations. The line where these two areas meet compose the edge.

Feeding Cover is necessary for wildlife to forage over a large area. Brush clearing strategies are important to consider when trying to improve habitat in a small area. The more edge created, the more wildlife will benefit. Another method creating edge for wildlife is leaving fallow strips in agricultural plantings. This allows for year around feeding. Patterns and food sources will be described in the Cover Project section.

The amount of edge created can be greatly limited by thick matted amounts of grass if livestock is totally excluded. Many properties are too small to support livestock grazing. Continuous grazing of livestock is not recommended for small acreage. Continuous grazing of livestock, even if not "overstocked", could lead to less biodiversity. A single cow will select towards the most choice forage. This leads to over utilization of these preferred foods and allows secondary, invader type species, to flourish. This ultimately leads to less desirable type foods.

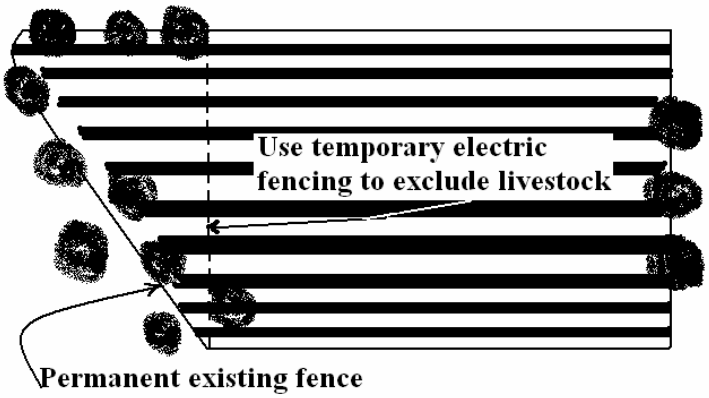
A good scenario for wildlife is a high intensity low frequency grazing system. By moving a large number of grazers into a pasture, a "mowing" effect can be achieved. Removal of old grass growth during late summer and winter can greatly benefit wildlife. The timing of grazing is important to prevent damage to vulnerable wildlife and plant species. Young trees and plants can be damaged, and nesting birds disturbed, during springtime grazing. Livestock should be rotated in and out of an area once the desired mowing effect has been achieved. For small property owners this poses a problem. A good solution is to incorporate the small property into a grazing system of a neighbor with a herd. Both parties can benefit if approximately 50% of grass is removed. Care should be taken that critical areas, such as food plots, structures and fragile riparian areas are restricted from the herd. Cattle are the best choice for grazing excess grass and the soil disturbance created by their "hoof action" will stimulate forb growth. Sheep, goats, and exotic species of deer will compete directly with native species for desirable food, water and space. Cattle are primarily grass foragers and do not pose a threat to native species for food if moderately stocked. "Moderation" is the key to deciding how many cows, goats, sheep, etc. are to be stocked. Remember that too many deer can over-utilize the vegetation in an area as drastically as sheep and goats.



Hunting, where permitted, is an important tool to keep many wildlife populations in check. Again, "moderation" is the key; care should be taken not to over-utilize any given species. Stay within the limits and recommendations provided by TPWD biologists for a given area.

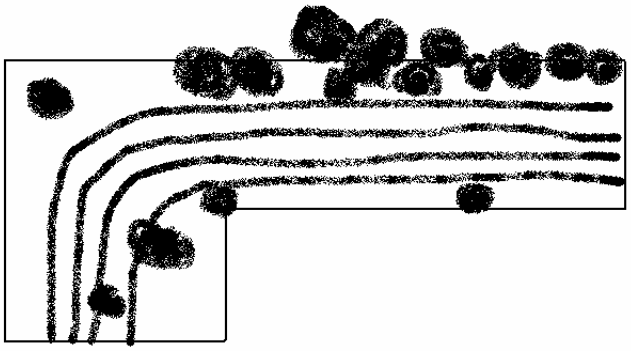
Modifying Existing Agricultural Stands

Allow irregular areas in cultivation, such as this triangular plot, to go fallow for winter food—especially adjacent to brushy cover.

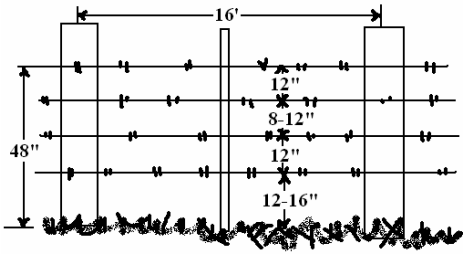


Food Plot. In Conservation Reserve Program (CRP) or old field.

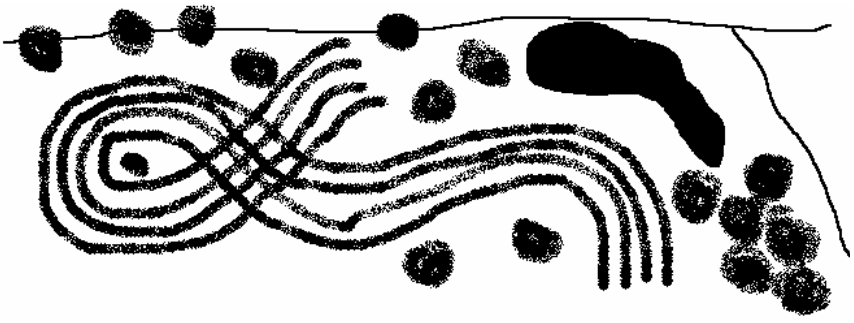
- Useful in areas where row cropping and necessary foods are scarce
- Plant row type crops specifically for wildlife
- Maximum edge can be created by long narrow plots (1/8 – 2 acres)
- Position between two cover types (ex. Between mature tree stand and open area).
- These areas can serve as wildlife corridors.



Fencing. Food plots specifically for wildlife, should be excluded from livestock with electric or barbed wire fence.



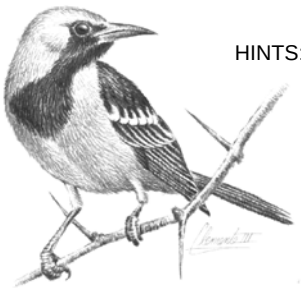
Barbed-wire Hints. Bottom wire should be a minimum of 12-16” from ground and smooth. Top wire should be no more than 48” (preferably lower), and 12” between it and next wire down. Fence stays should be used between posts to create a more rigid fence; this allows deer a better chance of struggling free should they become entangled.



Random Discing.

- Pull a disc or chisel plow behind tractor in early spring to stimulate native forbs for wildlife production.
- Slightly disc soil in non-highly erodable areas with good soil moisture.
- Try sparsely broadcasting wildlife food producing seeds. Follow up by dragging a log or chain to create a simple food plot.

Wildlife Plantings



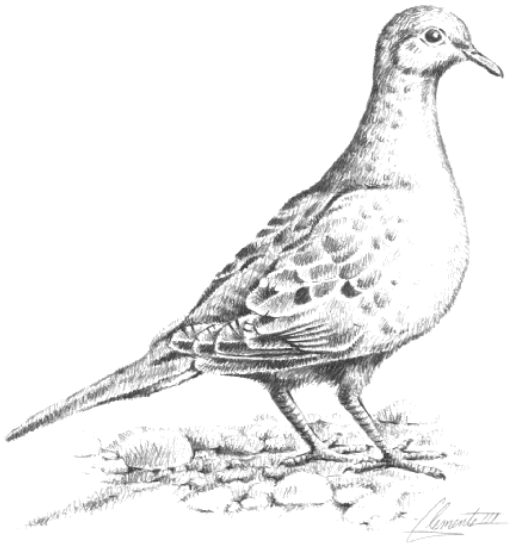
HINTS:
--Need 25 inches of annual precipitation to be beneficial.
--Irrigation is an expensive alternative.
--Supplemental feeding is cheaper and more reliable.
--Use seed sources from within 200 miles north and south, and 100 miles east and west.
--Exclude from livestock.

Seed Species	Rate (lbs/acre)	Depth (inches)	Planting Time	Time to Maturity (days)	Drought Tolerance	Species Benefited*
Annual Sunflower	3-5	.25-.5	Mar.-May	100	High	MD,Q
Good drought insurance; will reseed yearly with spring discing.						
Fox-tail Millet	15-20	1-1.5	Apr-June	60-80	Good	MD,Q,T,WF
Similar to native bristle grass; can be planted 0 days before frost.						
Proso Millet	20-50	1-1.5	Apr-June	50-70	Good	MD,Q,T
Best adaped for North Texas (Rolling Plains)						
Japanese Millet	15-20	1-1.5	Apr-June	60-80	Poor	WF
Good in playa lakes in High Plains for waterfowl						
Sorghum Alum	3-6	2-Jan	Apr-June	100-120	Fair	MD,Q,T,D,WF
Do not plant too thick, to allow free movement throughout food plot						
Corn	7- 10	2-Jan	Apr-June	170-190	Poor	MD,Q,T,D,WF
Should not be planted in areas less than 30 inches precipitation (unless irrigated). Shred in strips to allow free movement of wildlife.						
Sesbania	20-30	.5-1	June-July	120	Poor	MD,Q,T,D
Might require irrigation in arid areas						
Partridge Pea	2	1	Feb-March	120	Fair	ALL
Use local strains for best production						
Annual Pespedeza (Korean)	20-25	.25-.50	Post Frost	120	Poor-Fair	D,Q,T
Need 30+ inches of precipitation or irrigation						
Sesame (Benne)	1	.25-.50	Post Frost	120	Fair	D,Q
Use shattering variety for doves and quail						
Austrian Winter Peas	20-30	1-2	Fall			D,T
Illinois Bundle Flower	3	0.5	Spring-Fall		Good	MD,Q,T
Mix into areas when reestablishing grasses and other perennials.						
Clover	8-10	1-2	Fall		Poor	D,T
Engleman Daisy	3	1/8	Spring		Good	D,T
Four-wing Saltbush	8-10	0.5	Winter-Spring		Good	D,T
Oats	40-50	1-2	Fall-Spring		Fair	D,T,WF
Not as freeze resistant as wheat						
Reseeding Cow Peas	50-100	1-2	Spring		Fair	ALL
Maximillian	3	1/8	Fall-Winter		Good	D,Q,T

Sunflower					
Vetch	20-30	1-2	Fall	Fair	Q,D,T,MD
Egyptian Wheat	3-6	1-2	Spring	Fair	Q,MD,T
Winter Wheat	30-50	1-2	Fall-Spring	Fair	ALL

Best all round winter forage

***MD=mourning dove Q=Quail T=turkey WF=waterfowl D=deer**



RECOMMENDED SPECIES FOR CENTRAL TEXAS

Botanical Name	Common Name	Site Preference
WILDFLOWERS		
Annuals		
Amblyolepis setigera	Huisache daisy	Dry, well-drained soil; sun
Cassia fasciculata	Partridge pea	Open, sandy fields; sun
Castilleja indivisa	Indian paintbrush	Sandy loam; sum
Centaurea americana	Basket flower	Dry, well-drained soil; sun
Coreopsis tinctoria	Coreopsis	Moist, sandy soil; sun
Dracopis amplexicaulis	Clasping-leaf coneflower	Moist areas, ditches; sun
Eryngium leavenworthii	Eryngo	Plains, prairies; sun
Eustoma grandiflorum	Texas bluebell	Moist areas in prairies; sun
Gaillardia pulchella	Indian blanket	Variety of soils, disturbed areas; sun
Linum lewsii	Blue flax	Sandy or rocky soils; sun
Lupinus texensis	Bluebonnet	Well-drained, alkaline soil; sun
Machaeranthera tanacetifolia	Tahoka daisy	Rocky or sandy soils; sun
Monarda citriodora	Horsemint	Well-drained, sandy loam-rocky soil
Palafoxia callosa	Palafoxia	Limestone soil; sun
Phacelia congesta	Blue curls	Moist, well-drained soils; sun-shade
Phlox drummondii	Drummond's phlox	Prefers sandy soil; sun-part sun
Rudbeckia hirta	Black-eyed Susan	Varies widely; sun-part sun
Thelesperma filifolium	Greenthread	Calcareous soils; sun
Perennials		
Aquilegia canadensis	Columbine	Rocky, well-drained sites; part shade
Asclepias tuberosa	Butterfly weed	Moist areas in prairies, roadsides; sun
Callirhoe digitata	Winecup	Open woods, plains; sun
C. involucrata	Winecup	Open woods, rocky hills; sun
Calvlophus drummondianus	Square-bud primrose	Sandy or rocky soils; sun
Cooperia drummondii	Rain lily	Open fields, prairies, lawns; sun
C. pedunculata	Rain lily	Open fields, prairies, lawns; sun
Coreopsis lanceolata	Lanceleaf coreopsis	Variety of soils; sun
Delphinium carolinianum	Prairie larkspur	Dry, open woods and fields; sun
Echinacea angustifolia	Purple coneflower	Dry, rocky prairies and hillsides; sun
E. purpurea	Purple coneflower	Rocky, open woods; sun-part sun
Engelmannia pinnatifida	Engelmann daisy	Open, calcareous sites; sun
Eryngium leavenworthii	Eryngo	Plains and prairies; sun
Eupatorium coelestinum	Mistflower	Moist, sandy wooded area; sun-part sun
Helianthus maximiliani	Maxilillian sunflower	Moist, clay-like soil; sun
Hymenoxys scaposa	four-nerve daisy	Dry, well-drained sites; sun

Ipomopsis rubra (biennial)	Standing cypress	Dry, sandy or rocky soil; sun
Liatris mucronata	Gayfeather	Well-drained soils; sun
L. pycnostachya	Gayfeather	Well-drained, calcareous soil; sun
Lobelia cardinalis	Cardinal flower	Wet to moist soil; sun-part shade
Melampodium leucanthum	Blackfoot daisy	Calcareous soil; sun
Monarda fistulosa	Beebalm	Dry, open woods, wet meadow
Oenothera macrocarpa	Missouri primrose	Limestone hills and prairies; sun
O. speciosa	Showy primrose	Open areas in a variety of soils; sun
Penstemon baccharifolius	Rock penstemon	Limestone crevices; sun-part shade
P. cobaea	Wild foxglove	Loamy soil, prairies; sun
P. triflorus	Hill Country penstemon	Limestone soil; sun-part shade
Physostegia pulchella	Obedient plant	Wet soils of bottomlands; part shade
Ratibida columnifera	Mexican hat	Variety of soil; sun-part sun
Salvia coccinea	Scarlet Sage	Thickets and open woods; part shade
S. engelmannii	Englemann sage	Limestone soils; sun
S. farinacea	Mealy blue sage	Wide variety of soils; sun-part sun
S. roemeriana	Cedar sage	Woody, rocky areas; part shade
Solidago spp.	Goldenrod	Sandy to clay soil; sun
Tradescantia spp.	Spiderwort	Prairies, plains, moist areas; part sun
Verbena bepennatifida	Dakota vervain	Fields; sun
V. elegans var. asperata	Mountain vervain	Limestone & sandstone outcrops; sun
Vernonia baldwinii	Ironweed	Dry, well-drained sites; sun
V. lindheimeri	Wooly ironweed	Limestone soil; sun
Wedelia hispida	*Wedelia*	Dry, well-drained sites; sun

SHRUBS

Blackland Prairie (east of the Balcones fault line)

Amorpha fruticosa var. angustifolia	False indigo	Moist woods, stream banks; calcareous soil
Anisacanthus wrighii	Flame acanthus	Dry, well-drained soil
Berberis swasevi	Texs barberry	Dry, well-drained soil
B. trifoliolata	Agarito	Dry, well-drained soil
Callicarpa americana	American beauty bush	Rich woods, thickets
Dalea frutescens	Black dalea	Dry soil in full sun
Erythrina herbacea	Coral bean	Sandy or loamy soils; sun-part shade
Eupatoruim havenense	Mistflower	Well-drained soil; rocky ravines
E. odoratum	Blue mistflower	Well-drained soil; full sun
Eysenhardtia texana	Kidneywood	Dry hills and canyons
Hesperaloe parviflora	Red yucca	Dry, well-drained soil; full sun
Lantana horrida	Trailing lantana	Dry, well-drained soil; sun-part-sun
Leucophyllum frutescens	Cenizo, Texas sage	Dry, well-drained soil; sun
Malvavixcus drummondii	Turk's cap	Moist, shaded areas
Mimosa borealis	Fragrant mimosa	Well-drained soil; sun

Nolina texana	Bear grass	Well-drained sites; full sun
Pavona lasiopetala	Rose pavonia	Dry, rocky woods or stream banks
Rhus aromatica	Fragrant sumac	Wooded areas; rocky soil
R. virens	Evergreen sumac	Rocky hillsides
Ruellia brittoniana	Narrow-leaf petunia	Well-drained sites; full sun
Salvia greggii	Autumn sage	Dry, well-drained soils; full sun
Viburnum rufidulum	Rusty blackhaw	Wood borders, stream edges, thickets

Edwards Plateau (west of the Balcones fault line)

Amorpha fruticosa	False indigo	Moist woods, streambanks; calcareous soil
Anisacanthus wrightii	Flame acanthus	Dry, well-drained soil
Bauhinia congesta	Orchid tree	Dry, well-drained soil; S. side of bdg.
Berberis swasevi	Texas barberry	Dry, well-drained soil
B. trifoliolata	Agarito	Dry, well-drained soil
Callicarpa americana	American beauty bush	Rich woods and thickets
Capsicum frutescens	Chile piquin	Well-drained sites
Chrysactinia mexicana	Damianita	Dry, rocky well-drained sites; sun
Colubrina texensis	Texas snakewood	Dry, well-drained sites
Dalea frutescens	Black dalea	Dry soil in full sun
Dasylirion texanum	Texas sotol	Dry, well-drained sites; full sun
Erythrina herbacea	Coral bean	Sandy or loamy soils; sun-part shade
Eupatorium havanense	Mistflower	Well-drained soil, rocky ravines
E. odoratum	Blue mistflower	Well-drained soil, full sun
Hesperaloe parviflora	Red yucca	Dry, well-drained soil; full sun
Hibiscus cardiophyllus	Heart-leaf hibiscus	Well-drained soil; sun-part-sun
Lantana horrida	Trailing lantana	Dry, well-drained soil; sun-part-sun
Leucophyllum frutescens	Cenizo, Texas sage	Dry, well-drained soil; sun
Lonicera albiflora	White honeysuckle	Rocky or sandy soils; cedar brakes
Malvavixcus drummondii	Turk’s cap	Moist, shaded areas
Mimosa borealis	Fragrant mimosa	Well-drained soil; sun
Nolina texana	Bear grass	Well-drained sites; full sun
Pavona lasiopetala	Rose pavonia	Dry, rocky woods or stream banks
Pistacia texana	Pistache	Rocky, limestone stream banks, cliffs
Rhus aromatica	Fragrant sumac	Wooded areas; rocky soil
R. lanceolata	Flame-leaf sumac	Rocky hillsides; sun or shade
R. virens	Evergreen sumac	Rocky hillsides
Ruellia brittoniana	Narrow-leaf petunia	Well-drained sites; full sun
Salvia greggii	Autumn sage	Dry, well-drained soils; full sun
S. regia	Royal sage	Rocky, wooded slopes
Viburnum rufidulum	Rusty blackhaw	Wood borders, stream edges, thickets
Yucca rupicola	Twist-leaf yucca	Dry, rocky soil; full sun

TREES

Blackland Prairie (east of the Balcones fault line)

Conifers

Juniperus virginiana	Eastern red cedar	Fields, grasslands
Taxodium distichum	Bald cypress	Along stream banks

Shade Trees

Carya illinoinensis	Pecan	Rich, river-bottom soil
Catalapa speciosa	Catlpa	Deep, rich, moist soil
Fraxinus texensis	Texas ash	Prefers limestone hills
Juglans nigra	Eastern black walnut	Well-drained, loamy soil
Plantanus occidentalis	Sycamore	Rich bottomland soils along streams
Quercus glaucoides	Lacy oak	Limestone soils
O. macrocarpa	Bur oak	Moist forests along streams
O. muhlenbergii	Chinkapin oak	Calcareous uplands
O pungens var. vaseyana	Vasey oak	Dry, rocky slopes
O. shumardii	Shumard red oak	Moist hills, bottomlands, clay soils
O. texana	Texas red oak	Dry uplands
O. fusiformis	Escarpment live oak	Sandy loam soils, also clay soils
Sapindus drummondii	Western soapberry	Moist soils along streams
Ulmus crassifolia	Cedar elm	Prefers limestone soils

Small Trees

Cercis canadensis var. mexicana	Mexican redbud	Rich, moist sandy loam
C. canadensis var. texensis	Redbud	Rich, moist sandy loam
Chilopsis linearis	Desert willow	Dry, well-drained areas
Cotinus obovatus	Smoketree	Rocky banks and hillsides
Diospyros texana	Texas persimmon	Dry, well-drained sites
Eysenhardtia texana	Texas kidneywood	Dry, well-drained sites
Ilex decidua	Possom-haw holly	Rich, moist soils
I. vomitoria	Yaupon	Low, moist woods
Parkinsonia aculeata	Retama	Moist, sandy soils
Pistacia texana	Texas pistachio	Rocky limestone soil
Prosopis glandulosa	Mesquite	Variety of soils, well-drained site
Prunus mexicana	Mexican plum	Well-drained, but moist sites
Rhamnus caroliniana	Carolina buckthorn	Low areas, moist site
Rhus glabra	Scarlet sumac	Moist, rich soil
Sophora affinis	Eye's necklace	Limestone soils on hills and banks
S. secundiflora	Mountain laurel	Limestone soils
Ungnadia speciosa	Mexican buckeye	Limestone soils and moist areas

TREES

Edwards Plateau (west of the Balcones fault line)

Conifers

Juniperus virginiana	Eastern red cedar	Fields, grasslands
Taxodium distichum	Bald cypress	Along stream banks

Shade Trees

Arbutus xalapensis	Texas madrone	Limestone or igneous hills
Carya illinoinensis	Pecan	Rich, river-bottom soil
Fraxinus texensis	Texas ash	Prefers limestone hills
Juglans microcarpa	Texas black walnut	Valleys and rocky stream beds
J. nigra	Eastern black walnut	Well-drained, loamy soil
Plantanus occidentalis var. glabrata	Texas plane tree	Limestone soils
Quercus glaucoides	Lacy oak	Limestone soils
O. buckleyi	Buckley oak	Limestone soils
O. macrocarpa	Bur oak	Moist forests along streams
O. muhlenbergii	Chinkapin oak	Calcareous uplands
O pungens var. vaseyana	Vasey oak	Dry, rocky slopes
O. fusiformis	Escarpment live oak	Sandy loam soils, also clay soils
Sapindus drummondii	Western soapberry	Moist soils along streams
Ulmus crassifolia	Cedar elm	Prefers limestone soils

Small Trees

Acacia wrightii	Wright acacia	Dry, rocky soils
Acer grandidentatum	Bigtooth maple	Valleys & canyons (protected areas)
Aesculus arguta	White buckeye	Limestone and granite soils
A. pavia	Red buckeye	Limestone canyons and rocky hills
Cercis canadensis var. mexicana	Mexican redbud	Rich, moist sandy loam
C. canadensis var. texensis	Redbud	Rich, moist sandy loam
Chilopsis linearis	Desert willow	Dry, well-drained areas
Cotinus obovatus	Smoketree	Rocky banks and hillsides
Diospyros texana	Texas persimmon	Dry, well-drained sites
Eysenhardtia texana	Texas kidneywood	Dry, well-drained sites
Ilex decidua	Possom-haw holly	Rich, moist soils
I. vomitoria	Yaupon	Low, moist woods
Parkinsonia aculeata	Retama	Moist, sandy soils
Pistacia texana	Texas pistachio	Rocky limestone soil
Prosopis glandulosa	Mesquite	Variety of soils, well-drained site
Prunus mexicana	Mexican plum	Well-drained, but moist sites
Rhamnus caroliniana	Carolina buckthorn	Low areas, moist site
Rhus glabra	Scarlet sumac	Moist, rich soil
Sophora affinis	Eye’s necklace	Limestone soils on hills and banks
S. secundiflora	Mountain laurel	Limestone soils
Ungnadia speciosa	Mexican buckeye	Limestone soils and moist areas
Yucca thompsonia	Thompson yucca	Dry, rocky sites

VINES

Campsis radicans	Trumpet vine	Sun to part sun

Clematis pitcheri	Purple leatherflower	Sun to part sun
C. texensis	Scarlet leatherflower	Limestone cliffs, rocky areas, sun to part sun
Lonicera sempervirens	Coral huneysuckle	Sun
Parthenocissus quinquefolia	Virginia creeper	Sun to part sun
Passiflora incarnata	Passion flower	Sun to shade, part sun

GRASSES

Andropogon gerardi	Big bluestem	Prairies, open woods, sandy-loamy soil
A. glomeratus	Bushy bluestem	Prairies, open woods, sandy-loamy soil
Bouteloua curtipendula	Sideoats grama	Prairies, open woods, sandy-loamy soil
B. hirsuta	Hairy grama	Low, moist sites
B. pectinata	Tall grama	Loose, alkaline soils
Buchloe dactyloides	Buffalograss	Variety of soils
Hilaria belangeri	Curly mesquite	Limestone outcrops and hilltops
Melica nitens	Threeflower melic	Full sun; prefers clay soils
Muhlenbergia hindheimeri	Lindheimer muhly	Rocky slopes, hillsides, grassy plains
M. reverchonii	Seep muhly	Calcareous moist sites
Panicum virgatum	Switchgrass	Moist lowlands
Schizachyruim scoparium	Indiangrass	Open woods and prairies
Sporobolus asper	Tall dropseed	Borders of woods and prairies
Tripsacum dactyloides	Eastern gramagrass	Low, moist grasslands

Deer Resistant Plants That Are Well-adapted to Central Texas

Loss of habitat and other environmental stress can result in almost any plant being eaten by deer. Moreover, deer tastes vary widely. This list ranks each plant for deer resistance through the number in parentheses at the end of the listing.

1 = Safe; Deer don't eat
2 = Deer eat flowers only
3 = Deer sometimes eat
4 = Deer eat plants and flowers, but it's not a first choice

Annuals
Bluebonnet, LUPINUS (1)
Marigold, TAGETES spp. (3)
Periwinkle, VINCA rosea (3)
ZINNA (3)

Bulbs
CALADIUM (3)
Daffodil (1)
IRIS (1)
Snowdrop (1)
Tulip (1)

Grasses
Bamboos, BAMUSA (3)
Beargrass, NOLINA spp. (1)
Fescues, FESCUEA spp. (3)
Little bluestem (1)
Muhly Grass, MUHLENBERGIA lindeim (1)
Pampas grass, CORTADERIA spp. (1)
Purple Fountain Grass (1)
Seep Muhly (1)

Herbs
ALOE (1)
ARTEMISIA (3)
English Lavender (3)
Mexican Marigold Mint (3)
Mexican Oregano (1)
Rosemary (1)
Sage (1)
Yarrow (3)

Perennials
AGAVE (1)
AJUGA reptans (3)
Artichoke (3)
ASTER frikarti (3)
Bee Balm, MONARDA (3)
Black-eyed Susan, RUDECKIA hirta (3)
Blackfoot Daisy, MELAMPODIUM leucanthum (3)
Butterfly Weed, ASCLEPIAS tuberosa (3)
Cactus (1)
Columbine,AQUILEGIA canadensis (3)
Coneflower, ECHINACEA spp. (3)
COREOPSIS hyb. And spp. (2)
Dusty Miller, CENTAUREA cineraria (3)
Ferns: Wood fern, DRYOPTERIS spp. (1)
Foxglove, DIGITALIS (2)
Gayfeather, LIATRIS (2)
Hummingbird Bush, ANISACANTHUS (1)
IRIS (1)
Lamb's Ear, STACHYS byzintina (1)
LANTANA (horrida, no nibbling) (3)
Lavender Cotton, SANTOLINA (1)
Lily of the Nile, AGAPANTHUS (1)
Mexican Marigold Mint,TAGETES lucida (3)
Mexican Petunia, RUELLIA spp. (1)
OXALIS (3)
Oxeye Daisy, CHRYS leucanthurn (1)
PENSTEMON (3)
Red Yucca, HESPERALOE parvifolia (2)
Rock Rose, PAVONIA (3)
Roses (Lady Banks Rose, no nibbling) (4)
Rosemary, ROSMARINUS officinalis (1)
Russian Sage, PAERVOSDIA (1)

SALVIA coccinea (3)
SALVIA greggii (Cherry sage, less nibbling) (3)
SALVIA leucantha (1)
Silver Artemisia, ARTEMISIA ludoviciana (2)
Sotol, DASYLIRION spp. (1)
Spiderwort, TRADESCANTIA spp. (3)
Turks Cap, MALVAVISCUS arboreus (3)
Yarrow, ACHILLEA spp. (3)
YUCCA (2)
Zexmenia, WEDELIA hispida (1)

Shrubs

ABELIA spp. (3)
Agarito, BERBERIS trifoliata (1)
AGAVE
Barberry, BERBERIS (pygmy not resistant) (1)
Bear Grass, NOLINA spp. (1)
Beautyberry, CALLICARPA americana (1)
Buckeye, AESCULUS pavia (3)
Butterfly Bush, BUDDLEIA (3)
CASSIA spp. (3)
Cast Iron Plant, ASIDISTRA (3)
Cacuts (1)
Cenizo, LEUCOPHYLLUM frutescens (1)
Cherry Sage (3)
COTONEASTER (3)
Dwf. Chinese Holly, ILEX (1)
Dwf. Yaupon, ILEX (stokes variety) (1)
ELEAGNUS (3)
Evergreen Sumac, RHUS virens (1)
Germander, TEUCRIUM fruticans (3)
HYPERICUM (3)
Junipers (most varieties) (1)
Kidneywood, EYSENHARDTIA texana (3)
Mistflower, EUPATORIUM (1)
Mexican Oregano, POLIOMINTHA longiflora (1)
Mountain Laurel, SOPHORA secundiflora
NANDINA nana and domestica (3)
Oleander, NERIUM (1)
Pampas Grass, CORTADERIA selloana (1)
Prickly Pear Cactus (1)
Privet (3)
PYRACANTHA spp. (1)
Red Yucca, HESPERALOE parviflora (3)
Rosemary, ROSMARINUS officinalis (1)
SALVIA greggii (red) (3)
SALVIA leucantha (1)
SANTOLINA (1)
Sotol, DASYLIRION (2)
SPIREA (3)
Sumac, RHUS spp. (1)
Texas Persimmon, DIOSPYROS texana (1)
Texas Sage, LEUCOPHYLLUM frutescens (1)
VIBURNUM (1)
Wax Myrtle, MYRICA cerifera (1)
Yaupon, ILEX (Use Stokes, not Strahn) (1)
Yew Pine, PODOCARPUS macrophyllus (1)
YUCCA

Trees

Anacacho Orchid (1)
Ash, FRAXINUS spp. (1)
Bald Cypress, TAXODIUM distichurn (1)
Bois d'arc (1)
Cedar Elm (1)
Chaste Tree, VITEX spp. (1)
Cherry Laurel, PRUNUS caroliniana (1)
Crepe Myrtle (old varieties) (1)
Deodora Cedar (1)
Elm (all varieties) (1)
Fig, FICUS spp. (1)
Juniper (1)
Maple, ACER grandidentatum (1)
Mesquite, PROSOPIS (beans eaten) (1)
Mexican Persimmon, DIOSPYROS texana (1)
Mexican Plum, PRUNUS mexicana (1)
Mountain Laurel (1)

Oaks, QUERCUS spp. (1)
Palm (all varieties) (1)
Pecan (1)
Pine (3)
Possum Haw, ILEX decidua (1)
Redbud (Eastern & Mexican nibbled) (3)
Retama (3)
Smoke Tree, COTINUS obovatus (1)
Sumac, RHUS spp. (1)
Walnut (1)
Yaupon, ILEX vomitoria (1)

Vines & Groundcovers

AJUGA (3)
Asiatic Jasmine (1)
Carolina Jessamine (3)
CLEMATIS (3)
Confederate Jasmine (3)
Cross Vine (1)
English & Algerian Ivy (1)
Ferns (3)
Fig Ivy (3)
Honeysuckle (Coral & Purple nibbled less) (3)
Liriope (4)
Monkey Grass (3)
Muhly Grass (3)
SANTOLINA (1)
VERBENA (3)
Virginia Creeper (3)
WISTERIA (3)
Yarrow (3)

The Value of Dead and Down Wood

by John M. Davis, Urban Biologist
TX. Parks and Wildlife Department

In a healthy forested area, there are trees that are in many different stages of life. There are young trees, mature trees, old trees, and dead trees. Most everyone understands the value of living trees. They provide shade, homes for wildlife, and increase property values. However, many people don't understand the value of dead trees. Dead trees (or "snags") are caused many different factors. Natural processes such as wind, fire, flooding, drought, disease, and old age all function as natural controls on tree populations. Tree mortality is a natural process. (Unfortunately, many processes of man such as overwatering, construction damage to root zones, root suffocation, herbicides, etc., contribute unnaturally to the death of trees.)

Typically society wants to remove snags. We seem to think that once a tree has died, it is no longer useful and should be removed. That, however, is not the case. Standing snags and fallen logs are extremely valuable to the forest ecosystem.

Wildlife Benefits of Standing Dead Trees (Snags)

Many different species of wildlife rely heavily on snags to survive (see the attached list). While some woodpeckers nest in cavities excavated in living trees, many of them nest only in cavities excavated in snags. Without snags, these woodpeckers can't exist. Once cavities are excavated, used, and abandoned by woodpeckers, secondary cavity-nesters move in. These birds include: Chickadees, Titmice, Wrens, and Bluebirds. In addition to excavated cavities, the often hollow trunks and limbs of snags provide excellent homes for owls, raccoons, squirrels, and certain species of bats.

Wildlife Benefits of Fallen Logs

The shelter provided by logs on the forest floor is also valuable to many different species of wildlife (see the attached list). Many different types of invertebrates, reptiles, amphibians, and mammals can be found on, in, or under fallen logs. These logs may used as nesting sites, feeding sites, or escape cover. Fireflies require decaying logs to complete their life cycle. Without fallen logs, many of these animals could not exist. This is important because these animals form much of the foundation of the food web. Without them, hawks, owls, and other interesting animals would not be able to survive.

Nutrient Cycling Benefits of Fallen Logs

When a dead tree or limb falls to the ground, fungi, invertebrates, and other decomposers accelerate the process of decomposition. These decomposers disassemble the complex chemical structure of the wood and release nutrients back into the soil. Without this process, the forest ecosystem would have no way of recycling its

nutrients. The newly available nutrients are then taken up by the living vegetation and life benefits from death.

Management Recommendations

Dead and down woody material is certainly valuable to wildlife and the forested ecosystem, but there may be situations that require human action to maximize the usefulness of snags and fallen logs while minimizing any drawbacks. If the snag is located away from structures or walkways, then it can be left alone with no serious drawbacks. However, if the snag is near a structure, driveway, or walkway, then steps should be taken to reduce the risk of the trunk or limbs falling on them, causing damage to people or property.

The height of the tree determines the radius that could be affected should any part of the tree fall. For example, if a 30 foot tree falls, then anything within a 30 foot radius of the tree could be affected. To reduce the risk of damage, you can "limb" the tree or remove the major limbs leaving only the main trunk standing. You may also consider "topping" the snag or removing just enough of the top so that it does not extend beyond the height of surrounding trees. (Hire a professional to do this. It is not a job for someone without the right equipment.) Both of these techniques will reduce the wind stress on the snag, thus allowing it to stand longer.

Although fallen trees and limbs are valuable to wildlife and the forest itself, they may appear unsightly to some people. To minimize this, simply cut the multi-branched limbs into smaller sections and scatter them on the forest floor. If this practice is not satisfactory, you may create lots of small "criss-crossed" stacks of limbs located throughout the property or simply hide the limb sections within shrubbery. These practices will eliminate unsightliness while allowing the decaying wood to serve its purpose.

For large logs, you may consider splitting them and laying them on the forest floor with the flat side in contact with the soil. This isn't necessary as the log will decay by itself. However, doing this will create more surface area in contact with the soil. This will provide more shelter for wildlife and allow fungi and decomposers to disassemble the wood more quickly.

Because dead and down woody material is extremely valuable for many species of wildlife, it is often recommended that snags be "created" if none exist in the area. To do this, carefully select a tree and "girdle" it. To girdle a tree, you simply cut a ring into the base of the tree that is about an inch deep and an inch wide at the bark. Since it is only the outer rim of the tree that is alive and transporting nutrients, cutting this section will kill the standing portion of the tree. Depending on the species, the roots may or may not remain alive and re-sprout. When selecting the tree to girdle, consider those that are not native to the area, are short lived, or are undesirable for some other reason. Remember to also consider the tree's proximity to structures, driveways, etc. before girdling it.

Finally, it is important to help others understand the value of dead and down woody material. Educating others will not only help them understand why snags and logs are needed by wildlife, but will also help them to understand the actions of those who are employing the management practices previously described.

Species in North Central Texas That Will Use Standing Snags

***** Denotes non-native

Common Name	Scientific Name	Uses Excavated Cavities	Uses Hollow Trunk or Limbs	Nests in Crotch of Snag
Wood Duck	*Aix sponsa*	x	x	
American Kestrel	*Falco sparverius*	x	x	
Barn Owl	*Tyto alba*		x	
Eastern Screech Owl	*Otus asio*	x	x	
Great Horned Owl	*Bubo virginianus*		x	x
Barred Owl	*Strix varia*		x	
Red-headed Woodpecker	*Melanerpes erythrocephalus*	x		
Red-bellied Woodpecker	*Melanerpes carolinus*	x		
Downy Woodpecker	*Picoides pubescens*	x		
Ladder-backed Woodpecker	*Picoides scalaris*	x		
Hairy Woodpecker	*Picoides villosus*	x		
Northern Flicker	*Colaptes auratus*	x		
Great Crested Flycatcher	*Myiarchus crinitus*	x	x	
Carolina Chickadee	*Parus carolinensis*	x	x	
Tufted Titmouse	*Parus bicolor*	x	x	
Carolina Wren	*Thyrothorus ludovicianus*	x	x	x
Bewick's Wren	*Thryomanes bewickii*	x	x	
Eastern Bluebird	*Sialia sialis*	x	x	
* European Starling	*Sturnus vulgaris*	x	x	
* English Sparrow	*Passer domesticus*	x	x	
Prothonotary Warbler	*Protonotaria citrea*	x	x	
Big Brown Bat	*Eptesicus fuscus*		x	
Evening Bat	*Nycticeius h. humeralis*		x	
Silver-haired Bat	*Laionycteris noctivagans*		x	
Brazilian Free-tailed Bat	*Tadarida braziliensis*		x	
Eastern Flying Squirrel	*Glaucomys volans*	x	x	
Eastern Fox Squirrel	*Sciurus niger*		x	
White-footed Mouse	*Peromyscus leucopus*		x	
Gray Fox	*Urocyon cinereoargenteus*		x	
Ringtail	*Bassariscus astutus*		x	
Raccoon	*Procyon lotor*		x	
Long-tailed Weasel	*Mustela frenata*		x	
Eastern Spotted Skunk	*Spilogale putorious*		x	

Appendix T
References

Literature:

Refer to the following Texas Parks and Wildlife Department (TPWD), Natural Resources Conservation Service (NRCS) and Texas Agricultural Extension Service (TCE) bulletins and pamphlets for additional habitat management and specific species management information:

Habitat:

Wildlife Management: Past, Present and Future, A Field Guide to Demonstrations of Wildllife Management Practices and Principles on the Engeling Wildlife Management Area by H. Haucke and J. Hogan Rose, #TPWD-BK-N7100-10L-8/92

Prescribed Range Burning in Texas by L.D. White and C. W. Hanselka, TAEX, Reprinted by TPWD, # PWD-BK-7100-196-7/91

Management Options in Post Oak Woodlands For Wildlife by D. W. Rideout, TPWD, #PWD LF N7100-237A (10/93)

Green-Tree Reservoir Management by B. Ortego, C. Frentress, H. Haucke, and J. Hogan Rose, #PWD-BK-7100-157-11/88

Wetlands Assistance Guide for Landowners by J. K. Anderson, TPWD, #PWD BK R2000-020 (7/95)

Deer:

Learn About Whitetails by R. L. Cook, # PWD-BK-N7100-7-2/93

The Post Oak Savannah Deer Herd: Past, Present, Future by D. W. Rideout, # PWD RP W7100-237B (9/94)

Determining the Age Of a Deer by C. W. Ramsey, D. W. Steinbach, D. W. Rideout , TAEX #B-1453

The Management of Spike Bucks in a White-tailed Deer Population by B. Armstrong, D. Harmel, B. Young, and F. Harwell, TPWD, #PWD LF N7100-247 (8/94)

Coyote Creek Ranch - A Success Story by D. W. Rideout, TPWD, #PWD LF N&100-241 (10/93)

Supplemental Forage Management for East Texas White-tailed Deer by B. J. Higginbotham and J. C. Kroll, TAEX # L12457

Supplemental Feeding by J. R. Perkins, TPWD, #PWD-BK-N7100-033-11/91

Squirrel

Fox Squirrel Management in East Texas by B. G. Alexander, TPWD #PWD BK W7100-028 (10/94)

Quail:

Bobwhite Quail in Texas-Habitat Needs and Management Suggestions by A.S. Jackson, Clyde Holt, and Daniel Lay, TPWD, # PWD Brochure 7000-37 5/84

Bobwhite Facts & Fantasies by Horace Gore and Don Wilson, TPWD, #PWD LF (leaflet) C2000-063 (11/87).

The 182 page book "Beef, Brush and Bobwhites - Quail Management in Cattle Country" by Fred S. Guthery. Published by the Caesar Kleberg Wildlife Research Institute, Texas A&I University (now Texas A&M at Kingsville), Kingsville, Texas in 1986.

Dove:

Mourning Doves in Texas, Life History, Habitat Needs, and Management Suggestions by R. R. George, TPWD, #PWD-BK-7100-009A-3/88

Turkey:

The Eastern Wild Turkey in Texas by J. J. Campo and J. G. Dickson, TPWD, # PWD-BR-71---137B-2/90

Rio Grande Turkey Habitat Management by G. W. Litton and F. Harwell, TPWD, # PWD RP W7100-263 (10/95)

Feral Hog:

The Feral Hog in Texas by R. Taylor, TPWD, #PWD-BK-7100-195-10/91

Purple Martin:

The Purple Martin and Its Management in Texas by J. D. Ray, TPWD, # PWD BK W7100-254 (04/95)

Endangered Species

Endangered and Threatened Animals of Texas - Their Life History and Management by Linda Campbell,

Other Nongame:

Cantle P.C.1978. Avian population densities and species diversity on reclaimed strip-mined land in east-central Texas. M.S. Thesis , Texas A&M University. College Station. 131 pp.

Faanes, C.A. 1987. Bird behavior and mortality in relation to power lines in prairie habitats. U.S. Fish and Wildl. Serv. Tech. Rep. 7. 31pp.).

Mitchnick, A.D. 1979. Avian populations of urban woodlands: comparisons, habitat requirements, and management implications. M.S. Thesis, Texas A&M Univ., College Station. 120pp.;

Mitchnick, A.D., and R.D. Slack. 1979. Comparison and management of avian populations of urban woodlands. Am. Ornithol. Union 97:51

Owens, L.K. 1989. Avian use of fencerow habitat in a predominantly agricultural area. Ph.D. Thesis, Texas A&M Univ., College Station. 157pp

Senzota, R.B. M. 1985. Effects of prescribed burning on a small mammal community in Post Oak Savannah, Texas. Ph.D. Thesis, Texas A&M Univ., College Station. 105pp.

Texas Wildscapes Program. Texas Parks and Wildlife Department, 4200 Smith School Road, Austin, Texas, 78744.

Appendix U

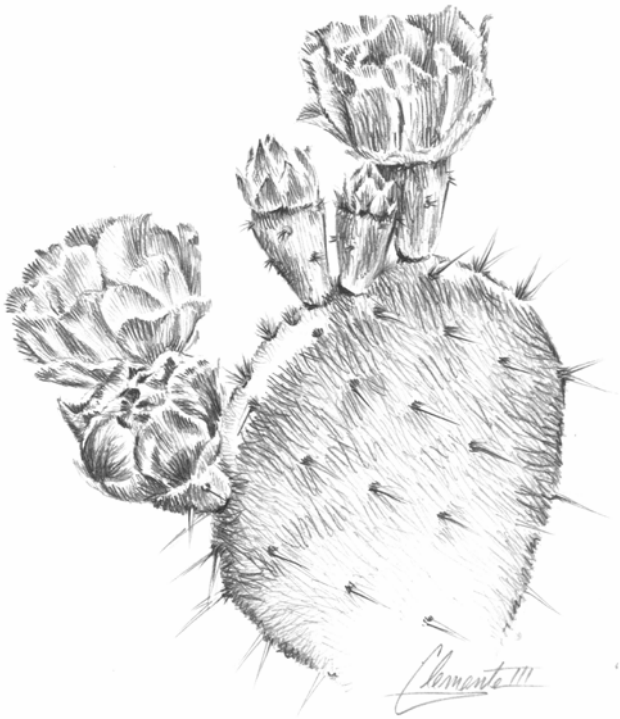
FORMS

Forms contained in this appendix include:

PWD 153-7100-10/03: Landowner Request for Technical Assistance. Landowners desiring technical assistance from Texas Parks and Wildlife Department should fill in this form and mail it to their local biologist.

PWD 885-W7000: 1-d-1 Open Space Agricultural Valuation Wildlife Management Plan. Landowners wishing to manage their property for wildlife as their agricultural practice must fill in and attach this form to their **1-d-1 Open Space Agricultural Valuation Application** form that is available from the county Central Appraisal District. *Do not return this form to Texas Parks and Wildlife Department.*

PWD 885-W7000: 1-d-1 Open Space Agricultural Valuation Annual Reporting Form. This form is not automatically required. For counties requesting a landowner report on wildlife management activities, this form will be provided to the landowner by the Chief Appraiser. *Do not return this form to Texas Parks and Wildlife Department.*



LANDOWNER REQUEST FOR TECHNICAL GUIDANCE

1. I hereby request technical assistance of the Texas Parks and Wildlife Department, Wildlife Division field staff, in my efforts to enhance habitat and manage wildlife populations on lands under my control.

2. Permission is granted to the Texas Parks and Wildlife Department, Wildlife Division field staff, to enter upon these lands and conduct, at a mutually agreeable time, wildlife and habitat inventories which may include the use of ground vehicles, aircraft, or nighttime spotlight counts to gather data necessary for the development of management recommendations.

Section 12.0251 of the Parks and Wildlife Code provides that information collected in response to a landowner request for technical guidance on private land relating to the specific location, species identification or quantity of any animal or plant life is confidential and may not be disclosed. The Department may release game census, harvest, habitat or program information if the information is summarized in a manner that prevents the identification of an individual or specific parcel of land and the landowner.

3. I understand that recommendations will be provided to me in the form of oral and/or written guidelines, which are non-binding and voluntary on my part. By my signature, I certify that I am the owner of the below-described property or that I have been specifically authorized by the landowner to act as their agent in this matter.

Signed:_____
Landowner or Authorized Agent Date

Name of Property:_____

County:_____Acres:_____

City, State, Zip:_____

Phone Number(s):

Home:_____Office:_____Other_____

Title V Compliance: The Texas Parks and Wildlife Department provides this service to land managers without discrimination in respect to race, color, national origin, age or handicap.

Texas Parks and Wildlife Department maintains the information collected through this form. With few exceptions, you are entitled to be informed about the information we collect. Under Sections 552.021 and 553.023 of the Texas Government Code, you are also entitled to receive and review the information. Under Section 559.004, you are also entitled to have this information corrected. For assistance call 512-389-4959.

PWD 153-W7000 (10/03)

Form PWD 885-W7000
1-D-1 Open Space Agricultural Valuation
Wildlife Management Plan

Instructions

This form is intended for use by landowners wishing to manage for wildlife under the 1-d-1 Open Space Agricultural Valuation. In order to be eligible, the property must already have a 1-d-1 Open Space Agricultural Valuation.

This form is intended to accompany the 1-d-1 Open Space Agricultural Valuation Form that can be obtained from your county Central Appraisal District.

Submit all completed applications to your county Central Appraisal District between January 1 and May 1 of each tax year. For further assistance with this form, contact your local office of Texas Parks and Wildlife Department.

DO NOT SUBMIT THIS FORM TO TEXAS PARKS AND WILDLIFE DEPARTMENT. Any forms received by Texas Parks and Wildlife Department will be returned.

1-D-1 Open Space Agricultural Valuation
Wildlife Management Plan for the Year (s)____

Submit this plan to your County Tax Appraiser, not to Texas Parks and Wildlife

Part I. Owner Information **Account Number:** _____

Owner's Name: _____

Current mailing address: _____

City, town, post office, state and zip code: _____

Phone number: _____

Tract Name: _____ Majority County: _____

Additional Counties (if any): _____

Part II. P Property Description

Legal Description of Property:

Location of Property (distance and direction from nearest town; specify highway/road numbers):

Is Acreage under high fence: ☐ Yes ☐ No ☐ Partial: (Describe) _____

Total Acreage: _____ Ecoregion _____

Habitat Types and Amounts of Acres: *(refer to Comprehensive Wildlife Management Planning Guidelines)*

☐ Cropland	_____	☐ Bottomland/Riparian		☐ wetlands	_____
☐ Non-native Pasture	_____	☐ Native Pasture/Grassland		☐ timberlands	_____
☐ Native Range/Brush	_____	☐ Other (describe)	_____		

III. Species targeted for management. (List all that apply. Attach additional page(s) if needed)

☐ Deer ☐ turkey ☐ quail ☐ songbirds ☐ waterfowl ☐ doves ☐ bats

☐ Neotropical songbirds (List) _____

☐ Reptiles (list) _____ ☐ Amphibians (list) _____

☐ Small mammals (list) _____ ☐ Insects (list) _____

☐ Identified species of concern (List) _____

☐ Other (List) _____

Part IV. Management Plan Goals and Objectives

Describe the wildlife management ***goals*** (*what you want the property to look like, or want to be able to do with it*) and ***objectives*** (*how you intend to achieve these goals)* for this piece of property. You may use an additional page if needed. (Note: This space will expand as you type.)

Part V. Qualifying Wildlife Management Activities

Check the wildlife management practices to be implemented on the property during the coming year that will support and achieve your management goals. A minimum of three practices is required.

- ☐ Habitat control
- ☐ Erosion control
- ☐ Predator control
- ☐ Making census counts to determine population.
- ☐ Provide supplemental supplies of water
- ☐ Provide supplemental supplies of food
- ☐ Provide shelters

Part VI. White tail Deer and Mule Deer Population Management

Is hunting to be a part of this wildlife management plan? ☐ Yes ☐ No

If YES, type of hunting: ☐ Lease hunting ☐ Family/guests only ☐ Both

List deer harvest for past three seasons:

Year: _____ Bucks: _____ Does: _____

Year: _____ Bucks: _____ Does: _____

Year: _____ Bucks: _____ Does: _____

Population Management Goals:

Target Density for Pre-season Deer Population (fall density) _____

Target Sex Ratio (does/buck): _____

Target Production (fawns/doe): _____

Other (may be age, weight, antler measurements, browse conditions, etc.

_____

Deer Harvest Strategy (numbers, types of deer to be harvested to achieve goals):

_____

Part VII. Wildlife Management Association Membership

Are you a member of a wildlife management association (co-op)? ☐ Yes ☐ No

Are you a member of a wildlife property association? ☐ Yes ☐ No

Name of wildlife property co-op/association, if YES is checked. _____

Part VIII. Wildlife Management Activities

Check the activities you intend to implement during the year to support each of the wildlife management activities listed in Part V.

1. HABITAT CONTROL

☐ *Grazing management*. Check grazing system being utilized.

☐ 1 herd/3pasture ☐ 1 herd/4 pasture ☐ 1 herd/multiple pasture

☐ High intensity/low frequency (HILF) ☐ Short duration system

☐ Other type of grazing system (describe)

_____

☐ *Prescribed Burning*

Acres to be burned: _____ Planned burn date: _____

☐ *Range Enhancement (Range Reseeding)*

Acres to be seeded: Date to be seeded:

Seeding Method: ☐ Broadcast ☐ Drilled ☐ Native Hay

Seeding mixture to be used:

Fertilized: ☐ Yes ☐ No

Weed control needed for establishment? ☐ Yes ☐ No

☐ *Brush Management*. Acres to be treated: _____ Check method of brush management:

☐ Mechanical

☐ grubber ☐ chain ☐ roller chopper/aerator ☐ rhome disc

☐ brush hog (shredder) ☐ dozer ☐ hand-cutting (chainsaw)

☐ hydraulic shears ☐ other (describe): _____

☐ Chemical Kind: _____ Rate: _____

☐ Brush management design:

☐ block ☐ mosaic ☐ strips: width: _____ Length: _____

☐ *Fence Modification*

Target species: ☐ pronghorn antelope ☐ bighorn sheep

Technique: ☐ fold up bottom of net-wire Gap width: _____

☐ replace sections of net-wire with barbed wire. Gap width: _____

Miles of fencing that will be modified: _____

☐ replace entire net-wire fence with barbed wire. Miles replaced: _____

☐ *Riparian management and enhancement*

☐ Fencing of riparian area

☐ Complete fencing ☐ Partial fencing

☐ Deferment from livestock grazing

☐ Complete deferment ☐ partial deferment Season deferred : _____

☐ Establish vegetation

☐ Trees (list species) _____

☐ Shrubs (list species) _____

☐ Herbaceous species (list) _____

☐ *Wetland enhancement*

☐ Provide seasonal water ☐ Provide permanent water ☐ Moist soil management

☐ Other (describe) _____

☐ *Habitat Protection for species of concern*

☐ Fencing ☐ Firebreaks ☐ Prescribed burning ☐ Control of nest parasites

☐ Habitat manipulation (thinning, etc.) ☐ Native/exotic ungulate control

☐ Other (describe) _____

☐ *Prescribed Control of Native, Exotic and Feral Species*

☐ Prescribed control of vegetation ☐ Prescribed control of animal species

☐ Species being controlled: _____

☐ Method of control: _____

☐ *Wildlife Restoration*

☐ Habitat restoration ☐ Wildlife restoration

☐ Target species: _____

☐ Method of restoration: _____

2. EROSION CONTROL

☐ *Pond construction and repair*

Surface area (acres): _____ Number of cubic yards of soil displaced: _____

Length of dam (feet): _____ Planned date of construction: _____

☐ *Gully shaping*

Total acres to be treated: _____ Acres treated annually: _____

Seeding mix used for reestablishment of vegetation: _____

Planned date of construction: _____

☐ *Streamside, pond, and wetland revegetation.* Techniques used:

☐ Native hay bales ☐ Fencing ☐ Filter strips ☐ Seeding upland buffer

☐ Rip-rap, etc. ☐ stream crossings ☐

Other: _____

Planned date of construction: _____

☐ *Herbaceous and/or woody plant establishment on critical areas (erodible)*

☐ Establish windbreak ☐ Establish shrub mottes ☐ Improve plant diversity

☐ Improve wildlife habitat ☐ Conservation/no-till practices ☐ Manage CRP cover

☐ *Dike/Levee Construction/Management*

☐ Reshaping/repairing erosion damage ☐ Revegetating/stabilize levee areas

☐ Install water control structure ☐ Fencing

☐ *Establish water diversion*

Type: ☐ Channel ☐ Ridge

Slope: ☐ level ☐ graded Length (feet) _____

Vegetated: ☐ No ☐ YES

If YES: ☐ Native: _____ ☐Crop: _____

3. PREDATOR CONTROL

☐ Imported red fire ants ☐ Control of cowbirds ☐ Grackle/starling/house sparrow control

Method of control: ☐ Trapping ☐ Shooting ☐ Baiting ☐ Scare tactics: _____

☐ Coyotes ☐ Feral hogs ☐ Raccoon ☐ Skunk ☐ Bobcat ☐ Mountain lion

☐ Rat snakes ☐ Feral cats/dogs

Method of control: ☐ Trapping ☐ Shooting ☐ M-44 (licensed applicators)

☐ Poison collars (1080 certified, licensed, applicator) ☐ Other _____

4. SUPPLEMENTAL WATER

☐ *Marsh/Wetland Restoration or Development*

☐ Greentree reservoirs ☐ Shallow roost pond development ☐ Seasonally flooded crops

☐ Artificially created wetlands ☐ Marsh restoration/development/protection

☐ Prairie pothole restoration/development/protection ☐ Moist soil management units

Planned date of construction: _____

☐ *Well/trough/windmill overflow/other wildlife watering facilities*

☐ Drill new well Depth: _____ Gallons per minute: _____

☐ Windmill ☐ Pump ☐ Pipeline: Size _____ Length: _____

☐ Modification(s) of existing water source

☐ Fencing ☐ Overflow ☐ Trough modification ☐ Pipeline

Distance between water sources (waterers): _____

Type of wildlife watering facility

☐ PVC pipe facility # _____ ☐ Drum with faucet or float # _____

☐ Small game guzzler # _____ ☐ Windmill supply pipe dripper # _____

☐ Plastic container # _____ ☐ In-ground bowl trough # _____

☐ Big game guzzler # _____ ☐ Inverted umbrella guzzler # _____

☐ Flying saucer guzzler # _____ ☐ Ranch Specialties guzzler # _____

☐ Other: _____

☐ *Spring development and/or enhancement*

☐ Fencing ☐ Water diversion/pipeline ☐ Brush removal ☐ Spring clean out

☐ Other: _____

5. PROVIDING SUPPLEMENTAL FOOD

☐ Grazing management ☐ Prescribed burning ☐ Range enhancement

☐ Food plots Size: _____ Fenced: ☐ Yes ☐ No

Irrigated: ☐ Yes ☐ No

Plantings: ☐ Cool season annual crops: _____

☐ Warm season annual crops: _____

☐ Annual mix of native plants: _____

☐ perennial mix of native plants: _____

☐ *Feeders and mineral supplementation*

Purpose: ☐ Supplementation ☐ Harvesting of wildlife

Targeted wildlife species: _____

Feed type: _____ Mineral type: _____

Feeder type: _____ Number of feeders: _____

Method of mineral dispensing: _____

Number of mineral locations: _____

Year round: ☐ Yes ☐ No If not, state when: _____

☐ *Managing tame pasture, old fields and croplands*

☐ Overseeding cool and/or warm season legumes and/or small grains

☐ Periodic disturbance (Discing/Mowing/Shredding) ☐ Conservation/no-till

☐ *Transition management of tame grass monocultures*

☐ Overseed 25% of tame grass pastures with locally adapted legumes

Species planted: ☐ Clover ☐ Peas ☐ Vetch ☐ Other: _____

6. PROVIDING SUPPLEMENTAL SHELTER

☐ *Nest boxes* Target Species: _____

☐ Cavity type. # _____ ☐ Bat boxes. # _____ ☐ Raptor pole. # _____

☐ *Brush piles and slash retention*

☐ Type: ☐ Slash ☐ Brush piles Number per acre: _____

☐ *Fence line management* Length: _____ Initial establishment: ☐ Yes ☐ No

Plant type established: ☐ Trees ☐ Shrubs ☐ Forbs ☐ Grasses

☐ *Hay meadow, pasture and cropland management for wildlife* Acres treated: _____

Shelter establishment: ☐ Roadside management ☐ Terrace/wind breaks ☐ Field borders

☐ shelterbelts ☐ Conservation Reserve Program lands management

Type of vegetation: ☐ Annual ☐ Perennial

Species and percent of mixture _____

☐ Deferred mowing Period of deferment: _____

☐ Mowing Acres mowed annually: _____

☐ No till/minimum till

☐ *Half-cutting trees or shrubs*

Acreage to be treated annually: _____ Number of half-cuts annually: _____

☐ *Woody plant/shrub establishment*

Pattern: ☐ Block ☐ Mosaic ☐ Strips: Width: _____

Acreage or length established annually: _____ Spacing: _____

Shrub/tree species used: _____

☐ *Natural cavity/snag development*

Species of snag _____ Size of snags: _____ Number/acre _____

7. CENSUS

☐ *Spotlight counts* Targeted species: _____

Length of route: _____ Visibility of route _____

Dates (3 required) A. _____ B. _____ C. _____

☐ *Standardized incidental observations* Targeted species: _____

Observations from: ☐ Feeders ☐ Food plots ☐ Blinds ☐ Vehicle ☐ Other _____

Dates: _____

☐ *Stand counts of deer* (5 one hour counts per stand required). Number of stands: _____

Dates: _____

☐ *Aerial Counts* Species counted: _____

Type of survey: ☐ Helicopter ☐ Fixed-wing

Percent of area surveyed: ☐ Total ☐ 50% ☐ Other: _____

☐ *Track counts:* ☐ Predators ☐ Furbearers ☐ Deer ☐ Other: _____

☐ *Daylight deer herd/wildlife composition counts*

Species: ☐ Deer ☐ Turkey ☐ Dove ☐ Quail ☐ Other _____

☐ *Harvest data collection/record keeping*: ☐ Deer ☐ Game birds

☐ Age ☐ Weight ☐ Sex ☐ Antler data ☐ Harvest date

☐ *Browse utilization surveys* (thirty 12 foot circular plots required)

☐ *Census of endangered, threatened, or protected wildlife.* Species: _____

Method and dates: _____

☐ *Census and monitoring of nongame wildlife species.* Species: _____

Method and dates: _____

☐ *Miscellaneous Counts:* Species being counted: _____

☐ Remote detection (i.e. cameras) ☐ Hahn (walking) line ☐ Roost counts

☐ Booming ground counts ☐ Time/area counts ☐ Songbird transects and counts

☐ Quail call and covey counts ☐ Point counts ☐ Small mammal traps

☐ Drift fences and pitfall traps ☐ Bat departures ☐ Dove call counts

☐ Chachalaca counts ☐ Turkey hen/poult counts ☐ Waterfowl/water bird counts

☐ Alligator nest/census counts ☐ Other: _____

IX. Additional Supporting Information. (Optional)

Attach any other supporting information, such as maps or photographs that you believe to be relevant to this wildlife management plan.

I certify that the above information provided by me in this application is to the best of my knowledge and belief, true and complete.

_____ _____

Landowner Signature Date

This area for use only if the wildlife management plan was prepared for the above landowner for a fee by a wildlife professional or consultant. *

_____ _____

Signature of person preparing wildlife management plan. Date

_____ _____

Company Phone Number

_____

*Signature by TPW not required for this plan to be valid.

Texas Parks and Wildlife does not maintain the information collected through this form. This completed form is only provided to the County Tax Appraiser. Please inquire with your County Central Appraisal District on any local laws concerning any information collected through this form.

Form PWD 888-W7000
1-D-1 Open Space Agricultural Valuation Annual Reporting Form

Instructions

This form is intended for distribution by the Chief Appraiser of each county to assist landowners in reporting work done towards fulfillment of the requirements for wildlife management under the 1-d-1 Open Space Agricultural Valuation.

At the discretion of the County desiring such a report, this form is intended to report on activities and practices undertaken by a landowner for no less than one year, and for no more than five years.

Submit all completed report forms to your county Central Appraisal District. For further assistance with this form, contact your local office of Texas Parks and Wildlife Department.

DO NOT SUBMIT THIS FORM TO TEXAS PARKS AND WILDLIFE DEPARTMENT. Any forms received by Texas Parks and Wildlife Department will be returned.

1-D-1 Open Space Agricultural Valuation
Wildlife Management Annual Report for the Years)____

Submit this plan to your County Tax Appraiser, not to Texas Parks and Wildlife

Part I. Owner Information **Account Number:** _____

Owner's Name: _____

Current mailing address: _____

City, town, post office, state and zip code: _____

Phone number: _____

Tract Name: _____ Majority County: _____

Additional Counties (if any): _____

Part II. Qualifying Wildlife Management Activities

Check the wildlife management practices implemented on the property during the year being reported. A minimum of three practices is required.

☐ Habitat control

☐ Erosion control

☐ Predator control

☐ Making census counts to determine population.

☐ Provide supplemental supplies of water

☐ Provide supplemental supplies of food

☐ Provide shelters

Part III. Wildlife Management Association Membership

Are you a member of a wildlife property association? ☐ Yes ☐ No

Name of wildlife property co-op/association, if YES is checked. _____

Part IV. Wildlife Management Activities

Check the activities you have implemented during the year to support each of the wildlife management activities listed in Part II.

1. HABITAT CONTROL

☐ *Grazing management*. Check grazing system being utilized.

☐ 1 herd/3pasture ☐ 1 herd/4 pasture ☐ 1 herd/multiple pasture
☐ High intensity/low frequency (HILF) ☐ Short duration system
☐ Other type of grazing system (describe)

_____

☐ *Prescribed Burning*
Acres to be burned: _____ Planned burn date: _____

☐ *Range Enhancement (Range Reseeding)*

Acres to be seeded: _____ Date to be seeded: _____
Seeding Method: ☐ Broadcast ☐ Drilled ☐ Native Hay
Seeding mixture to be used: _____
Fertilized: ☐ Yes ☐ No
Weed control needed for establishment? ☐ Yes ☐ No

☐ *Brush Management*. Acres to be treated: _____ Check method of brush management:
☐ Mechanical
☐ grubber ☐ chain ☐ roller chopper/aerator ☐ rhome disc
☐ brush hog (shredder) ☐ dozer ☐ hand-cutting (chainsaw)
☐ hydraulic shears ☐ other (describe): _____
☐ Chemical Kind: _____ Rate: _____
☐ Brush management design:
☐ block ☐ mosaic ☐ strips: width: _____ Length: _____

☐ *Fence Modification*
Target species: ☐ pronghorn antelope ☐ bighorn sheep
Technique: ☐ fold up bottom of net-wire Gap width: _____
☐ replace sections of net-wire with barbed wire. Gap width: _____
Miles of fencing that will be modified: _____
☐ replace entire net-wire fence with barbed wire. Miles replaced: _____

☐ *Riparian management and enhancement*

☐ Fencing of riparian area

☐ Complete fencing ☐ Partial fencing

☐ Deferment from livestock grazing

☐ Complete deferment ☐ partial deferment Season deferred : _____

☐ Establish vegetation

☐ Trees (list species) _____

☐ Shrubs (list species) _____

☐ Herbaceous species (list) _____

☐ *Wetland enhancement*

☐ Provide seasonal water ☐ Provide permanent water ☐ Moist soil management

☐ Other (describe) _____

☐ *Habitat Protection for species of concern*

☐ Fencing ☐ Firebreaks ☐ Prescribed burning ☐ Control of nest parasites

☐ Habitat manipulation (thinning, etc.) ☐ Native/exotic ungulate control

☐ Other (describe) _____

☐ *Prescribed Control of Native, Exotic and Feral Species*

☐ Prescribed control of vegetation ☐ Prescribed control of animal species

☐ Species being controlled: _____

☐ Method of control: _____

☐ *Wildlife Restoration*

☐ Habitat restoration ☐ Wildlife restoration

☐ Target species: _____

☐ Method of restoration: _____

2. EROSION CONTROL

☐ *Pond construction and repair*

Surface area (acres): _____

Length of dam (feet): _____

☐ *Gully shaping*

Total acres to be treated: _____ Acres treated annually: _____

Seeding mix used for reestablishment of vegetation: _____

Planned date of construction: _____

☐ *Streamside, pond, and wetland revegetation.* Techniques used:

☐ Native hay bales ☐ Fencing ☐ Filter strips ☐ Seeding upland buffer

☐ Rip-rap, etc. ☐ stream crossings ☐ Other: _____

Planned date of construction: _____

☐ *Herbaceous and/or woody plant establishment on critical areas (erodible)*

☐ Establish windbreak ☐ Establish shrub mottes ☐ Improve plant diversity

☐ Improve wildlife habitat ☐ Conservation/no-till practices ☐ Manage CRP cover

☐ *Dike/Levee Construction/Management*

☐ Reshaping/repairing erosion damage ☐ Revegetating/stabilize levee areas

☐ Install water control structure ☐ Fencing

☐ *Establish water diversion*

Type: ☐ Channel ☐ Ridge

Slope: ☐ level ☐ graded Length (feet) _____

Vegetated: ☐ No ☐ YES

If YES: ☐ Native: _____ ☐ Crop: _____

3. PREDATOR CONTROL

☐ Imported red fire ants ☐ Control of cowbirds ☐ Grackle/starling/house sparrow control

Method of control: ☐ Trapping ☐ Shooting ☐ Baiting ☐ Scare tactics: _____

☐ Coyotes ☐ Feral hogs ☐ Raccoon ☐ Skunk ☐ Bobcat ☐ Mountain lion

☐ Rat snakes ☐ Feral cats/dogs

Method of control: ☐ Trapping ☐ Shooting ☐ M-44 (licensed applicators)

☐ Poison collars (1080 certified, licensed, applicator) ☐ Other _____

4. SUPPLEMENTAL WATER

☐ *Marsh/Wetland Restoration or Development*

☐ Greentree reservoirs ☐ Shallow roost pond development

☐ Seasonally flooded crops

☐ Artificially created wetlands ☐ Marsh restoration/development/protection

☐ Prairie pothole restoration/development/protection ☐ Moist soil management units

Planned date of construction: _____

☐ *Well/trough/windmill overflow/other wildlife watering facilities*

☐ Drill new well Depth: _____ Gallons per minute: _____

☐ Windmill ☐ Pump ☐ Pipeline: Size: _____ Length: _____

☐ Modification(s) of existing water source

☐ Fencing ☐ Overflow ☐ Trough modification ☐ Pipeline

Distance between water sources (waterers): _____

Type of wildlife watering facility:

☐ PVC pipe facility	# _____	☐ Drum with faucet or float	# _____
☐ Small game guzzler	# _____	☐ Windmill supply pipe dripper	# _____
☐ Plastic container	# _____	☐ In-ground bowl trough	# _____
☐ Big game guzzler	# _____	☐ Inverted umbrella guzzler	# _____
☐ Flying saucer guzzler	# _____	☐ Ranch Specialties guzzler	# _____

☐ Other: _____

☐ *Spring development and/or enhancement*

☐ Fencing ☐ Water diversion/pipeline ☐ Brush removal ☐ Spring clean out

☐ Other: _____

5. PROVIDING SUPPLEMENTAL FOOD

☐ Grazing management ☐ Prescribed burning ☐ Range enhancement

☐ Food plots Size: _____ Fenced: ☐ Yes ☐ No

Irrigated: ☐ Yes ☐ No

Plantings: ☐ Cool season annual crops: _____

☐ Warm season annual crops: _____

☐ Annual mix of native plants: _____

☐ perennial mix of native plants: _____

☐ *Feeders and mineral supplementation*

Purpose: ☐ Supplementation ☐ Harvesting of wildlife

Targeted wildlife species: _____

Feed type: _____ Mineral type: _____

Feeder type: _____ Number of feeders: _____

Method of mineral dispensing: _____

Number of mineral locations: _____

Year round: ☐ Yes ☐ No If not, state when:

☐ *Transition management of tame grass monocultures*

☐ Overseed 25% of tame grass pastures with locally adapted legumes

Species planted: ☐ Clover ☐ Peas ☐ Vetch ☐ Other: _____

6. PROVIDING SUPPLEMENTAL SHELTER

☐ *Nest boxes* Target Species: _____

☐ Cavity type. # _____ ☐ Bat boxes. # _____ ☐ Raptor pole. # _____

☐ *Brush piles and slash retention*

☐ Type: ☐ Slash ☐ Brush piles Number per acre: _____

☐ *Fence line management* Length: _____ Initial establishment: ☐ Yes ☐ No

Plant type established: ☐ Trees ☐ Shrubs ☐ Forbs ☐ Grasses

☐ *Hay meadow, pasture and cropland management for wildlife* Acres treated: _____

Shelter establishment:

☐ Roadside management ☐ Terrace/wind breaks ☐ Field borders

☐ shelterbelts ☐ Conservation Reserve Program lands management

Type of vegetation: ☐ Annual ☐ Perennial

Species and percent of mixture _____

☐ Deferred mowing Period of deferment: _____

☐ Mowing Acres mowed annually: _____

☐ No till/minimum till

☐ *Half-cutting trees or shrubs*

Acreage to be treated annually: _____ Number of half-cuts annually: _____

☐ *Woody plant/shrub establishment*

Pattern: ☐ Block ☐ Mosaic ☐ Strips: Width: _____

Acreage or length established annually: _____ Spacing: _____

Shrub/tree species used: _____

☐ *Natural cavity/snag development*

Species of snag _____ Size of snags: _____ Number/acre _____

7. CENSUS

☐ *Spotlight counts* Targeted species: _____

Length of route: _____ Visibility of route _____

Dates (3 required) A. _____ B. _____ C. _____

☐ *Standardized incidental observations* Targeted species: _____

Observations from: ☐ Feeders ☐ Food plots ☐ Blinds ☐ Vehicle ☐ Other _____

Dates: _____

☐ *Stand counts of deer* (5 one hour counts per stand required). Number of stands: _____

Dates: _____

☐ *Aerial Counts* Species counted: _____

Type of survey: ☐ Helicopter ☐ Fixed-wing

Percent of area surveyed: ☐ Total ☐ 50% ☐ Other: _____

☐ *Track counts:* ☐ Predators ☐ Furbearers ☐ Deer ☐ Other: _____

☐ *Daylight deer herd/wildlife composition counts*

Species: ☐ Deer ☐ Turkey ☐ Dove ☐ Quail ☐ Other _____

☐ *Harvest data collection/record keeping*: ☐ Deer ☐ Game birds

☐ Age ☐ Weight ☐ Sex ☐ Antler data ☐ Harvest date

☐ *Browse utilization surveys* (thirty 12 foot circular plots required)

☐ *Census of endangered, threatened, or protected wildlife.* Species: _____

Method and dates: _____

☐ *Census and monitoring of nongame wildlife species.* Species: _____

Method and dates: _____

☐ *Miscellaneous Counts:* Species being counted: _____

☐ Remote detection (i.e. cameras) ☐ Hahn (walking) line ☐ Roost counts

☐ Booming ground counts ☐ Time/area counts ☐ Songbird transects and counts

☐ Quail call and covey counts ☐ Point counts ☐ Small mammal traps

☐ Drift fences and pitfall traps ☐ Bat departures ☐ Dove call counts

☐ Chachalaca counts ☐ Turkey hen/poult counts ☐ Waterfowl/water bird counts

☐ Alligator nest/census counts ☐ Other: _____

Part V. Attach copies of supporting documentation such as receipts, maps, photos, etc. Use additional pages if necessary.

I certify that the above information provided by me is to the best of my knowledge and belief true and complete.

_____ _____

Signature Date

Texas Parks and Wildlife does not maintain the information collected through this form. This completed form is only provided to the County Tax Appraiser. Please inquire with your County Central Appraisal District on any local laws concerning any information collected through this form.

Appendix V

Palatability Rating of Browse Species for Deer of Eastern Texas

First Choice (Preferred)

St. Peterswort
American cyrilla
White ash
Honeylocust
Georgia holly
Japanese honeysuckle
Sassafras
American snowbell
Alabama supplejack
Brook euonymus, strawberry bush
Carolina jessamine
St. Johnswort
Virginia sweetspire
Blackberry
Greenbrier
Kentucky viburnum

Second Choice (Moderately Preferred)

Red maple
Chokeberry
Azalea
American berry
White fringetree
Roughleaf dogwood
Largeleaf gallberry
Sweetbay magnolia
Red mulberry
Virginia creeper
Flatwoods plum
Water oak
Smooth sumac
Common sweetleaf
Poisonoak
Mapleleaf viburnum
Blackhaw viburnum
Muscadine
Peppervine
Common pawpaw
Crossvine
Buttonbush
Flowering dogwood
Hawthorn
Deciduous holly
Partridgeberry
Black tupelo
Redbay persea
White oak
Willow oak
Black willow
Poison sumac
Elm
Possumhaw viburnum
Rusty blackhaw
Yaupon

Third Choice (Least Preferred)

American hornbeam
Florida chinkapin
Common persimmon
Twowing silverbell
American holly
American sweetgum
Southern magnolia
American hophornbeam
Loblolly Pine
Black cherry
Southern red oak
Blackjack oak
Dwarf greenbrier
Blueberry
Hickory
Eastern redbud
American beech
Common witchhazel
Eastern redcedar
He-huckleberry
Southern waxmyrtle
Shortleaf pine
Carolina laurelcherry
Bluejack oak
Post oak
Flameleaf sumac
Mexican buckeye
Carolina buckthorn

Appendix W

SUNFLOWERS FOR WILDLIFE IN THE CROSS TIMBERS

by

Jim Dillard, Technical Guidance Biologist, Texas Parks & Wildlife Department, Mineral Wells

North Texas is home of two native species of sunflowers that have important value to wildlife. Where they occur, these members of the Daisy Family Compositae provide cover and food for a wide variety of wildlife species. Although there are many plant species in this large family that also provide important food and cover sources for wildlife, management of the **annual sunflower** and **Maximilian sunflower** in the **Cross Timbers & Prairies Region of Texas** offers landowners the opportunity to economically produce and sustain these plants on an annual basis to benefit wildlife. These true sunflower species of the genus *Helianthus* are adapted to the rainfall, climatic extremes and varieties of soils found in the Cross Timbers and Prairies Region, making establishment and maintenance of these two plants a natural choice for many landowners. These species can be grown and managed on small or large tracts of land.

Native annual sunflowers are commonly found along roadside ditches and field borders, in cultivated fields and on other disturbed soil sites primarily in the western 2/3 of Texas and from Canada to Mexico. Often considered a nuisance weed in farming country and on rangelands, their overall value to wildlife is significantly beneficial. The myriad of insects found on sunflowers provide food for insectivorous species such as neotropical and native songbirds, bobwhite quail, and Rio Grande turkeys. Their high oil content also provides birds an excellent source of energy for body maintenance. Dense stands provide overhead screening cover for ground dwelling wildlife species. The late summer and early fall blooming **Maximilian sunflower** has value as a forage plant for livestock and deer and is a source of cover and seeds for many songbirds and small mammals. Both species can be propagated from seed or managed as naturally occurring plants on the landscape. The following information is provided for landowners who have an interest in producing or managing these sunflowers species or enhancing habitat for wildlife in the **Cross Timbers & Prairies Region of North Texas.**

ANNUAL SUNFLOWERS

Annual sunflower (*Helianthus annuus*) is a native, warm season, tap-rooted annual forb that was used and domesticated by pre-Columbian Indians of Central North America around 1000 B.C. and spread eastward. In 1510 the Spaniards encountered it along the Atlantic coastal areas and carried seeds back to Europe where they were grown in gardens or as curiosities. Sometime before 1800 it reached Russia where it was raised for food and later, through

selective breeding, the giant one-headed, large-seeded plants were developed. Subsequent breeding has produced a number of varieties with high oil content for commercial crop production. In 1991, 2.7 million acres were grown in the U.S. with 85% being oilseed varieties and the rest used for confectionery purposes. Sunflower seeds used as a snack food has increased in recent years.

Native annual sunflowers reproduce by seeds only and grow to variable heights from 1-14 feet, depending on soil moisture. Their leaves are sticky, dark green, and alternately arranged on the stalk. Shapes range from broad and ovate or almost triangular with rough hairs or bristles and toothed margins. The 1-5 inch flower heads have 20-25 1-2 inch long bright yellow rays that surround the central brown or reddish brown disk flowers where seeds are produced. Multiple seed heads grow from rough, branching stems. Seeds are 1/8 to1/4 inches long, ovate to wedge-shaped, slightly four-angled and flattened. Color ranges from gray to dark brown with light stripes or spots. There are approximately 350,000 seeds per pound. Seeds may remain viable in the soil for many years until conditions are optimum for germination. Dormancy of native annual sunflower seeds is influenced by their depth in the soil, soil moisture, cold winter temperatures and their high resin content. Native annual sunflowers have a chemical inhibitor called auxin that is on the caropisis (meat) of the seed that must be broken down by cool temperatures and adequate moisture. This ability to remain dormant often results in growths of annual sunflowers in areas where soil disturbance have occurred and no seeds were planted. Native annual sunflowers are very drought tolerant.

GROWING NATIVE ANNUAL SUNFLOWERS

Initial plantings of **native annual sunflowers** should be conducted during the **fall** or **early winter** in a well prepared seedbed for growth during the following spring and summer. Plant at the rate of **3-5 pounds per acre** for pure stands and at a **depth of 1 inch or less** using a seed drill. Native annual sunflower seeds may also be planted along with winter wheat, oats, rye or other small grains in a mix. Sunflowers will begin to germinate as these cool season small grains mature and die back during late spring and early summer. In subsequent years where a stand of sunflowers has been established, lightly plow or disk between October and January for the next year's growth. If winter small grains are to be planted during the fall or early winter where sunflowers are established, no additional sunflowers seed should be added and the cultivation associated with these plantings will also replant existing native annual sunflower seeds. Grazing small grain plantings by cattle will also help incorporate sunflower seeds into the soil. Native annual sunflowers planted during the spring will germinate at the rate of only about 2% to 5% but may germinate the following year if conditions are right. Check for locally available seed sources well in advance to determine seasonal availability and price. Be sure you ask for "native annual sunflowers". Annual sunflowers are not a preferred forage plant for cattle or white-tailed deer.

Many old fields or croplands taken out of crop production contain a diverse seed bank in the soil including annual native sunflowers. Disking or other soil disturbance operations

in such areas during late fall and winter often results in vigorous growth of annual sunflowers the following spring and summer. Fallow winter disking is the most economical method for growing native annual sunflowers and many other native annual seed producing plants used by wildlife.

HYBRID BLACK OILSEED SUNFLOWERS

Hybrid black oilseed sunflower is an improved variety of the native annual sunflower with a high oil content and grown primarily for its oil. This variety is also very nutritious for birds and provides a good source of energy. It is often used in bird feeders or mixed with other grains for feeding birds. Over 40 species of birds are know to eat black oilseed sunflowers. Hybrid black oilseed sunflowers may be planted during the **spring** at the rate of **3-5 pounds per acre** but must be replanted annually. Growth is 3-4 ft. in height with a single seed head. For wildlife plantings, it is less preferred over annual native sunflowers and requires cultivation for good growth.

MAXIMILIAN SUNFLOWERS

Maximilian sunflower (*Helianthus maximiliani*) is a native, warm season rhizomatous perennial forb found in the eastern 2/3 of Texas. It also occurs from the plains and prairies of southern Canada to South Texas and eastward. It was named for Prince Maximilian of Wied Neuweid, a naturalist who made scientific explorations in North America from 1832-1834. Depending on moisture, it grows from 2 to 10 feet tall and reproduces from seeds and short underground stems. Stout and rough annual stems rise from the perennial root crown or woody root system during late winter or early spring, often growing in clusters from moist ditches or depressions in prairies or rangelands. Leaves are characteristically long (up to 10 inches), narrow and drooping with a rough surface texture and gray-green coloration. During dry conditions, leaves fold inward toward the center. The 3-4 inch yellow flowers appear in dense clusters along the upper half of the stem on short stalks during late summer from July through October, producing numerous four-angled achenes with flat seeds inside that are approximately 1/4 inches long.

Maximililan sunflowers spread and may form dense clusters that provide habitat for insects and cover for wildlife. Its seeds are a good food source for many songbirds and small mammals. They are grazed by livestock and white-tailed deer, particularly during the early growth stages and may disappear or be severely diminished with heavy grazing pressure or high deer numbers. The presence of Maximilian sunflowers on native rangeland is indicative of good range conditions and management. It benefits from rotation grazing systems where periods of rest from grazing prevents heavy use or total elimination of individual plants.

GROWING MAXIMILIAN SUNFLOWERS

Aztec Maximilian Sunflower is a variety released from the USDA Natural Resources Conservation Service's Knox City Plant Materials Center in 1978. It may be planted in **range seeding mixtures** during the spring at approximately **¼ to ½ pound per acre** to a depth of **3/8 to ½ inches**. It should be planted on a well prepared seed bed cultivated during the previous fall to reduce weed growth. It is adapted to a variety of soil types from sands to clays in areas receiving at least 18 inches of rainfall annually. Removal of the previous year's growth by late

winter mowing may increase production the following spring. Excessive grazing by livestock or deer may prevent establishment. **Pure stands** of Maximilian sunflowers planted in rows or strips benefit from light fertilization and should be planted at the rate of **1 pound per acre in 36 inch rows** or **drilled or broadcast at 3 pounds per acre**. On a smaller scale, individual plants may be hand dug during early spring and transplanted, being sure to include a sufficient amount of the root system. Remove old top growth from the previous year and water regularly until growth occurs.

Existing native Maximilian sunflowers plants may be heavily grazed by cattle with unrestricted access to growing young plants during the spring and summer months. Dense stands of this species is often found along roadside or other protected areas where fencing restricts grazing. Use of rotation grazing or fencing of areas containing Maximilian sunflowers to exclude cattle during the growing season may help promote this plant for seed production and cover. Late winter mowing of standing stems will also help stimulate regrowth during the spring.

WILDLIFE USE OF SUNFLOWERS

Mourning Doves Annual native sunflowers provide a major source of food for resident and migratory mourning doves throughout the Cross Timbers & Prairies Region. Large fields may attract concentrations of doves for short periods of time during the late summer and fall and provide excellent sport hunting opportunities. In small grain producing areas, timing of soil preparations for planting winter wheat has a significant impact on sunflower seed availability to migrating mourning doves. Cultivation of fields containing sunflowers during late August and September makes sunflower seed unavailable to doves and other seed eating wildlife species and may contributes to movement to other feeding areas. Delaying fall plowing until mid-October will greatly improve sunflower seed availability to doves. To facilitate access and feeding by mourning doves, strips should be mowed through sunflower fields during late summer to create openings and shatter mature seeds. Mowed strip widths may vary, depending on the size of the field, but generally should be twice the width of the unmowed strips (i.e. 200 ft. mowed X 100 ft. unmowed).

Bobwhite Quail Bobwhite quail eat native annual sunflower seed that shatter to the ground, providing a source of food over an extended period of time during the fall and winter months. Weed patches along fence lines, field borders, roadsides and other out areas containing stands of annual and Maximilian sunflowers provide important overhead screening cover and feeding security from predators. Young growing native annual and Maximilian sunflower plants also sustain populations of a variety of insects and other arthropods eaten by bobwhites and provide bugging area for quail chicks.

Songbirds and Small Mammals Both sunflower species provide seeds for a wide variety of seed-eating songbirds and small mammals. Some bird species will feed on the seed heads of mature standing annual and Maximilian sunflowers while other locate shattered seeds on the ground. Seed eating species such as sparrows (house, grasshopper, Harris, lark, Lincoln, savannah, tree, vesper, white-crowned and others),

house and gold finches, pine siskins, blackbirds, chickadees, nuthatches, titmouse, meadowlarks, grackles, buntings and others are know to eat native sunflower seeds. Small mammals including pocket gophers, ground squirrels, and other native rat and mouse species also eat the seeds, often stashing them in caches in their dens or burrows for later consumption.

White-tailed Deer White-tailed deer will eat the leaves of young Maximilian sunflower plants but tend to discontinue use as plants mature. Annual sunflowers are not a preferred forage plant for deer but they may consume young tender leaves and developing seed heads.

CONCLUSION

Growing or managing growth of annual native and Maximilian sunflowers contributes to the diversity of herbaceous vegetation on the land and provides seasonal food and cover for various wildlife species found in the **Cross Timbers & Prairies Region of Texas**. Whether planted and grown in food plots, added to cool season forage mixes, seeded on rangelands or stimulated from timely soil disturbance practices, these two naturally adapted native species should be considered in wildlife habitat enhancement projects. For additional information on growing sunflowers, contact Texas Parks and Wildlife Department, Natural Resources Conservation Service, Texas Agricultural Extension Service and local seed companies.

Texas Parks and Wildlife Department's Private Lands and Habitat Program has a staff of 10 regional technical guidance wildlife biologists and other district wildlife biologists who are available upon written request to help landowners develop management plans to address their long term goals and objectives for habitat enhancement and wildlife management. For more information, contact Texas Parks and Wildlife Department, 4200 Smith School Rd. Austin, TX 78744

Appendix X

The Post-Oak Savannah

Lying immediately west of the East Texas Piney Woods, the Post Oak Savannah emerges almost imperceptibly, marked by subtle changes in soils and vegetation. Occupying approximately 8,500,000 acres, the area's topography is gently rolling to hilly with elevations ranging from 300 to 800 feet, and rainfall averages from 35 to 45 inches per year from west to east. Annual average temperatures ranges from 65 F to 70 F. Soils of the Post Oak Savannah are interesting and complex. They are usually acidic, with sands and sandy loams occurring on the uplands, clay to clay loams on the bottomlands, with a dense clay pan underlying all soil types. Because of this peculiarity, the Post Oak Savannah is sometimes referred to as the "Clay Pan Savannah." Clay pan soils are nearly impervious to water and underlie the surface layers of soil at depths of only a few feet. As a consequence, the moisture available for plant growth is limited making the habitat surprisingly arid at times. One curious exception to the clay pan soils occurs in Bastrop County -- home of the renowned Lost Pines. The Carrizo sands, a sandy inclusion of moist soils, harbor a unique community of loblolly pine, post oak and blackjack oak and is also home to sphagnum bogs with ferns and carnivorous pitcher plants.

The Post Oak Savannah is punctuated by scattered oaks -- mainly post oaks, of course -- and blackjack oaks (Wasowski, 1988). Black hickory may also be locally abundant. Widespread trees of lesser importance include cedar elm, sugarberry, eastern red cedar and common persimmon. Other important species of the region are Southern red oak, sassafras, flowering dogwood, yaupon, and winged elm. Some authorities believe that this region was once predominantly a tall-grass prairie, but that trees, mostly oaks, and brushy shrubs proliferated with the suppression of fires and the conversion of the land to farming and grazing. When fires were frequent, the land was not as it appears today. Historically, wide vistas of tall-grasses -- little bluestem, Indiangrass, switchgrass and a myriad of wildflowers, broken only by the occasional motte of venerable "giants," lent a park-like atmosphere to the landscape. Peat bogs, like the ones found in the Piney Woods, are also found here, mingled amongst stands of flowering dogwood, sassafras, bumelia and yaupon.

Early European settlers were especially attracted to the Post Oak Savannah because it was clearly transitional between woodland and prairies (Wasowski, 1988). Today, the Post Oak Savannah is used largely for improved pasture, with vast acreages seeded to introduced grasses such as Bahia Grass or Bermuda Grass (Simpson, 1988).

Mostly prairie animals with some woodland species abound in the Post Oak Savannah region. The distinctive sandy inclusion of the Lost Pines area also harbors one of the last refuges for the endangered Houston Toad.

The Blackland Prairies

Taking their name from the fertile, dark clay soil, the Blackland Prairies constitute a true prairie ecosystem and have some of the richest, naturally fertile soils in the world. Characterized by gently rolling to nearly level topography, the land is well dissected and marked by rapid surface drainage. Pecan, cedar elm, various oaks, soapberry, honey locust, hackberry and Osage orange dot the landscape, with some mesquite invading from the south. A true tall-grass prairie, the dominant grass is little bluestem. Other important grasses include big bluestem, Indiangrass, eastern gammagrass, switchgrass and sideoats grama. While elevations from 300 to more than 800 feet match those of the Post Oak Savannah, the annual rainfall varies from 30 to 40 inches west to east, and the average annual temperatures range from approximately 66 F to 70 F. Described as "black velvet" when freshly plowed and moistened from a good rain, true blackland soils are deep, dark, calcareous deposits renowned for their high productivity (Wasowski, 1988). Scientists believe the richness of the prairie soils is derived from the abundant invertebrate fauna and fungal flora found in the soils themselves. The Blackland prairies are today almost entirely brought under the plow, with only 5,000 acres of the original 12 million remaining. For this reason, many authorities believe that the Blackland Prairies represent some of the rarest landscapes in Texas.

Like many of the prairie communities comprising the Great Plains of North America, the Blackland Prairies harbor few rare plants or animals. What is so special and unique about this ecosystem today, are the grassland communities themselves.

TEXAS WILDSCAPES NATIVE PLANT TABLES
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Texas WildScapes Plant List -- Post Oak Savannah

SPECIES	FAMILY	HABIT/ HEIGHT	FLOWER	FRUIT	SUN EXPOSURE	HABITAT	SOILS & MOISTURE REGIMES	1	2	3	4	5	6	7	8	9	10	ORNAMENTAL VALUE	WILDLIFE VALUE
Betula nigra River birch	Betulaceae - Birch Family	25' - 90' Tree, large	inconspicu-ous catkins, m brown & f green on same tree. Feb. - March	Cones, cylinder-shaped with small winged seeds. April - June	Full sun, Part shade	Occurs in wetlands near creeks, swamps & sloughs	Sands, loams, or clays. Mesic-hydric, poor drainage O.K.	X		X								Attractive ornamental tree with dark red-brown bark peeling off branches in papery sheets. Has graceful silhouette and good yellow fall color. Fast grower but short lived. Doesn't tolerate flooding, but likes moist soils. Does well in Houston. Deciduous.	Several species of small birds including chickadees and finches eat the ripe seeds. Twigs & buds are browsed by white-tailed deer. Beaver, rabbits & squirrels also eat various parts.
Bumelia lanuginosa Woolly-bucket bumelia	Sapotaceae - Sapodilla Family	40' - 80'. Tree, large	White perfect flowers, fragrant. June - July	Berries, blue-black. Sept. - Oct.	Full sun, Part shade	Mostly uplands, sometimes bottomlands, woodlands, edges and fencerows.	Sandy loams, loams, and clays. Tolerates gumbo. Well-drained, mesic.	X	X	X	X	X	X	X	X		X	Large shade tree with simple green leaves with white woolly undersurface. Persistent.	Several species of birds feed on the fruit, including cardinals, finches, robins, cedar waxwings, warblers, and vireos. Good cover and nesting tree due to protective thorns. Good substrate for insectivorous birds.
Carya illinoenensis Pecan	Juglandaceae - Walnut Family	50' - 60' Tree, large	inconspicu-ous catkins, m & f, yellowish on same tree . March - May	Nut. Sept. - Oct.	Full sun, Part shade	Prefers rich bottomlands	Sands, loams, or clays. Well-drained, mesic.	X	X	X	X	X	X	X	X			Beautiful shade tree with elegant compound leaves. Prefers deep, rich soils but will grow in thinner soils. Sometimes turns yellow in fall. Deciduous.	Sweet edible nuts valuable for all kinds of wildlife, birds and mammals alike including woodpeckers, jays, sparrows, fox squirrel, gray squirrel, opossum, and raccoons. Good substrate for insectivorous birds. Larval host plant for Gray hairstreak.
Carya texana Black hickory	Juglandaceae - Walnut Family	30' - 80' Tree, large	inconspicu-ous catkins, m & f, reddish on same tree. March	Nut. Oct. - Nov.	Full sun, part shade	Prefers dry, sandy uplands or rocky slopes throughout the eastern portion of the state, often associated with Post & Blackjack oaks. West to Gillespie & Bexar counties.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X				This medium to large-sized shade tree is the most wide-ranging hickory in Texas. It occasionally grows to 100' tall, has crooked branches & either a narrow or spreading crown depending on amount of sun. Leaves are compound & alternate. Deciduous.	Texas hickory is a good substrate for insectivorous birds. Excellent cover & nesting tree. Nuts are fairly sweet, but hard to crack. Gamebirds, quail & turkey, eat them from the ground after shells have softened. LHP for Banded hairstreak.

Celtis laevigata Sugarberry	Ulmaceae - Elm Family	40' - 60' Tree, large	inconspicu-ous, small, greenish. May - June	Berry (drupe), orange-red to purplish-black. July - Aug.	Full sun, part shade	Rocky or alluvial soils along streams, in woodlands & thickets.	Sands, loams, and clays. Prefers rich soils, but will tolerate wide range. Well-drained, mesic to xeric; drought tolerant once established.	X	X	X	X	X	X	X	X	X	X	Fast-growing shade tree adapted to most soils. Very drought tolerant. Yellow autumn color. Deciduous.	Fruit eaten by bluebirds, robins, cardinals, mockingbirds, cedar waxwings, thrashers, & sparrows. Good nest & cover tree, esp. for neotropical migrants. Larval food plant for Question Mark, Mourning Cloak, Pale Emperor, Snout & Hackberry butterflies.
Fraxinus americana White ash	Oleaceae - Olive Family	60' - 70' Tree, large	inconspicu-ous m & f flower clusters. April - May	Samara. Aug. - Sept.	Full sun, part shade	Grows in deep, rich moist soils on slopes & stream bottoms in eastern third of Texas.	Sands, loams & clays. Needs moisture, but good drainage.	X	X	X	X	X						Beautiful shade tree with compound leaves turning delicate shades of pink, orange & purple in fall. Trees in open condition have short trunk & round top, in the forest, long trunk & narrow crown. Deciduous.	Excellent cover & nesting tree. Seeds are eaten by several species of birds, i.e., wood duck, bobwhite, sapsuckers, cedar waxwings, finches, cardinals & sparrows. Deer browse leaves. LHP for Mourning cloak, Two-tailed and Tiger swallowtails.
Juglans nigra Black walnut	Ulmaceae - Elm Family	40' - 80' Tree, large	inconspicu-ous catkins, m & f, yellowish-green. April - May	Walnut. Sept. - Oct.	Full sun, part sun	Deep, rich soils of woodlands	Limestone soils, rich in calcium. Well-drained, mesic.		X	X	X	X		X	X			Shade tree with graceful appearance and fast growth rate. Immune to pests. Deciduous.	Nuts are preferred food of squirrels which disperse seeds. Woodpeckers, jays and gamebirds also like nuts. Good cover and nest tree for birds. Larval host plant of the Banded hairstreak.
Liquidamber styraciflua Sweetgum	Hamamelidac eae Witch hazel Family	60' - 100' Tree, large	inconspicu-ous m & f greenish flowers on same tree. March - May	Capsules arranged in spiny globe. Sept. - Nov.	Full sun, part shade	Grows in low wet areas on acid sands, flooded river bottoms, also in drier upland hills.	Sands, loams & clay loams. Needs moisture, mesic.	X	X	X								Beautiful tall shade tree with symmetrical pyramidal crown and striking star-shaped leaves. Leaves turn gorgeous colors in the fall, from gold to bright scarlet then to deep crimson. Fast growing & long lived. Highly ornamental. Deciduous.	Good protective cover and nesting tree. At least 25 specie of birds feed upon the fruit as do beaver, gray & fox squirrels. Birds include mallards, doves, finches, juncoes, sparrows, towhees, chickadees, titmice & siskins.

Platanus occidentalis Sycamore	Platanaceae - Sycamore Family	100' - 150' Tree, large	inconspicu-ous m & f globose heads reddish, greenish. April - May	Round seed head. Sept. - Oct.	Full sun, part shade	Rich bottomland soils along streams and creek bottoms	Sands, sandy loams, and clays. Well-drained, mesic.	X	X	X	X	X	X	X			Majestic shade tree. Fast-growing with pretty leaves and bark. Deciduous.	Globose fruit with seeds eaten by a variety of birds and mammals, including muskrat. Goldfinches, purple & house finches are especially fond of fruit. Good substrate for insectivorous birds.
Quercus falcata Southern red oak	Fagaceae - Beech Family	60' - 70' Tree, large	inconspicu-ous m & f downy catkins, on the same tree. March - May	Acorns, rounded with shallow cup, ripening every fall. Sept. - Oct.	Full sun, part shade	Prefers upland sites in the forests of East Texas.	Sands, to sandy loams. Likes acid soils. Well-drained, mesic.	X	X	X							Large shade tree with open, round-topped crown & stout branches. Deeply lobed leaves are attractive & produce showy red autumn color. Fast growing & long-lived. Does not like clay soils. Deciduous.	Small acorns are eaten by several species of birds, woodpeckers, jays, game birds, etc. Deer, fox & squirrels also relish them. Good cover & nesting tree & good substrate for insectivorous birds. LHP of Banded hairstreak & White M hairstreak.
Quercus macrocarpa Bur oak	Fagaceae - Beech Family	60' - 80' Tree, large	inconspicu-ous m & f catkins, red & greenish. March - April	Acorns. Sept. - Oct.	Full sun, part shade	Prefers moist forests along streams & in fallow fields	Sands, loams, and clays. Well-drained, mesic.		X	X	X	X		X	X		Very graceful shade tree, widely adaptive, fast-growing for an oak. Attractive leaves, unusual acorn, drought resistant & long-lived. Deciduous.	Important source of food for several species of birds, woodpeckers, jays, game birds. Also sought after by mammals, white-tailed deer, squirrels & raccoons. Good substrate for insectivorous birds. Larval host plant for Sleepy & Juvenal's Duskywing.
Quercus marilandica Blackjack oak	Fagaceae - Beech Family	40' - 60' Tree, large	inconspicu-ous m & f catkins, red & greenish. April	Acorns, every 2 years. Nov. - Dec.	Full sun, part shade	Prefers upland forests of timber belt in East & Central Texas.	Sands, sandy loams, loams & clays. Tolerates dry, sandy, gravelly soils. Well-drained, mesic-xeric.	X	X	X		X		X	X		Beautiful shade tree often associated with Post oak. Leaves are dark green, distinctive & puppet-shaped. Slow-growing & hard to transplant. Can tolerate relatively poor conditions. Deciduous.	Provides dense canopy cover. Good nesting tree & substrate for insectivorous birds. Turkey & deer love acorns. Woodpeckers, jays, & doves eat & cache them. Smaller wildlife eat crushed ones. LHP of Juvenal's, Horace's duskywings & White M hairstreak.

Quercus muehlenbergii Chinkapin oak	Fagaceae - Beech Family	40' - 60' Tree, large	inconspicu-ous catkins, m & f, cream to yellowish. March - June	Acorns. Sept. - Oct., every two years	Full sun, part shade	Prefers upland forested areas	Loams, clays & limestone soils. Well-drained, mesic.				X	X		X			X	Beautiful, fast-growing shade tree. Attractive leaf shape. Bronze autumn color. Deciduous.	Sweet, edible nuts favored by many species of birds & mammals, deer, raccoons, opossums & squirrels. Good nesting and cover tree. Good substrate for insectivorous birds. Larval host plant to Horace's Duskywing.
Quercus shumardii Shumard red oak	Fagaceae - Beech Family	50' - 100' Tree, large	inconspicu-ous catkins, m & f, greenish. March - May	Acorns. Sept. - Oct., every two years	Full sun, part shade	Prefers moist forest & limestone upper woods	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X					Gorgeous shade tree with beautiful leaves. Red color in autumn. Fast-growing & disease resistant. Deciduous.	Acorns eaten by a number of birds & mammals. Good cover and nesting tree. Good substrate for insectivorous birds. Larval host plant for a few species of Duskywings.
Quercus stellata Post oak	Fagaceae - Beech Family	40' - 50' Tree, large	inconspicu-ous catkins, m & f, reddish. March - May	Acorns. Sept. - Nov.	Full sun, part shade	Prefers dryish uplands, also grows in moister areas in East Texas.	Sands, sandy loams, prefers acid soils. Also neutral clays. Well-drained, mesic.	X	X	X	X	X	X	X	X		Slow-growing oak with maltese-cross leaves. Widespread in TX. Rugged shade tree good in otherwise inhospitable conditions. Dramatic winter silhouettes. Provides dense canopy cover. Dominant in sandy areas in north & east central Texas. Deciduous.	Good nesting & cover tree; fine substrate for insectivorous birds. Turkey & deer relish acorns as do doves, woodpeckers & jays. Smaller birds eat crushed ones that fall on ground. LHP for Northern hairstreak, Horace's & Juvenal's duskywings.
Sapindus drummondii Western soapberry	Sapindaceae - Soapberry family	15' - 50' Tree, large	clusters of small white flowers. May - June	Round, amber, wrinkled berry-like fruit with 1 seed. Sept. - Oct.	Full sun, part shade	Prefers moist soils along streams & fencerows, scattered throughout Texas	Sands, loams & clays, likes limestone soils. Well-drained, mesic.	X	X	X	X	X	X	X	X	X	Fine-looking shade tree with dependable yellow fall foliage. Translucent amber fruits have white seeds which are poisonous to us. Moderately fast growing; also tolerates poor sites. Forms thickets but does not live long. Deciduous.	Fruit highly prized by many kinds of birds that are not affected by poison. Bluebirds, robins, cedar waxwings devour them. Small flowers provide nectar to various insects. Good nest & cover tree. Substrate to insectivores. LHP to Soapberry hairstreak.

Tilia caroliniana Carolina basswood	Tiliaceae - Linden Family	40' - 80' Tree, large	Showy clusters of white, 5-petaled flowers, highly fragrant. April - June	Nutlets. May - August	Full sun, slight shade	Prefers deep rich soils of open woodlands along forested streams & lowlands in East or Central Texas, also part of Upper Texas Coast.	Sands, loams & clays. Well-drained, mesic.	X	X	X				X				Large, often leaning shade tree with narrow irregularly rounded crown, attractive lopsided heart-shaped leaves & highly fragrant blooms. You can smell the tree almost before you see it. You can also hear the buzzing from bees. Fast grower. Deciduous.	Fragrant flowers literally drip with nectar & attract all kinds of nectar-loving insects. Excellent honey tree. Fruit is eaten by several species of birds & small mammals. Good cover & nesting tree.
Ulmus alata Winged elm	Ulmaceae - Elm Family	30' - 60' Tree, large	inconspicu-ous, perfect, petalless flowers, red to yellow. Feb. - March	Samara, reddish, winged. May - August	Full sun, part shade	Prefers woodlands, thickets & streamside areas, also fencerows & abandoned fields, in East Texas Piney Woods, Oak Woods & Prairies, Blackland Prairies, & Upper Gulf Coast.	Sands & sandy loams, neutral to acid. Well-drained, mesic-xeric.	X	X	X	X	X						Handsome shade tree with an open, round-topped crown, straight trunk and alternate simple coarsely toothed leaves. Beautiful yellow autumn color. Rapid growing, & easy to transplant. Deciduous.	Excellent cover & nesting tree; also good substrate for insectivorous birds. Seeds eaten by gamebirds, songbirds & squirrels. Twigs & leaves browsed by deer, opossum & rabbits. Larval host plant of the Question Mark.
Ulmus americana American elm	Ulmaceae Elm Family	40' - 80' Tree, large	inconspicu-ous red to green flowers. Feb.-April	Samara. March - June	Full sun, part shade	Prefers rich soils along streams & lowland areas	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X		X	X			Excellent shade tree turning yellow gold in autumn. Fast growing & handsome shape. Long-lived. Larval host plant to Comma, Question Mark, Mourning Cloak & Painted Lady. Deciduous.	Seeds & buds eaten by gamebirds, woodpeckers, chickadees, robins, vireos, sparrows, orioles & finches. Good cover & nest tree with plenty of insects for insectivorous birds. Deer browse leaves; squirrels, foxes & rabbits eat seeds & buds.
Ulmus crassifolia Cedar elm	Ulmaceae - Elm Family	30' - 60' Tree, large	inconspicu-ous greenish flowers. July.-Sept.	Samara. Aug. - Oct.	Full sun, part shade	Prefers woodlands, ravines & open slopes	Sands, loams & clays. Seasonal poor drainage O.K.	X	X	X	X	X	X	X	X			Good shade tree, each with a unique shape. Fast growing & long lived. Excellent yellow fall color. LHP for Mourning Cloak & Question Mark. Deciduous.	Seeds & buds eaten by gamebirds, woodpeckers, chickadees, finches, sparrows & warblers. Good nesting and cover tree with lots of insects for insectivorous birds. Deer browse leaves; squirrels, foxes & rabbits eat seeds & buds.

Carpinus caroliniana American hornbeam (Blue beech)	Betulaceae - Birch Family	15' - 30' Tree, small	inconspicu-ous m & female catkins on same tree. March - May	Nutlets, in clusters. Sept. - Oct.	Part shade, dappled shade, shade	Prefers rich bottomlands, often along steams in moist woods.	Sands, loams & clays. Well-drained, mesic-hydric soils.	X	X	X									Airy, graceful understory tree with simple, alternate leaves & jaunty fruits. Notable for its beautiful, smooth & sinewy trunk. Very shade tolerant. Though it likes moisture, it doesn't tolerate flooding. Slow-growing & short-lived but pretty. Deciduous.	Nutlets are eaten by squirrels & other small mammals. Birds such as cardinals & finches also savor them. Larval host plant of Striped hairstreak, Red-spotted purple & Tiger swallowtail.
Diospyros texana Texas persimmon	Ebenaceae - Ebony Family	15' - 40' Tree, small	Small greenish white flowers, fragrant. March	Fruit, small, round black & fleshy with lots of seeds. June - July	Full, part shade	Prefers limestone hills, shinnery oak dunes, breaks & rocky canyons, mesquite groves, areas along water courses.	Sands, loams & clays. Well-drained, xeric.		X	X	X	X	X	X			X		Very attractive tree with smooth gnarled bark. Quite drought-resistant once established. Deciduous.	Fragrant whitish flowers attract insects of many kinds. Ripe fruits eaten by several species of game & song birds. Mammals, especially javalina, relish the fruit. Leaves browsed by white-tailed deer. Larval host plant for Gray hairstreak & Henry's elfin.
Diospyros virginiana Common persimmon	Ebenaceae - Ebony Family	30' - 40' Tree, small	inconspicu-ous, m & f greenish yellow flowers on separate tree, fragrant. April - June	Berry - persimmon. August - Feb.	Full sun, part shade	Prefers dryish woods, old fields & clearings, ditch banks in East Texas. Also mud bottomlands.	Sands, loams & clays. Thrives on almost any kind of soil. Well-drained, mesic.	X	X	X	X	X			X				Good understory tree or accent tree with drooping branches & conical crown. Good erosion control plant. Deciduous.	Fruit eaten by 16 species of birds, also by skunks, raccoons, opossums gray & fox squirrels. Leaves browsed by deer.
Fraxinus texensis Texas ash	Oleaceae Olive Family	30' - 45' Tree, small	Small m flowers, f flowers in clusters, purplish. Feb. - March	Samara. August - Sept.	Full sun, part shade	Prefers canyons, bluffs, rocky slopes, open woodlands, near lakes in Edwards Plateau & Western Cross Timbers.	Sands, loams & clays. Likes limestone soils. Well-drained, mesic-xeric.				X	X	X	X					Short-trunked medium-sized tree with contorted branches. Has beautiful reddish-yellow fall color. Long-lived & healthy & very drought tolerant. Flowers & fruit quite decorative. Deciduous.	Good substrate for insectivorous birds. Fine nesting & cover tree. Several species of birds relish both flowers & fruits, esp. finches, cardinals & grosbeaks. Foliage browsed by rabbits, porcupine & white-tailed deer.

Ilex decidua Deciduous Holly	Aquifoliaceae Holly Family	10' - 30' Tree, small	inconspicu-ous m & f flowers on separate trees. March - May	Drupes, orange-red on f tree. Sept. - Feb	Full sun, part shade	Prefers moist areas near streams and woodlands	Sands, loams & clays. Well-drained, mesic. Seasonal poor drainage O.K.	X	X	X	X	X		X				Good understory tree or accent tree with spreading open crown, often with inclined trunk. Female trees have red berries held over winter, very ornamental. Deciduous.	Fruits are eaten by several species of birds, bobwhite, doves, robins, cedar waxwings, bluebirds, jays & mockingbirds. Squirrels, opossum, rabbits & fox eat berries too. Flower nectar & pollen attract several insects. Good nest tree.
Juglans microcarpa Little walnut	Juglandaceae Walnut Family	10' - 30' Tree, small	inconspicu-ous m & f flowers, greenish, on same trees. March - April	Walnut, small. Sept. - Oct.	Full sun, part shade	Prefers rocky areas near streams, arroyos & rocky ravines in Central, South & West Texas.	Loams, clays. Likes rocky limestone soils. Well-drained, mesic.					X		X	X		X	A man-trunked small tree with a long tap root. Often hybridizes with Arizona walnut. Quite disease resistant. Deciduous.	Produces small walnuts with high-quality meat eaten by rock squirrels & other small mammals. Gamebirds & songbirds also favor nuts. Good nesting & cover tree. Larval host plant of the Banded hairstreak.
Morus rubra Red mulberry	Moraceae Fig Family	35' - 40' Tree, small	inconspicu-ous m & f greenish flowers. March - June	Mulberry (syncarp of aggregated red-black drupelets). April - Aug.	Full sun, part shade, dappled shade	Prefers rich soils along streams, creek bottoms & moist woodlands	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X	X		X	Handsome understory tree with polymorphic leaves, reddish black fruit and broad spreading crown. Deciduous.	Red mulberries are the prime source of spring fruit for neotropical migrant birds. 21 species devour them as soon as they ripen as do squirrels, raccoons, opossums & skunks. Larval host plant for Mourning Cloak.
Myrica cerifera Wax myrtle	Myricaceae - Wax myrtle Family	6' - 12' Tree, small, or shrub	inconspicu-ous whitish flowers. March - April	Berries, globose, waxy. Nov. - Dec.	Full sun, part shade, dappled shade	Prefers moist or dry soils of piney woods & hardwoods. Woodlands & grasslands in East Texas, Gulf Coast Prairies & Marshes.	Sands, loams & clays. Mesic, poor drainage O.K. can tolerate drier substrate.	X	X	X								Softly shaped, low-growing evergreen shrub or small tree. Is fast growing & has aromatic leaves & distinctive waxy pale bluish berries. If left unpruned, it is naturally shrubby looking. Tolerates poor drainage. Evergreen.	Dense growth provides excellent cover & nesting sites. Over 40 species of birds eat the waxy berries, cedar waxwings, robins, cardinals, mockingbirds, warblers, towhees, & sparrows. Eaten by bobwhite, quail & turkey, too. LHP for Red-banded hairstreak.

Prosopis glandulosa Honey mesquite	Leguminosae - Legume Family	20' - 30' Tree, small	Showy creamy yellow elongated spike-like racemes. May - Sept.	Legumes in loose clusters. Aug. - Sept.	Full sun, part shade	Tolerates wide range of situations, open fields, edges of woodlands, etc.	Sands, loams & clays. Well-drained, xeric.	X	X	X	X	X	X	X	X	X	X	Attractive tree with crooked, drooping branches, feathery leaves & rounded crown. Fast growing & often shrubby, forming thickets. Fixes nitrogen in the soil. Deciduous.	Good nectar plant for bees & other insects. Many species of wildlife like quail, bobwhite, doves depend on it for food & shelter from the sun. Squirrels, coyotes, skunks, rabbits &deer eat pods. LHP for Long-tailed skipper & Reickert's blue.
Quercus incana Bluejack oak	Fagaceae - Beech Family	30' 40' Tree, small	inconspicu-ous m catkins & f flowers, red to yellowish green. April	Acorns, every second year. Sept. - Nov.	Full sun, part shade	Prefers dry, sandy uplands in timber belt of East & Central Texas.	Sands & sandy loams. Tolerates deep sugar sands. Well-drained, mesic-xeric.	X	X	X								Very striking & decorative small oak tree. Leaves with white hoary undersides. Highly drought tolerant. Very interesting branching pattern. Trees often form dense thickets. Deciduous.	Wildlife feeds on the acorns. The dense thickets that are formed provide excellent cover & nesting sites on otherwise barren sandy habitats.
Quercus sinuata v. breviloba Scaly-bark oak	Fagaceae - Beech Family	12' - 40' Tree, small	inconspicu-ous m & female catkins, reddish. March	Acorns, every year. Sept.	Full sun, part shade	Prefers open wooded limestone hills at low elevations, also grows in grasslands	Loam, clays. Likes limestone soils. Well-drained, mesic-xeric.			X	X	X		X	X			A shaggy-barked multi-trunked tree which has many growth forms, responding to different habitat & moisture regimes. Can form dense thickets through suckering. Deciduous.	Excellent cover & nesting tree. Good substrate for insectivorous birds. Gamebirds, woodpeckers & jays eat or cache acorns. Also important food source for deer, small mammals & other wildlife. LHP of duskywings & hairstreaks.
Rhamnus caroliniana Carolina buckthorn	Rhamnaceae - Buckthorn Family	12' - 20 Tree, small	inconspicu-ous, small greenish-yellow flowers. May - June	Drupes, reddish brown. Aug. - Sept.	Full sun, part shade, shade	Prefers moist woods, fence rows, along creeks, heads of draws & canyon slopes.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X				Very attractive understory tree with pretty leaves and berries. Quite ornamental and adapted to a wide range of sites. Has good fall color & fruits borne over a long time. Deciduous.	When ripe, fruits are devoured by several species of birds, i.e. thrashers, robins, mockingbirds, cardinals, finches, etc. Flowers are good nectar source for bees, butterflies & other insects. Larval host plant for Gray hairstreak.

Rhus copallina Flameleaf sumac	Anacardiaceae Sumac Family	15' - 25' Tree, small	m & f flowers, small greenish white, on separate trees. July - Aug.	Drupes, small red, in clusters, remain after leaves fall. Sept. - Nov.	Full sun, part shade, dappled shade	Prefers fence rows, fields and bottomlands in East & East Central TX. Tolerates rocky areas.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X				A small, commonly clump-forming shrub or small tree with elegant compound leaves and showy red fruit clusters. Only trees with f flowers have fruit. Beautiful red color in the fall. Fast growing. Deciduous.	Fruit is eaten by at least 21 species of birds, Flowers attract numerous insects in spring, good nectar source for bees & butterflies. Larval host plant for Red-banded hairstreak.
Rhus lanceolata Lance-leaf sumac	Anacardiaceae Sumac Family	10' - 20' Tree, small	m & f flowers, small greenish white, on separate trees. June	Drupes, small red, in clusters, remain after leaves fall. Sept. - Dec.	Full sun, part shade	Occurs on limestone & in calcareous soils, woodlands & roadside edges, along fencerows. Tolerates disturbed soils.	Sands, sandy loams, neutral clays, likes limestone soils. Well-drained, mesic.				X	X		X			X	Sometimes thicket-forming small tree with elegant compound leaves and showy red fruit clusters. Only trees with f flowers have fruit. Beautiful red color in the fall. Fast growing with a very attractive shape. Deciduous.	Fruit is eaten by more than 20 species of birds, favored by quail & turkey. Flowers attract numerous insects in spring, good nectar source for bees & butterflies. Leaves browsed by deer. Larval host plant for Red-banded hairstreak.
Acer rubrum v. drummondii Drummond red maple	Aceraceae - Maple Family	90' 100' Ornamental tree, large	Showy bright red clusters, before leaves. Feb.	Samara with two wings. March - June	Full sun, Part shade	Prefers wet areas on sandy lands, swamps & alluvial forest. Also found on drier ridges throughout Piney woods in East TX.	Sands, loams, and clays. Likes acid soils. Mesic-hydric, poor drainage O.K.	X	X	X								Large shade tree with simple distinctively-shaped leaves which turn red in the fall. Popular ornamental and shade tree, as they are beautiful both spring & fall. Relatively short-lived with shallow root system. Does well in Houston. Deciduous.	Many kinds of birds feed on the winged seeds, i.e. woodpeckers, cardinals, finches, robins, cedar waxwings, warblers, & sparrows, also squirrels & rabbits. Good cover & nesting tree. Good substrate for insectivorous birds. Foliage browsed by deer.
Aesculus glabra v. arguta Texas buckeye	Hippocastanaceae Horse chestnut Family	15' - 40' Ornamental tree or shrub	Showy yellowish-green panicles of tubular flowers. March - May	Capsule, round & leathery. Sept. - Oct.	Part shade, dappled shade, shade	Prefers moist, rich soils in woodlands, along river banks. Prefers northern exposures.	Sands, loams & clays. Well-drained, mesic. Moderate moisture.	X		X	X	X		X				Showy small tree or shrub with rounded crown. Has distinctive flower clusters and attractive pointy palmate leaves. Good understory tree. Deciduous.	The yellowish-green tubular flowers are attractive to insects. Good protective cover shrub. White-tailed deer will not browse the leaves of this tree. Seeds are poisonous, however, and not eaten by wildlife.

Cercis canadensis v. canadensis Eastern redbud	Leguminosae - Legume Family	10' - 40' Ornamental tree	Showy magenta pea-like flowers, before leaves. March	Legumes, brownish-red, in clusters. Sept.	Full sun, part shade, dappled shade	Prefers forested sandy areas, upland woods, woodland edges & and along stream banks in Eastern Texas.	Sands, loams & heavy black clays. Well-drained, mesic. Moderate moisture.	X	X	X	X							Highly ornamental and showy small tree with spreading, flat or rounded crown. Good understory tree or accent plant. Fast growing, usually with single trunk. Deciduous.	Beautiful magenta flowers are copious early nectar source for butterflies, moths, bees, etc. Seeds are eaten by a number of species of birds; foliage browsed by white-tailed deer. Larval host plant to Henry's Elfin.
Cornus drummondii Rough-leaf dogwood	Cornaceae - Dogwood Family	10' - 20' Ornamental tree	Showy, creamy-white flower heads. May - August	Drupes, white, globular. Aug. - Oct.	Part shade, dappled shade, shade	Prefers damp woodlands & thickets, occasionally found on dry hills in eastern half of Texas.	Sandy loams, clays; likes limestone soils. Mesic, likes fairly moist soils.				X	X		X				Irregularly branched small spreading tree with smooth gray bard, opposite leaves & creamy-white flowers. Deciduous.	Dogwood flowers are a good nectar source for many species of insects. The white fruit is highly prized & eaten by at least 40 species of birds, including bobwhite, turkey, woodpeckers, doves & several species of songbirds.
Cornus florida Flowering dogwood	Cornaceae - Dogwood Family	25' -40' Ornamental tree	Showy white flowers (bracts). March - May	Berries, red. Aug. - Sept.	Dappled shade, part shade; can tolerate full sun. Very shade tolerant.	Prefers moist woodlands and edges of thickets, also along streams.	Sands, sandy loams, loams, slightly acid soils. Well-drained, mesic.	X		X								Tree with graceful horizontal branches turning up at the tip. Single trunk is short & dark green leaves are opposite, simple, turning various shades of red in the fall. Spectacular in spring, striking in the fall. Good under shade trees. Deciduous.	Twenty-eight species of birds forage on the berries, from large gamebirds to small songbirds. Squirrels & white-tailed deer also favor fruit. Larval host plant for Spring Azure butterfly.
Crataegus marshallii Parsley hawthorn	Rosaceae - Rose Family	10' - 25' Tree, small ornamental	Showy white flowers. March	Red haws. Sept. - Oct.	Full sun, dappled shade, part shade	Prefers sandy woodlands & pastures. Found mostly along fencelines and woodland edges in East Texas.	Sands & sandy loams, acid. Also tolerates calcareous soils. Well-drained, mesic.	X		X								Beautiful blossoms add a touch of ethereal beauty to this understory tree. Usually with several trunks & flaky gray bark revealing an orange layer underneath. Fruits are a shiny bright red color. Deciduous.	Beautiful white blossoms attract nectar lovers. Red haws are gone in a flash as they are highly prized by many species of birds, also by mammals. Large thorns make it a good protective cover & nest tree. Larval host plant of the Gray Hairstreak.

Crataegus reverchonii Reverchon hawthorn	Rosaceae - Rose Family	10' - 25' Tree, small ornamental	Showy white flowers, fragrant. May - August	Pomes, red, roundish & shiny. Sept. - Oct.	Full sun, part shade	Prefers thickets & open woods in north central Texas	Sands, neutral to slightly acid; clays & limestone soils. Well-drained, mesic.				X	X		X				Highly attractive small tree with glistening tan flakey bark with lovely white flowers. Good accent plant. Deciduous.	Fragrant flowers offer copious nectar to bees, butterflies & juicy fruit favored by several species of birds & small mammals. Thorns make this an excellent protective cover & nest tree. Larval host plant of a few hairstreaks.
Crataegus viridis Green hawthorn	Rosaceae - Rose Family	20' - 35' Ornamental tree	Showy, white perfect flowers. March - April	Pome (apple-like fruit) orange or red in color. Sept. - Nov.	Full sun, part shade	Prefers low, wet alluvial woods, also sandy fields in East Texas & Upper Texas Coast.	Sands, loams & clays. Medium to high moisture. Seasonal poor drainage O.K.	X	X	X	X	X		X				Medium-sized tree forming a broad rounded crown, serrated dark green shiny leaves, with bark that shreds into small scales. Often thornless. Deciduous.	Beautiful white flowers with yellow stamens attract bees & butterflies. Red orange haws disappear quickly, highly prized by several species of birds & mammals. Good cover & nesting tree. Larval host plant for some Hairstreaks.
Ilex opaca American holly	Aquifoliaceae Holly Family	15' -25' Tree, small ornamental	inconspicu-ous m & f greenish flowers on separate trees. March - April	Berries, red on f tree, persist through winter. Sept. - Dec.	Full sun, part shade, dappled shade, shade	Prefers moist woods; hammocks along streams, upper river bottoms; can tolerate drier soils on hillsides. Found in East Texas west to Wilson Co.	Sands & loams, acidic soils. Well-drained, mesic.	X	X	X								Slow-growing, long-lived understory leaves with narrow bushy triangular crown and Christmas holly evergreen leaves and brilliant red berries on female trees. This is a handsome ornamental all year round, also useful as a screening plant. Evergreen.	Excellent cover and nesting tree. Red berries are relished by several species of birds. Larval host plant for Henry's Elfin.
Prunus mexicana Mexican plum	Rosaceae - Rose Family	15' - 35' Tree, ornamental	Showy, white perfect flowers, fragrant. Feb.- April	Plum, red-purple. Sept. - Oct.	Full sun, part shade	Prefers river or creek bottoms, hardwood slopes & hillsides, & prairies.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X		X				Medium sized, single-trunked ornamental tree with broad crown and satiny silver bark with dark fissures. Excellent accent plant with heavenly fragrance when in bloom. Deciduous.	Early spring clouds of white flowers are wonderful nectar source, attracting bees, butterflies & diurnal moths. Gamebirds, songbirds & several species of mammals feast on the ripe plums. Larval host plant for Tiger swallowtail.
Prunus munsoniana Munson plum	Rosaceae - Rose Family	15' - 25' Ornamental tree	Showy, white perfect flowers, fragrant. March	Plum, red or yellow with white dots. Sept. - Oct.	Full sun, part shade	Prefers limestone ledges & slopes; also grassy thickets.	Sands, loams & clay (esp. those with high limestone content.). Well-drained, mesic.				X	X		X				Thicket-forming ornamental shrub or small round-topped tree with bright lustrous green leaves and smooth thin bark. Deciduous.	Spring flowers with copious nectar attract butterflies, bees & other insects. Plums are relished by several species of birds and small

																		mammals.
Prunus serotina v. serotina Black cherry	Rosaceae - Rose Family	60' - 100' Ornamental tree	Showy racemes of white perfect flowers, fragrant. March - April	Cherries, small purple black, sweet or tart. June - Oct.	Full sun, part shade	Prefers eastern woodlands, thickets, fencerows & areas along roadsides.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X						Attractive ornamental with decorative flowers, copious fruits, shiny green leaves & grayish brown horizontally striped bark. Easy to grow. Other varieties available for all regions of Texas except South TX. Deciduous.	Copious fruits are eagerly devoured by a wide variety of wildlife including 33 kinds of birds, raccoons, opossums, squirrels & rabbits. Foliage is not browsed by deer. Larval host plant to some Hairstreak species.
Sambucus canadensis American elderberry	Caprifoliaceae Honeysuckle Family	15' - 30' Ornamental shrub or small tree	Showy white 4-8' flower clusters. June - Sept.	Berries, blue-black. Sept. - Nov.	Full sun, part shade	Prefers wet soils in low places esp. along streams & swamp edges.	Sands, loams & gravelly clays. Mesic-hydric, poor drainage O.K.	X	X	X	X	X		X			Attractive erect shrub with white flower pompons which prefers moist conditions in alluvial soils. Has attractive pinnate leaves. It loves extra water and will grow fast if well supplied. Can stand a certain amount of drought, though. Persistent.	Flowers are an excellent source of nectar for bees, butterflies, diurnal moths & other insects. Fruits are eaten by several species of birds, including gamebirds & songbirds. Small mammals also relish the ripe fruit. Leaves are browsed by deer.
Ungnadia speciosa Mexican buckeye	Sapindaceae - Soapberry Family	15' - 30' Ornamental shrub or small tree	Showy clusters of pink-magenta flowers cloak branches, before leaves come out. Fragrant. March - May	Capsules (tripartite leathery "buckeyes"), brown-black. Oct. - Nov.	Full sun, part shade	Prefers rocky areas in canyons, slopes & ridges & along fencerows.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X		X		X	Showy, small, shrubby often multi-trunked ornamental with irregular shape. Spectacular pink blossoms in spring. Good understory tree, prefers at least half a day in sun. Has pretty yellow fall color also. Deciduous.	Splashy pink flowers are a good nectar source for bees, butterflies, diurnal moths. Good honey plant. Sweet seeds eaten by a few species of birds and mammals, though poisonous to humans. Larval host plant for Henry's Elfin.
Vaccinium arboreum Farkleberry	Ericaceae - Heath Family	15' - 30' Tree, small ornamental	small drooping, urn-shaped white flowers. May - June	Berries, blue. Sept. - Oct.	Part shade, dappled shade	Prefers open mixed woods, dry sterile hillsides or pimple mounds in bottomland woods. Found in East Texas west to Bastrop & Nueces counties.	Sands & sandy loams. Well-drained, mesic.	X	X	X							Attractive irregular shrub to small tree with shiny smooth dark green leaves. Good understory tree. Tree had good red fall color fading to deep purple. Persistent to Evergreen.	The small blue berries which ripen in the fall are devoured by several species of resident & wintering birds. Berries also sought after by various small mammals, i.e., squirrels, rabbits, etc. Larval host plant to Henry's elfin & Striped

																			hairstreak.
Viburnum rufidulum Rusty black-haw viburnum	Caprifoliaceae - Honeysuckle Family	20' - 30' Ornamental tree or large shrub	Showy creamy-white clusters of flowers. March - May	Berries, bluish-black (drupes). Sept. - Oct.	Full sun, part shade	Prefers moist soils along streamsides, in open woods & thickets.	Sands, loams & clays, esp. limestone soils. Well-drained, mesic.	X	X	X	X	X		X	X		X	Small, single-trunked, ornamental with broad crown. Attractive as understory tree, also beautiful in the open. Leaves very glossy, turning red, mauve or orange in fall. Slow growing, staying shrub size for a long time. Deciduous.	Flowers are good nectar source for bees, butterflies & other insects. Fruits relished by several kinds of birds & small mammals. Robins, cedar waxwings, cardinals, bluebirds & mockingbirds love fruit, as do squirrels, opossum, raccoons & rabbits.
Juniperus ashei Ashe juniper	Cupressaceae Cypress Family	10' - 30' Conifer	inconspicu-ous. Feb.	Cones, flesh & berry-like. Aug. - Sept.	Full sun, part shade	Prefers rocky soils in canyons, ravines, arroyos, rimrock & breaks; on eroded slopes & flats.	Sands, loams & clays likes limestone soils. Well-drained, xeric.				X	X	X	X				Multi- or single-trunked thick evergreen tree with wonderfully shaggy bark. Leaves scale-like, dark green & aromatic. Female plant with large blue fruits. Dominant plant of the hill country. Evergreen.	Bark strips used as nest material by the Golden-cheeked warbler. Blue fruits a winter-time favorite of wildlife: bluebirds, robins, cedar waxwings, cardinals, finches & mammals. Good substrate for insectivorous birds. LHP of Olive & Juniper hairstreak.
Juniperus virginiana Eastern red-cedar	Cupressaceae Cypress Family	30' - 60' Conifer	inconspicu-ous m catkins, f cones, appearing on separate trees. March - May	Cones, berry-like, bluish, sweet & resinous when ripe. Aug. - Dec.	Full sun, part shade, dappled shade	Prefers dry hillsides, old fields, pastures, areas along fence rows.	Sands, loams & clays. Well-drained, mesic. Tolerate dry land.	X		X	X	X			X	X		Evergreen tree of variable shape, with scalelike or appressed leaves. Foliage is dense and aromatic. Often planted as an ornamental. Long-lived and slow-growing. Evergreen.	Dense-foliaged tree is excellent cover and nesting tree. Bluebirds, mockingbirds, robins, cedar waxwings, thrashers, warblers, finches & sparrows relish fruit, esp. in winter. Opossum also eat fruit. Larval host plant to Olive hairstreak.

Pinus taeda Loblolly pine	Pinaceae - Pine Family	60' - 100' Conifer	inconspicu-ous, m & f cones. Feb. - March	Cones, medium-sized, 2-6" long, light reddish brown, often armed with prickles. Sept. - Oct.	Full sun, some shade	Prefers gravelly uplands & bottomlands of East Texas Piney Woods, Gulf Coast Prairies & Marshes & Oak Woods & Prairies, west to Bastrop.	Sands, sandy loams, acid soils preferred; but tolerates many other soil types. Also tolerates poor drainage. Well-drained, mesic but is more drought tolerant than long-leaf.	X	X	X								Fast-growing, medium-coned pine with spreading branches & compact rounded crown. Also fire resistant. Highly drought tolerant. Most common pine in Eastern forests. Has good ornamental potential. Evergreen.	Provides excellent cover & nesting substrate for birds, cavities for woodpeckers. Many birds & mammals eat the seeds exposed as 2-year old cones open, i.e., doves, woodpeckers, chickadees, titmice, sparrows, goldfinch, siskins. LHP of Eastern Pine Elfin.
Taxodium distichum Bald cypress	Taxodiaceae Bald Cypress Family	45' - 100' Conifer	inconspicu-ous 5'-long drooping clusters of m cones. F cones at branch tips. March - April	Cones, wrinkled, rounded, 1-inch in diameter. Sept. - Oct.	Full sun, part shade	Prefers moist soils in swamps, river bottoms, forests along streams.	Sands, loams & clays. Mesic-hydric, seasonal poor drainage O.K.	X	X	X	X		X	X				Large conifer with feathery, deciduous, needle-like leaves. Fast-growing with reliable bronze fall color. Long-lived tree often used as ornamental. Spanish moss (good nesting material) festoons branches. Deciduous.	Excellent cover & nesting tree. Seeds eaten by many different kinds of birds, esp. waterfowl & sandhill cranes. Squirrels, & many other forms of wildlife eat seed cones. Good foraging substrate for insectivorous birds.
Amorpha fruticosa False indigo	Leguminosae - Legume Family	5' 10' Shrub	Showy purple flower spikes with yellow anthers. April - May	Pods, clustered, small & brown. July - Aug.	Full sun, part shade	Prefers low areas at the water's edge, along streams.	Sands, loams & clays. Mesic, seasonally poor drainage O.K.	X	X	X		X	X					This moisture loving shrub is notable for its beautiful flowers, attractive leaves & airy form. Relatively fast growing. Deciduous.	Flowers are a good nectar source for bees, butterflies & other insects. Leaves are browsed by deer. Larval host plant for Dogface butterfly, Gray hairstreak, Silver-spotted skipper, Hoary edge skipper.
Baccharis halimifolia Baccharis	Asteraceae - Sunflower Family	6' - 8' Shrub	Showy, silvery white flowers, f tree esp. Sept. - Oct.	Achenes. Oct. - Nov.	Full sun	Colonizes disturbed soils. Prefers open sandy places in east, south east & north central Texas.	Sands, & loams, prefers slightly acid soils. Mesic.	X	X	X								Female plants are gorgeous in full bloom which can last until Christmas. Easy to grow, tolerates poor soils. Good erosion control plant especially in disturbed areas. Deciduous.	Flowers are highly attractive to all kinds of insects: bees, butterflies, diurnal moths, etc. A good cover plant. Achenes eaten by seed-eating birds.

Callicarpa americana American beauty-berry	Verbenaceae - Vervain Family	3' - 9' Shrub	Small clusters of white or pink flowers at nodes, May - July	Berries, magenta, in clusters at nodes. Aug. - Nov.	Part shade, dappled shade.	Prefers moist soils of canyons and bottomlands, woods & thickets.	Sands, loams & clays. Likes rich soils. Well-drained, mesic.	X	X	X	X	X		X				Open, much branched shrub with showy magenta berries. Has mounding form. Likes to be watered during dry periods. Deciduous.	Fruits are favored by several species of birds, i.e.., bobwhite, mockingbirds, cardinals, thrashers, robins, finches & towhees. Raccoons, opossum & gray fox also relish berries.
Cephalanthus occidentalis Buttonbush	Rubiaceae - Madder Family	5' - 20' Shrub	Showy, creamy white round heads. June - Sept.	Capsule clusters, round & dark brown. Aug. - Nov	Full sun, part shade	Prefers moist soils near swamps, ponds, along streams & stream margins.	Sands, loams, clays. Likes limestone soils. Mesic/hydric. Moderate to high moisture. Seasonally poor drainage O.K.	X	X	X	X	X	X	X	X	X	X	Shrub or small tree growing in low areas, often with swollen base. Leaves opposite & whorled. , variously shaped. Bright yellow anthers around white flower balls create a halo effect. Highly ornamental. Suitable for bog or pond area. Deciduous.	Flowers attract hordes of bees, butterflies & other insects. Fruits are highly favored by more than 25 species of birds, including waterfowl, cardinals, finches, sparrows, etc.
Dalea frutescens Black dalea	Leguminosae - Legume Family	1' - 3' Shrub	Showy magenta flowers. Aug. - Sept.	Leguminous pod. Oct. - Nov.	Full sun	Prefers dry limestone hills in brushy vegetation	Sands, loams clays; likes limestone soils. Well-drained, xeric.					X	X	X				Attractive, bonsai-like shrub which is easy to maintain. Serves as a good low understory plant. Deciduous.	Flowers are an excellent nectar source for bees & many other kinds of insects. Good cover for small animals. Leaves are browsed by white-tailed deer & rabbits. Larval host plant of Dogface butterfly.
Forestiera pubescens Elbowbush	Oleaceae - Olive Family	5' - 10' Shrub	Showy yellow bracts appear before leaves, early in spring. Feb.	Berries, bluish-black (drupes). June - Oct.	Full sun, part shade, dappled shade	Prefers open pastures, brushy prairies, woodlands & thickets	Sands, loams, & clays. Well-drained soils, mesic to semi-dry.					X	X		X			Straggling, irregularly shaped shrub. Though not beautiful, this is the first shrub to bloom in spring. Opposite softly fuzzy leaves and blue-black berries. Deciduous.	Yellow flowers appear early in spring providing early nectar source for bees, butterflies & other insects. Berries are eaten by several species of birds & small mammals. Leaves are browsed by white-tailed deer.

Lantana horrida Lantana	Verbenaceae Vervain Family	3' - 6' Shrub	Showy yellow & orange heads made up of tiny florets. May to December (first frost).	Berries, green then dark blue-black. Sept. - Nov.	Full sun, part shade	Occurs in fields, thickets, swamps, rich sandy woods, scrub & gravelly hills.	Sands, loams & clays. Well-drained, mesic-xeric.	X	X	X	X	X	X	X				This showy shrub is planted has a long, profuse blooming season. Though not a native of Texas, it is planted almost throughout the state. It loves the hot weather. It's good to prune it back to the ground each winter. Deciduous.	Colorful, long-blooming flowers attract both butterflies and hummingbirds throughout the season. Northern cardinals and other species of birds eat the ripe fruit. Fairly deer resistant. Larval host plant of the Painted Lady.
Lonicera alba Texas honeysuckle	Caprifoliaceae Honeysuckle Family	4' - 10' Shrub	Showy white flowers. April - May	Berries, red. June - July	Full sun, part shade	Prefers rocky slopes, cliffs; also found in sandy soils, cedar brakes in Central, North Central Texas.	Sands, loams, & clays. Likes limestone soils. Well-drained, mesic.				X	X		X			X	This is a beautiful native honeysuckle. Flowers are showy in the spring and the red berries are beautiful while they last. Plant is drought tolerant in the Eastern Cross Timbers. This is not a difficult species to grow. Deciduous.	Flowers attract butterflies, bees & other insects. Translucent red fruits popular with bluebirds, cardinals, finches & sparrows, as well as neotropical migrants. Leaves browsed by white-tailed deer.
Rhus aromatica Fragrant sumac	Anacardiaceae Sumac Family	3' 8' Shrub	inconspicu-ous yellow flowers appearing before leaves. Feb. - March	Berries, red. May - June	Full sun, part shade, dappled shade.	Prefers limestone outcrops, rocky slopes, prairies, & mesquite plains.	Sands, loams & clays. Likes limestone soils. Well-drained, mesic.	X	X	X	X	X	X	X	X	X	X	Aromatic shrub with pretty leaves & early flowers. Tends to form thickets & is irregularly branched. Deciduous.	Early flowers provide early nectar source for insects like bees, butterflies & moths. The red berries are one of the earliest summer fruits making it popular with several species of birds & small mammals. Larval host plant to Red-banded hairstreak.
Rhus glabra Smooth sumac	Anacardiaceae Sumac Family	3' - 10' Shrub	Cluster of small white flowers. June - August	Red, velvety berries in clusters. Sept. - Oct.	Full sun, part shade	Occurs on dry sandy hillsides & banks in East Texas to Bryan, Blackland Prairies & Rolling Plains	Sands, loams & claims. Well-drained, mesic-xeric.	X	X	X	X							Thicket-forming shrub or sometimes small tree with lance-shaped compound leaves. Excellent for erosion control & beautiful red fall color. It prefers sand, but does in other soil types. Outside its range it needs more water & lots of sun. Deciduous.	Flowers provide lots of nectar for butterflies & other insects. The fruit is eaten by cottontails, white-tailed deer and nearly 35 species of birds. Wild turkey & bobwhite also love fruits. Larval host plant of some species of Hairstreaks.

Salvia greggii Autumn sage	Lamiaceae - Mint Family	2' - 4' Shrub	Showy magenta red flowers, also comes in white, pink or coral. April - Dec.	Nutlets. June - Dec.	Full sun, part shade	Prefers rocky soils in central, south & west Texas.	Sands, loams & clays. Likes limestone soils, esp. Well-drained, mesic-xeric.				X		X	X			X	Aromatic showy shrub which blooms prolifically spring, summer & fall. Adaptable to other areas of the state where not native. Good as ground cover or hedge. Really needs good drainage. Persistent, almost evergreen.	Abundant flowers provide copious nectar which is attractive to bees & especially hummingbirds. Ruby-throats can't seem to get enough. Provides food over the long hot summer for them when other plants have waned.
Sassafras albidum Sassafras	Lauraceae Laurel Family	15' - 20' Shrub	Showy yellow drooping clusters, before leaves sprout. March - April	Drupes, blue-black, lustrous. Sept.	Full sun, part shade	Prefers sandy woods, old fields, on road cuts & along fence rows in eastern third of Texas.	Sands, loams & clays. Poor, dry upland soils tolerated. Well-drained, mesic.	X		X								Thinly branched, well-shaped aromatic shrub. Quite ornamental with variously shaped leaves. Leaves turn yellow orange & red in fall. Female plants put on better display. Not drought tolerant, good for East Texas only. Deciduous.	Blue black fruits are bobbled up by several species of birds, i.e., king birds, great-crested flycatchers, gray catbirds, brown thrashers, robins, bluebirds, vireos, warblers & sparrows. LHP of Palamedes, Spicebush & Tiger swallowtails.
Symphoricarpus orbiculata Coral-berry	Caprifoliaceae Honeysuckle Family	1 1/2' - 6' Shrub	Showy, many-flowered greenish-white or pink, in terminal spikes. June - August	Drupe, berry-like, pink to coral-red. Sept. - Oct.	Dappled shade, part shade	Prefers woods, thickets & streamside areas in eastern 1/3 of Texas	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X		X				Hardy, slender erect thicket-forming shrub with brown shreddy bark & opposite oval-shaped leaves. Great erosion control plant. Highly ornamental. Deciduous.	Excellent cover shrub when bushy. Fruits are eaten by at least 12 species of birds including cardinals, bobwhite, quail, wild turkey bluebirds, robins, mockingbirds, thrashers & cedar waxwings.
Hesperaloe parviflora Red yucca	Agavaceae - Agave Family	Leaves 2-3' Flower stalk 5' Succulent	Showy, coral to salmon pink flowers on tall stalk. May - Nov.	Capsules. Aug. - Dec.	Full sun, part shade, dappled shade	Prefers prairies, rocky slopes & mesquite groves	Sands, loams & clays; likes limestone soils. Xeric, well-drained.			X	X	X		X				Very elegant succulent, used alot in landscapes as an accent plant. Widely adaptable to various soils. Flowers bloom profusely and for a long time. Evergreen.	Ruby-throated and Black-chinned hummingbirds are highly attracted to flowers which provide copious nectar for long periods. White-tailed deer also love to eat the flowers.
Opuntia lindheimeri Prickly-pear cactus	Cactaceae - Cactus Family	1' - 5' Succulent	Showy yellow or orange to red flowers. May	Tuna, purplish. Sept. - Oct.	Full sun	Prefers open areas, woodlands, openings, pastures, disturbed & eroded soils O.K.	Sands, loams & clays. Xeric, well-drained.		X			X	X	X	X	X	X	Hardy succulent with attractive flowers & juicy rosy-purplish fruits. Makes a good barrier plant. Evergreen.	Flowers attract many kinds of insects, especially bees, betters, butterflies, beetles &flies, etc. which are attracted to both nectar & pollen. Fruits & pads are highly sought after by several species of mammals which must brave the guard glochids.

Yucca angustifolia Narrow-leaf yucca	Agavaceae - Agave Family	1-2' leaves 2'- 6' flower stalk. Succulent	Showy panicles of creamy-white flowers. June - July	Capsules. Sept. - Oct.	Full sun, part shade	Prefers rolling, well-drained grasslands & plains.	Sands, loams & clays. Well-drained, xeric.					X			X	X		Very winter-hardy attractive accent plant, magnificent when in bloom. This plant is the most flower-like of all the yuccas. Leaves are pale green edged with fine, curly white hairs. Tips are armed with healthy spines. Can tolerate shade. Evergreen.	Waxy white flowers emit their fragrance at night attracting moths which pollinate them. Flowers are edible and popular with white-tailed deer. Larval host plant to Yucca giant skipper & Strecker's giant skipper.
Yucca arkansana Thread-leaf yucca	Agavaceae - Agave Family	2' leaves 3'- 6' flower stalk. Succulent	Showy panicles of creamy-white flowers. May - June	Capsules. Aug. - Sept.	Full sun, part shade	Prefers prairies, limestone outcrops & rocky areas	Sands, loams & clays. Well-drained, xeric.		X	X	X	X						Very striking accent plant, magnificent when in bloom. This plant is the most flower-like of all the yuccas. Leaves are pale green edged with fine, curly white hairs. Tips are armed with healthy spines. Can tolerate shade. Evergreen.	Elegant waxy flowers emit their fragrance at night attracting moths which pollinate them. Flowers are edible and popular with white-tailed deer. Larval host plant to Yucca giant skipper.
Ampelopsis arborea Peppervine	Vitaceae - Grape Family	Climber, Vine	inconspicu-ous greenish-white flowers. June - Aug.	Berries, bluish-purple. Sept. - Oct.	Part shade, dappled shade, shade	Prefers rich woodlands & bottomlands, edges of swamps, fence rows & waste places.	Sands, loams & clays. Mesic, likes soils to be moist.	X	X	X	X	X	X	X				This vigorous vine with the beautiful compound dissected leaves which are dark green on top & pale underneath can sometimes be too successful in a small garden. It is very attractive, however, if kept under control. Deciduous.	Bluish-purple berries provide a great source of food for many gamebirds & songbirds alike. Bobwhite, flickers, brown thrashers & hermit thrushes love them. Small mammals also relish them. Excellent browse for white-tailed deer.
Aristolochia tomentosa Woolly pipevine	Aristolochiaceae - Pipevine Family	Climber to 50', Vine	Bizarre dark purple & greenish yellow flower. March - May	Pods. June - Aug.	Part shade, dappled shade	Prefers deep soils along streams & river bottoms.	Sands, sandy loams, loams. Well-drained, mesic.	X	X	X	X							High climber with large handsome heart-shaped leaves and unusual flower which is slow to come into bloom. Flower looks like a Dutchman's pipe or a strange bird. Best when planted next to other shrubs so that it can use them as support. Perennial.	Woolly pipevine stems & leaves are the larval host plant of the Pipevine swallowtail.

Bignonia capreolata Cross-vine	Bignoniaceae Catalpa Family	Climber to 50', Vine	Showy, tubular flowers, red on outside, yellow on inside. March - April	Capsule with winged seeds. Aug. - Sept.	Full sun, part shade, dappled shade, shade	Prefers cool moist soils of woodlands, pinelands, also creek bottoms.	Sands, loams & clays. Moderate to high moisture. Seasonal poor drainage O.K.	X	X	X	X							Beautiful flowering vine clinging to bricks, stones & fences as well as other shrubs & trees. Profuse flowers when in bloom. Tolerates pollution well. Persistent.	Striking orange & yellow tubular flowers are highly attractive to butterflies and especially the Ruby-throated hummingbird. Bloom time coincides with migration when other sources of nectar are scarce, helping this little mite on the way.
Campsis radicans Trumpet-creeper	Bignoniaceae Catalpa Family	Climber "to the sky" , Vine	Showy orange tubular flowers in dense clusters. June - Sept.	Capsule with winged seeds. Sept. - Nov.	Full sun, part shade	Tolerates a variety of soils throughout Eastern half of Texas	Sands, loams & clays. Mesic; moderate moisture; poor drainage O.K.	X	X	X	X	X	X	X				Striking vine adapted to nearly every soil type. Excellent for hiding ugly structures. Sometimes can do too well & needs to be cut back. Persistent.	This is premier plant to attract hummingbirds. Both Ruby-throat and Black-chinned hummers are highly fond of it. Copious nectar sustains these beauties. The plant is also an excellent nectar source for the larger butterflies.
Clematis drummondii Old man's beard	Ranunculaceae Buttercup Family	Climber, Vine	Creamy white to palest yellow flowers. March - Sept.	Achenes, slender & plumose. Aug. - Oct.	Full sun, part shade	Prefers dryish soils, dry washes & rocky canyons, roadsides, fencerows & thickets.	Sands, loams & clays, likes limestone soils. Xeric, well-drained, drought tolerant.			X	X	X	X	X	X		X	A vigorous climber that will drape other trees & shrubs. Especially beautiful in late summer & fall when the feathery achenes are backlit by the sun, they glisten. This can be a very ornamental vine. Deciduous.	Old man's beard serves as an excellent protective cover & nesting site. Achenes are eaten by many species of birds. Larval host plant of the Fatal metalmark butterfly.
Clematis pitcheri Purple leatherflower	Ranunculaceae Buttercup Family	Climber, high, Vine	Showy, purple nodding urn-shaped flowers. June - Aug.	Achenes, filiform. Sept. - Oct.	Part shade, dappled shade, shade	Prefers thickets, woodland borders, likes moist low ground	Sands, loams, clays; likes limestone soils. Prefers moisture, mesic.	X	X	X	X	X	X	X				This high climbing vine with the elegant leaves and lovely flowers will clamber over a trellis, trees, or shrubs. This species is fairly cold-hardy. Deciduous.	This vine provides good cover for small birds. A thick clump is an excellent place to hide from predators. Achenes eaten by a few species of birds.
Cocculus carolinus Carolina moonseed	Menespermaceae Moonseed Family	Climber to 15' , Vine	inconspicu-ous greenish flowers. July - Aug.	Conspicuous brilliant red berries (drupes). Sept. - Oct.	Full, part shade	Prefers rich moist soils of woods & thickets	Sands, loams & clays. Tolerates gumbo soils of Houston. Well-drained, mesic.	X	X	X	X	X		X				Relatively fast growing, slender twining vine that prefers full some & some kind of support. Leaves are attractively shaped and fruits are highly ornamental. Will grow over shrubs & small trees. Evergreen.	Dense clusters of brilliant red fruit are relished by bluebirds, mockingbirds, cardinals, robins, warblers & sparrows.

Ibervillea lindheimeri Globe-berry	Curcurbitaceae - Cucumber Family	Climber, Vine	Small greenish yellow flowers. April - July	Orange to bright red globular fruit. Aug. - Oct.	Full sun, part shade	Prefers dryish soils in open woodlands or thickets, among brush, along fence rows. Tolerates rocky soils.	Sands, loams & clays. Well-drained, mesic-xeric.		X	X	X	X		X				Drought-tolerant and salt-tolerant climber with interestingly shaped leaves and decorative colorful fruit. Deciduous.	Many species of birds, both gallinaceous & large song birds eat this fruit when it is ripe. Insects are attracted to the floral nectar
Lonicera sempervirens Coral honeysuckle	Caprifoliaceae Honeysuckle Family	Climber to 40', Vine	Showy orange red tubular flowers in clusters. March - Dec.	Berries, red. April - Jan.	Full sun, part shade	Prefers moist fertile soils of East Texas, woods & thickets	Sands, loams & clays. Mesic-hydric soils; poor drainage O.K.	X	X	X	X	X						A beautiful everblooming vine that grows well & is well-behaved. Likes morning sun & afternoon dappled shade. Needs extra water when getting established, but not later. Persistent.	Ruby-throated and Black-chinned hummers are attracted to this vine spring, summer and fall, esp. during migration. Orioles also sip nectar, as do butterflies. Fruit-eating birds relish the succulent red berries in the fall. LHP of Spring Azure.
Maurandya antirrhiniflora Snapdragon vine	Scrophulariaceae Figwort Family	Climber to 3', Vine	Showy purple flowers. March - Sept.	Capsule, round. Sept. - Dec.	Full sun, part shade	Prefers limestone hills & bluffs, also dunes, shrubs & boulders.	Sands, loams, clays. Well-drained, mesic.	X	X	X	X	X	X	X			X	Elegant, delicate-leafed climber & ground cover. Fast grower; tolerates salt. Looks great in a pot. Leaves have excellent fall color. Perennial.	Fruits are a favorite with many species of birds. Flowers are a good nectar source for many kinds of insects, especially butterflies. Lush clumps provide good cover. Larval host plant of Buckeye.
Parthenocissus quinquefolia Virginia creeper	Vitaceae Grape Family	Climber & ground cover, Vine	inconspicu-ous greenish flowers. May - June	Berries, blue-black. Sept. - Nov.	Full sun, part shade, dappled shade	Prefers rich soils of woodlands & thickets & rocky banks in eastern half of TX.	Sands, loams, clays. Tolerates gumbo soils. Well-drained, mesic.	X	X	X	X	X		X				Very attractive vine with lush green palmate leaves. Vigorous climber well able to cloak walls, columns, etc. by fastening on to masonry. Also good ground cover. Striking red-orange fall color. Deciduous.	Many species of birds compete for the blue-black berries including woodpeckers, kingbirds, great-crested flycatchers, titmice, cardinals, mockingbirds, bluebirds, warblers & sparrows.
Passiflora incarnata May-pop	Passifloraceae Passionflower Family	Climber to 6', also ground cover. Vine	Showy Pink-purple flower. April - Sept.	Ovoid fruit with seeds. June - Oct.	Full sun, part shade, dappled shade	Grows in old fields, along roadsides & streams & woodland edges in Eastern 1/3 of TX.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X						This healthy climber is graced with an unbelievable intricate & eye-catching flower. It uses its tendrils for climbing & is often found sprawling over the ground, thus serving as excellent ground cover. Dormant in winter.	These beautiful vines are larval food plants for the Zebra long-wing, Gulf Fritillary & Julia butterflies. Several species of birds dine on the ripened fruits.

Passiflora lutea Yellow passionvine	Passifloraceae Passionflower Family	Climber to 3', Vine	Showy whitish-yellow flowers. May - Sept.	Fleshy globose fruit. Aug. - Nov	Part shade, dappled shade, shade	Prefers shady, low moist woods	Sands, sandy loams; likes limestone soils. Likes moisture, mesic.	X	X	X		X	X	X				Delicate looking vine with interestingly shaped leaves and complex flowers. Prefers moist & shady areas. Deciduous.	Flowers attract several kinds of insects, especially butterflies. Birds & small mammals partake of the fruit. Larval host plant of the Julia, Mexican & Gulf fritillaries, as well as Zebra & Crimson-patch longwing.
Rosa setigera Prairie rose	Rosaceae Rose Family	Climber from 9' - 15', Vine	Showy rose-pink flowers. May	Rosehips, red. July - Aug.	Full sun, part shade	Prefers openings and post oak woodlands	Sands, loams & clays, esp. calcareous soils. Well-drained, mesic.	X		X	X	X							Luscious rose-red blossoms gradually fade to white, leaving all shades in between in a tapestry of pinks. Shiny leaves turn reddish in the fall. This vine has no thorns. Fruits are bright red and highly decorative. Deciduous.	Several species of birds devour the red fruits including cardinals, mockingbirds, bluebirds, woodpeckers, Great-crested flycatchers, catbirds & thrashers.
Vitis cinerea Gray-leaf grape	Vitaceae - Grape Family	Climber, Vine	inconspicu-ous whitish-green flowers. May - June	Grapes, blue-purple to black, Aug. - Nov.	Full sun, part shade, dappled shade	Prefers moist alluvial soils along streams, thickets & bottomlands.	Sands, loams & clays. Needs moisture, mesic.	X	X	X	X	X		X				High climbing vine which can reach a large size. Leaves are large with attractive gray hairs on the under-surface. Bears lots of juicy grapes. Deciduous.	The ripe grapes are highly favored by several species of gamebirds & songbirds. Squirrels, opossums, raccoons, & foxes also partake of them.
Vitis mustangensis Mustang grape	Vitaceae - Grape Family	Climber, Vine	inconspicu-ous greenish flowers. April - May	Grapes, purple-black. Aug. - Sept.	Full sun, part shade, dappled shade	Prefers steam bottoms, thickets, fence rows, woodland edges & sandy areas.	Sands, loams, clays; likes limestone soils. Well-drained, mesic.	X	X	X		X	X	X				Highly vigorous climber. May need to be cut back. Can grow over trellises, fences, arbors & trees. Deciduous.	Birds such as mourning doves, gallinaceous birds, woodpeckers, kingbirds, blue jays, flycatchers, mockingbirds, cardinals, thrashers, thrushes, finches & sparrows dine voraciously on the fruit. Grapes are also a favorite of many mammals.
Andropogon gerardi Big blue stem	Poaceae Grass Family	3' - 6', Grass	Flowering spikelets of green to golden-tan in form of turkey foot. Aug. - Nov	Seeds. Sets seed shortly after flowering.	Full sun	Prefers moist soils of meadows & prairies in the eastern 1/2 of state	Sands, loams & clays, acid or calcareous. Moderate moisture, mesic.	X	X	X	X	X	X	X	X	X	X	This big prairie perennial can be used as meadow grass with wildflowers, pocket tallgrass prairie or garden accent. Adds dramatic component. Needs rich, deep soil with moisture present. Good erosion control. Best placed at bottom of slope. Winter dormancy	Provides good cover & food for many species of wildlife. Grass parts used as nesting & denning material. Larval host plant of Delaware Skipper, Dusted Skipper, Bunchgrass Skipper, Large Wood Nymph, Cobweb, Clouded & Beard grass skippers.

Andropogon glomeratus Bushy bluestem	Poaceae Grass Family	3' - 4' Grass	Flowering spikelets green to buffy gold. Sept. - Nov.	Seeds. Sets seed shortly after flowering.	Full sun, part shade	Prefers low moist sites	Sands, sandy loams, soils can be fairly sterile. Mesic, poor drainage O.K.	X	X	X	X	X	X	X	X	X	X	Very attractive bunch grass for moist areas. Especially pretty in the fall. Tolerates poor drainage. Warm-season perennial.	Provides food & cover for many species of wild birds & mammals. Culms, leaves are used as nesting & denning material. Larval host plant of several eastern skippers.
Andropogon ternarius Split-beard bluestem	Poaceae Grass Family	1 1/2' - 4' Grass	Flowering spikelets green to silvery gold, Aug. - Nov.	Seeds. Sets seed shortly after flowering.	Full sun, part shade	Prefers open areas & woodland edges, cut over woodland pastures	Sands & sandy loams. Well-drained, mesic.	X	X	X	X	X						This beautiful grass is its most beautiful in the autumn backlit by the sun. A good meadow grass planted with wildflowers. Warm-season perennial.	Provides food & cover for many species of wild birds & mammals. Culms, leaves are used as nesting & denning material. Butterflies use grass as shelter on windy days. Larval host plant of several skippers.
Andropogon virginicus Broomsedge	Poaceae Grass Family	3' - 4' Grass	Flowering spikelets green to yellow gold. Sept. - Nov.	Seeds. Sets seed shortly after flowering.	Part shade, dappled shade	Prefers loose moist soils of oak woods & prairies, also shaded banks along streams	Sands & sandy loams, loams. Mesic.	X	X	X	X							This beautiful grass is its most beautiful in the fall with its perky bushy head that looks like a broom. Takes on a lovely golden color. Warm-season perennial, dies back in winter.	Provides food & cover for many species of wild birds & mammals. Culms, leaves are used as nesting & denning material. Provides fair grazing for wildlife. Butterflies use grass as shelter on windy days. Larval host plant of Zabulon skipper.
Bouteloua curtipendula Sideoats grama	Poaceae Grass Family	2' - 6' Grass	Spikelets, yellowish, arranged down along stem. May - Oct.	Seeds. June - Nov.	Full sun, part shade, dappled shade	Tolerates a variety of open places throughout state. Does well in disturbed areas. Not as common in eastern forests.	Sands, loams & clays, both limestone & igneous soils. Well-drained, mesic-xeric.	X	X	X	X	X	X	X	X	X	X	Our state grass is a strong perennial and works well as a garden accent. Competes well with short grasses but not tall-grass prairie grasses. Great choice for wildflower meadow garden. Warm-season perennial bunch grass. Dormant in winter.	Provides good grazing for wildlife and an abundance of bird seed for seed-eating birds of several varieties. Food available spring, summer & fall. Grass parts used as nesting & denning material. Larval host plant for Dotted skipper & green skipper.

Bothriochloa barbinodes Cane bluestem	Poaceae Grass Family	3' - 6' Grass	Flowering spikelets from whitish green to silver. April - Aug.	Seeds. May - Oct.	Full sun, a little shade O.K.	Prefers looser soils in the western 2/3rds of the state. Grows in open areas & grasslands.	Sands, sandy loams, loams; likes limy soils. Well-drained, xeric.			X			X	X	X	X	X	X	Very attractive accent plant or member of a pocket prairie or field of wildflowers. Perennial bunch grass.	Cane bluestem is an excellent forage grass for wildlife. Leaves are grazed, especially later on in the season. Grass parts used as nesting & denning material. Seeds eaten by granivorous birds & small mammals.
Buchloe dactyloides Buffalograss	Poaceae Grass Family	3" -12" Grass	Flowering spikelets yellowish green. June - Nov. or whenever not dormant.	Seeds. Sets seed shortly after flowering.	Full sun	Prefers open areas in many kinds of soils, short-grass prairies of Central & North Central Texas	Sands, loams & clays. Well-drained, xeric.			X	X	X	X	X	X	X	X	X	This is a wonderful turf grass. It takes a little longer to establish in caliche soils. Once established, it is very drought tolerant. It turns a soft golden brown when it goes dormant. Perennial - Turf grass.	Buffalograss provides fine nesting & denning materials, especially for lining bird's nests. Seeds of male flowers are eaten by small granivorous birds. Is the larval host plant of the Green skipper.
Chasmanthium latifolium Inland sea-oats	Poaceae Grass Family	2' - 4' Grass	Flowering spikelets green to buffy tan. June - Oct.	Seeds. Sets seed shortly after flowering.	Part shade, dappled shade, full shade	Prefers moist woodland soils, often along creek bottoms & near streamsides.	Sands, loams & clays. Mesic, seasonal poor drainage O.K.	X	X	X	X	X	X	X	X			In moist soils in shaded areas, this beautiful grass makes a solid mat. Big drooping spikelets are especially fetching, esp. when turned to whitish gold in the fall. Great garden accent plant in shady moist areas. Warm season perennial dies back in winter	Serves as excellent forage for wildlife esp. birds & mammals. Many parts of the grass used as nesting & denning material. Larval host plant for Northern pearly eye, Pepper & salt skipper, Bell's roadside skipper & Bronzed roadside skipper.
Chloris cuculata Hooded windmillgrass	Poaceae Grass Family	1' - 1 1/2' Grass	Flowering spikelets yellow green to straw then brown. May - June	Seeds. Aug. - Sept.	Full sun, part shade	Prefers pastures, lawns, parks & vacant lots	Sands, sandy loams of medium to coarse texture, acid to neutral. Mesic.				X		X		X				Attractive octopus-like flowering head. Warm-season perennial.	Hooded windmillgrass provides fairly good forage for wildlife. Seeds are eaten by birds & small mammals. Grass parts used as nesting & denning material.
Elymus canadensis Canada wildrye	Poaceae Grass Family	3' - 5' Grass	Flowering spikelets green turning gold, with long awns. March - June	Seeds. May - Sept.	Full sun, part shade, dappled shade	Prefers shaded sites along fence rows, woods borders & moist ravines throughout state. Absent in southern part of South TX.	Sands, loams & clays. Well-drained, mesic.		X	X	X	X	X	X	X	X	X	X	This tufted grass with attractive seed heads does best in shady areas with adequate moisture. Cool-season tufted perennial.	Provides good early food for many species of birds & small mammals that eat grain. Grass parts, leaves, stems, & spikelets used as nesting & denning material. Larval host plant for Zabulon skipper.

Eriochloa sericea Texas cupgrass	Poaceae Grass Family	3' - 4' Grass	Flowering spikelets green turning yellowish. March - August	Seeds. April - Nov.	Full sun, some shade O.K.	Prefers prairies & grassy openings in scrub woodlands	Sands, loams & clays; likes limestone soils. Well-drained, mesic.	X		X	X	X	X	X			Texas cupgrass can be used as a meadow grass with wildflowers or as a pocket prairie grass. Perennial.	Texas cupgrass provides good cover & excellent forage for many species of wildlife. Grass parts are used as nesting & denning material by birds & small mammals.
Muhlenbergia lindheimeri Big muhly	Poaceae Grass Family	2' - 5' Grass	Flowering spikelets silvery green to golden tan. July - Aug.	Seeds. Sept. - Nov.	Full sun, part shade	Prefers limestone uplands near streams	Calcareous clays & limestone soils. Well-drained, mesic.			X	X	X	X				This is a highly attractive bunch grass. Serves as a striking accent plant in any garden. Plant sports silvery golden plumes in the fall. Warm-season perennial.	Big muhly is a good forage grass for wildlife. Birds readily eat the ripe seeds. Grass parts are used for nesting & denning material.
Muhlenbergia reverchonii Seep muhly	Poaceae Grass Family	1' 3' Grass	Flowering spikelets green to golden tan. Aug. - Nov	Seeds. Sept. - Dec.	Full sun, a little shade O.K.	Prefers rocky soils with limestone base often in seep areas.	Calcareous soils, clays, limestone based soils. Well-drained, mesic.			X	X		X	X			This is a very attractive delicate-headed grass with curly-cue leaves bunched at the base. Warm-season perennial.	Seep muhly offers fair forage for small seed-eating birds. Leaves are used as nesting & denning material.
Panicum virgatum Switchgrass	Poaceae Grass Family	3' - 6' Grass	Flowering spikelets green turning rich gold. Aug. - Sept.	Seeds. Oct. - Nov.	Full sun, part shade	Prefers seasonally moist, open areas throughout Texas.	Sands, loams & clays. Moist. Seasonal poor drainage O.K.	X	X	X	X	X	X	X	X	X	Gorgeous tall-grass can be used as dramatic accent plant. Turns deep, rich golden color in fall. Has airy, filigreed seedhead. Can also be used in small pocket prairie. Does great in Houston, loves the extra water. Warm-season perennial bunch grass.	Provides fair grazing for wildlife, seeds sought after by seed-eating birds. Excellent sparrow food in winter. Provides good protective cover and nesting & denning material. Good place for butterflies to get out of the wind. LHP for Delaware skipper.
Paspalum plicatulum Brownseed paspale	Poaceae Grass Family	3' - 5' Grass	Flowering spikelets green turning dark brown. May - July	Seeds. June - Nov.	Full sun, part shade	Prefers open oak woodlands	Sands, & sandy loams. Mesic.	X		X	X	x					This bunch grass sets seed throughout much of the year. Warm-season perennial.	Seeds provide fairly good forage for wildlife, both grazers & seed-eating birds. Parts of the grass are used as nesting & denning material.
Schizachyrium scoparium Little bluestem	Poaceae Grass Family	2' - 5' Grass	Flowering spikelets bluegreen to silvery gold. Aug. - Dec.	Seeds. Sept. - Dec.	Full sun, part shade	Prefers woods openings, rocky slopes of pastures & rangeland, along forest borders and prairies throughout Texas.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X	X	X	Most wide-ranging bunchgrass, a dominant of the tallgrass prairie. Tolerant of a wide variety of moisture & drought. Little bluestem is a symphony of beautiful color changes through the year from blue-green to coppery gold. Perennial. Winter	Provides fairly good grazing for wildlife. Good cover grass, grass parts provide denning & nesting material for birds & mammals. Larval host plant for Dusted skipper, Delaware skipper, Dixie skipper, Cross-line skipper & Cobweb skipper.

																		dormancy.	
Sorghastrum nutans Indiangrass	Poaceae Grass Family	3' - 8' Grass	Flowering spikelets a deep yellow. Oct. - Nov.	Seeds. Nov. - Dec.	Full sun, some shade O.K.	Prefers moist rich soils of tall-grass prairies of central & coastal TX	Sands, loams & clays. Likes calcareous soils. Likes moisture, mesic.		X	X	X	X		X				This gorgeous grass was major component of tallgrass prairie. Striking accent plant or member of pocket tallgrass prairie. Does well in a naturally moist rich swale area. Warm-season perennial bunch grass. Dormant in winter.	Fairly good grazing for wildlife when green. Seed-eating birds and small mammals eat ripe seeds. Stems, leaves used as nesting & denning material. Provides excellent protective cover for wildlife. Larval host plant of Pepper-and-salt skipper.
Sporobolus asper Tall dropseed	Poaceae Grass Family	3' - 5' Grass	Flowering spikelets light green to straw, in contracted panicles. Aug. - Oct.	Seeds, Sept. - Dec.	Full sun, some shade O.K.	Prefers open, rocky prairie sites, open meadows & woods	Sands, loams, clays; likes limestone soils. Mesic, tolerates dry soils.	X	X	X	X	X	X	X	X			There are many varieties of this species that are adapted to the various soils. Warm-season perennial.	Provides good forage for seed-eating mammals & birds, also fair grazing for larger mammals. Grass parts used as nesting & denning material.
Tridens flavus Purple-top grass	Poaceae Grass Family	2' - 4' Grass	Flowering spikelets yellow to purplish. June - Aug.	Seeds. Aug. - Nov	Part shade, dappled shade	Prefers shade of open woods or along roadways throughout the state	Sands, sandy loams, clays. Well-drained, mesic.	X	X	X	X	X		X	X	X	X	Tall, slender bunch grass with elegant purplish seed head. Very graceful appearance. Warm-season perennial.	Purple-top grass provides fairly good grazing & forage for wildlife. Parts of the grass are used for nesting & denning material. Larval host plant for Cross-line skipper, Large wood nymph, Little Glassywing & Broad-winged skipper.
Triplasis purpurea Purple triplasis	Poaceae Grass Family	2' - 3 Grass	Flowering spikelets greenish-tan to purplish. June - Sept.	Seeds. Aug. - Nov	Full sun	Prefers open areas of loose sands	Sands, sandy loams. Well-drained, xeric.	X	X	X	X	x	X	X	X			This diminutive attractive grass with the small purplish seed head prefers sandy areas. Warm-season perennial.	Purple triplasis provides fairly good grazing & seed crop for granivorous birds & other kinds of wildlife.

Tripsacum dactyloides Eastern gammagrass	Poaceae Grass Family	3' - 8' Grass	Flowering spikelets yellow & cornlike. July.-Sept.	Seeds. April - Nov.	Full sun, part shade, dappled shade	Prefers low moist grassland sites in eastern portion of state.	Sands, loams & clays. Mesic, likes extra moisture. Seasonal poor drainage O.K.	X	X	X	X	X		X				Forms very dense clump useful for buffer or areas of separation. Likes more shade & moisture than most grasses. Also dramatic accent plant. Can be grown in pure stands as pasture grass. Warm-season perennial bunch grass.	Good protective cover for small birds & mammals. Grass parts provide nesting & denning material. Provides very good forage for wildlife. Larval host plant to the Bunchgrass skipper.
Asclepias tuberosa Butterfly-weed	Asclepiadaceae Milkweed Family	1' - 2' Wildflower	Showy orange complex flowers. April - Sept.	Follicle with comose seeds. June - Nov.	Full sun, part shade, dappled shade	Prefers prairies, meadows, open woods & thickets in Eastern Texas & west to Hill Country.	Sands, loams, clays & limestone soils. Well-drained, mesic.	X	X	X	X		X					With its splashy orange, complex flowers, this is our most striking milkweed. It is very drought-tolerant once it is established and lives for a very long time. Has a big taproot. Perennial.	This milkweed is a larval host plant for Milkweed butterflies such as the Monarch and the Queen. The female lays her eggs on the stems & leaves of the plant. Caterpillars feed on the milky sap sequestering the secondary compounds making them poisonous.
Callirhoe involucrata Winecup	Malvaceae Mallow Family	6" - 12" Wildflower	Showy deep magenta to wine-red flowers. March - May	Capsules. May - July	Full sun, part shade, dappled shade	Prefers open woods, prairies, meadows & fields	Sands, loams, clays or gravelly soils, either calcareous or acid-based. Well-drained, mesic.	X	X	X	X	X	X	X	X	X	X	Beautiful wine-colored wildflowers that can grace any wildflower meadow garden. These plants tend to sprawl & have trailing stems. Even clambering over small shrubs. Respond to extra watering by blooming for a much longer of period of time. Perennial.	Winecup is visited by bees which gather pollen from the flowers.
Camassia scilloides Wild hyacinth	Liliaceae - Lily Family	6" - 2' Wildflower	Showy lavender flowers on 6-inch spikes, fragrant. March - May	Capsule, three-valved with roundish black shiny seeds. March - May	Full sun, part shade, dappled shade	Prefers sandy or rocky soils in meadows, fields prairies & open woods from Central Texas northward, also Edwards Plateau.	Sands, loams, clays & limestone soils. Well-drained, mesic.			X	X	X		X				Delicate lavender spikes do best on a gentle slope where there is good drainage. Does well in shady areas especially where the soils are drier. Perennial.	Bees & butterflies are attracted by the fragrant flowers & forage avidly for nectar.

Delphinium carolinianum Prairie larkspur	Ranunculaceae Buttercup Family	1 1/2' - 3' Wildflower	Showy blue to white spurred flowers on 6-inch spikes. April - May	Follicle with numerous brown seeds. June - July	Full sun, part shade	Prefers open woods, fields, meadows & prairies, also grows along roadsides of Northeast Texas & the Edwards Plateau	Sands, loams, clays; tolerates calcareous or acid soils. Well-drained, mesic.	X		X	X	X		X				Attractive wildflowers for a pocket prairie or meadow garden. This species come in various color varieties from white to pale blue to dark blue. Perennial.	Prairie largespur attracts several varieties of insects that forage on the nectar. Bees are especially fond of these flowers.
Erythrina herbacea Coralbean	Leguminosae - Legume Family	6' - 15' Wildflower, shrub in S. Texas	Showy coral red tubular flowers. May - Dec.	Pods with poisonous red seeds. Oct. to Dec.	Full sun, part shade	Prefers sandy woods on coastal plain, but will grow elsewhere.	sands, loams & clays. Well-drained, mesic.	X	X	X	X	X						Striking shrubby wildflower dies back in winter like a perennial in all areas but south Texas. Flamboyant summer flowers are highly ornamental. Seeds are also attractive, though extremely poisonous. Perennial.	Elegant tubular flowers have copious nectar & are highly attractive to the Ruby-throated hummingbird. Seeds, though highly appealing visually, are poisonous and not eaten by wildlife.
Eupatorium serotinum Late boneset	Asteraceae - Sunflower Family	2' - 5' Wildflower	Showy off-white flower heads. Sept. - Nov.	Achenes. Nov. - Jan.	Full sun, part shade	Prefers open places, woodland edges, near ponds.	Sands, loams & clays. Likes moisture, mesic.	X	X	X	X	X						This late blooming shrub with opposite leaves and much-branched, flat-topped terminal flower clusters often forms colonies. Deciduous/Persistent.	Masses of off-white flowers is an excellent nectar source for migrating monarch butterflies & other late foraging insects. Plants provide good protection for butterflies on windy days. Many species of sparrows &finches eat the ripe achenes in winter.
Helianthus maximiliani Maximilian sunflower	Asteraceae Sunflower Family	4' - 6' Wildflower	Showy bright yellow flowers. Aug. - Oct.	Achenes. Nov. - Dec.	Full sun, part shade	Prefers seasonally moist ditches & depressions in grasslands, prairies & meadows in Edwards Plateau, North & South East Texas.	Sands, loams, clays & limestone-based soils. Well-drained, xeric; tolerates seasonally poor drainage.			X	X	X	X	X	X		X	With its bright yellow flowers, Maximilian sunflower is gorgeous in the fall. Does very well growing among native grasses in a pocket prairie. Occurs in colonies on both dry & moist ground. Perennial.	Maximilian sunflower provides copious nectar to butterflies & bees in the fall.
Lobelia cardinalis Cardinal flower	Campanulaceae Campanula Family	6" - 6' Wildflower	Showy red tubular flowers, fragrant. May - Oct.	Capsules with seeds. June - Nov.	Full sun, part shade, dappled shade	Prefers moist soils in open places along streams, meadows & along roadsides; also about ponds & springs, & near swamps where the shade is not too dense.	Sands, loams, clays & limestone based soils. Moist soils, poor drainage O.K.	X	X	X	X	X	X	X	X	X	X	Cardinal flower cannot be equalled for sheer visual impact, planted in dense stands in a shady part of the garden. In peak bloom they create an incredible spectacle. Bright scarlet flowers are clustered on racemes as long as 18". Perennial.	Cardinal flower is a premiere hummingbird plant and will not fail to draw in any Ruby-throats passing through your area.

Malvaviscus drummondii Turk's cap	Malvaceae - Mallow Family	4' - 9' Wildflower, shrub in South TX	Showy red flowers. May - Nov.	Berry-like fruit, red, flattened. Aug. - Sept.	Part shade, dappled shade, shade	Prefers moist woodlands, wood margins, streamsides, river edges in shady conditions. Low grounds.	Sands, loams & clays. Likes limestone soils, tolerates gumbo. Hydric-mesic, likes moisture.	X	X	X	X	X	X	X				A good ornamental for shady situations. Forms colonies in shady spots. Serves as good ground cover. Best pruned back after 2 years. Deciduous.	Attractive red flowers are very popular with hummingbirds. Butterflies, diurnal moths & other insects are also attracted to the flowers. The bland fruit is eaten by several species of birds & small mammals.
Nemastylis geminiflora Prairie celestial	Iridaceae Iris Family	5" - 10" Wildflower	Showy lavender-blue to white flowers. March - May	Capsules with angular brown seeds. March - May	Full sun, part shade, dappled shade	Prefers clay & limestone soils from South to North Central Texas, including the Edwards Plateau.	Sands, clays, especially limestone soils. Well-drained, mesic.			X	X	X		X				Prairie celestials are an ethereally beautiful flower that will grace any wildflower meadow garden. They grow well in grassy areas & are often found in colonies. Perennial.	Bees of various kinds are attracted to the flowers.
Salvia coccinea Scarlet sage	Lamiaceae Mint Family	2'- 4' Wildflower	Showy red tubular flowers. May - Dec.	Calyx with nutlets. June - Dec.	Full sun, part shade, dappled shade	Prefers sandy soils in thickets, chaparral, on edges of open woods from East to South Texas.	Sands, loams, clays & caliche-type soils. Mesic, seasonal poor drainage O.K.	X	X	X	X	X	X	X				Scarlet sage can thrive in any part of the state. It is not very cold-hardy, however. Oddly, it looks better if planted in dry, shady areas with poor soil. In rich soils with lots of water it gets very tall, coarse & slightly unattractive. Perennial.	Scarlet sage is another excellent hummingbird plant & will draw in the hummingbirds of your area, including any migrants passing through in spring & fall. Bees & other insects are also attracted to the nectar, despite the red flower color.
Solidago canadensis Giant goldenrod	Asteraceae - Sunflower Family	2' - 7' Wildflower	Showy yellow flowers in pyramidal heads. Sept. - Nov.	Achenes. Oct. - Nov.	Full sun, part shade	Prefers open fields, meadows, prairies & moist soils near streams	Sands, loams & clays, also caliche-type soils. Mesic, poor drainage O.K.	X	X	X	X	X	X	X	X	X	X	Goldenrod is spectacular in the autumn. Its large pyramidal flower clusters infuse golden color into wildflower meadows. Perennial.	Bees & butterflies gather pollen from goldenrod in the fall.
Castilleja indivisa Indian paintbrush	Scrophulariaceae Figwort Family	6" - 12" Wildflower	Showy orange to red bracts. March - May	Capsules with seeds. May - July	Full sun, a little shade O.K.	Prefers fields, meadows, prairies & roadside areas in Eastern portion of the state including the Coastal plains	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X				Indian paintbrush is an excellent choice for a pocket prairie or meadow garden. Grows very well when planted with native grasses. Looks great when interspersed among masses of bluebonnets & showy evening primrose. Annual.	Insects of several varieties are attracted to the small flowers. Hummingbirds will also feed from them, attracted to the red-orange bracts that surround them. Larval host plant of the Buckeye.

Coreopsis tinctoria Golden wave	Asteraceae Sunflower Family	1' - 4' Wildflower	Showy yellow daisy-like flowers with brown centers. March - June or later depending on rain.	Achenes. May - Aug.	Full sun, part shade	Prefers seasonally moist soils in the eastern portion of the state, but grows throughout.	Sands, loams, clays; either calcareous or acid. Mesic, seasonal poor drainage O.K.	X	X	X	X	X	X	X				Great profusions of this golden yellow flower blanket roadsides & meadows, like undulating waves of a golden ocean. Annual.	Golden wave attracts a wide variety of insects, especially bees & butterflies who sip nectar from the disk flowers. Ripe achenes are sought after by many species of seed-eating birds, especially the Painted Bunting.
Eustoma grandiflora Texas bluebells	Gentianaceae Gentian Family	1' - 2' Wildflower	Showy blue-purple flowers. June - Oct.	Capsule with seeds. Aug. - Nov.	Full sun, part shade	Prefers damp prairies, pond edges, open fields & banks along streams throughout much of Texas	Sands, loams & clays. Mesic, seasonal poor drainage O.K.	X	X	X	X	X	X	X	X			Texas Bluebell, otherwise known as Bluebell Gentian is a showy wildflower that responds favorably to good soils, extra water & a little fertilizer. Leaves are pale greenish blue & very attractive also. Annual.	Texas bluebell is very attractive to several kinds of insects, especially bees & butterflies.
Gaillardia pulchella Indian blanket	Asteraceae Sunflower	1' Wildflower	Showy yellow & red daisy-like flowers. March - Oct.	Achenes. May - Nov.	Full sun, part shade	Prefers open grassy areas, prairies, meadows, also disturbed areas in a variety of soils	Sands, loams & clays. Well-drained, mesic-xeric.	X	X	X	X	X	X	X	X	X	X	This is a marvelously easy wildflower to grow & it comes in various coloration patters from mainly yellow to mostly reddish. Blooms most of the season from spring to late fall & provides lots of color to a wildflower meadow. Annual.	Indian blanket attracts bees, butterflies & several other varieties of small insects who forage on the nectar. Ripe seed heads are favorites with many species of seed-eating passerines like the Painted Bunting.
Ipomopsis rubra Standing cypress	Polemoniaceae Phlox Family	2' - 6' Wildflower	Showy red-orange tubular flowers. May - June	Seeds elongate, swelling when wet. July - Aug.	Full sun, part shade, dappled shade	Prefers rocky or sandy ground in fields or along edges of woods in Edwards Plateau, Cross Timbers, Oak Woods & Prairies & East Texas. Also Piney Woods	Sands, loams & gravelly soils. Well-drained, mesic.	X		X	X	X	X		X			With splashy red-orange flowers & elegantly divided threadlike leaves, standing cypress is a spectacular plant. It does not flower the first year seeds are planted but forms a low attractive basal rosette. Biennial.	Standing cypress is a wonderful hummingbird plant. Exerted yellow anthers & red tubular flowers attract any hummer in the area. Hummer's heads get yellow with pollen as they zip from flower to flower.

Lupinus texensis Texas bluebonnet	Leguminosae Legume Family	8" - 16" Wildflower	Showy blue and white pea-like flowers in racemes, fragrant. March - May	Legume. May - July	Full sun, a little shade O.K.	Prefers open fields, meadows & prairies, also roadside areas throughout much of the state from Corpus Christi to Abilene.	Sands, loams, clays & limestone soils; really likes calcareous soils. Well-drained, mesic-xeric.	X	X	X	X	X	X	X	X			Our state flower, this Texas endemic cloaks meadows, prairies & roadsides come spring in an ocean of blue. An incredible sight that dazzles all newcomers to the state. Takes a little work to get established and depend on the fall rains. Annual.	Bluebonnets are attended by bees & other insects who forage on the nectar & pollinate the plants. Plants let the bees know a particular flower has been pollinated by turning from white to dark red at the center of the banner. LHP of hairstreaks & elfins.
Rudbeckia hirta Brown-eyed Susan	Asteraceae Sunflower Family	1' - 2' Wildflower	Showy yellow ray flowers with dark brown centers. May - Sept.	Achenes. July - Nov.	Full sun, part shade, dappled shade	Prefers open prairies, grasslands & woodland meadows in the eastern two-thirds of the state.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X	X			Black-eyed Susans provide a lush splash of color in your meadow garden or pocket prairie. It does especially well if the rains are good or with a little extra watering. It will grow well in both partially shady areas & the sun. Annual.	Bees, butterflies & many other kinds of insects forage for nectar from these flowers all summer. In the fall when the flowers have good to seed, numerous seed-eating birds forage on the ripe achenes.

WildScapes Plant List -- Blackland Prairie

SPECIES	FAMILY	HABIT / HEIGHT	FLOWER	FRUIT	SUN EXPOSURE	HABITAT	SOILS & MOISTURE REGIME	VEGETATION ZONE									ORNAMENTAL VALUE	WILDLIFE VALUE
								1	2	3	4	5	6	7	8	9	10	
Bumelia lanuginosa Woolly-bucket bumelia	Sapotaceae - Sapodilla Family	Tree, large 40' - 80'	White perfect flowers, fragrant June - July	Berries, blue-black Sept. - Oct.	Full sun, Part shade	Mostly uplands, sometimes bottomlands, woodlands, edges and fencerows.	Sandy loams, loams, and clays. Tolerates gumbo. Well-drained, mesic..	X	X	X	X	X	X	X	X		X	Large shade tree with simple green leaves with white woolly undersurface. Persistent.	Several species of birds feed on the fruit, including cardinals, finches, robins, cedar waxwings, warblers, and vireos. Good cover and nesting tree due to protective thorns. Good substrate for insectivorous birds.
Carya illinoenensis Pecan	Juglandaceae - Walnut Family	Tree, large 50' - 60'	inconspicu-ous catkins, m & f, yellowish on same tree. March - May	Nut Sept. - Oct.	Full sun, Part shade	Prefers rich bottomlands	Sands, loams, or clays. Well-drained, mesic.	X	X	X	X	X	X	X	X			Beautiful shade tree with elegant compound leaves. Prefers deep, rich soils but will grow in thinner soils. Sometimes turns yellow in fall. Deciduous.	Sweet edible nuts valuable for all kinds of wildlife, birds and mammals alike including woodpeckers, jays, sparrows, fox squirrel, gray squirrel, opossum, and raccoons. Good substrate for insectivorous birds. Larval host plant for Gray hairstreak.
Celtis laevigata Sugarberry	Ulmaceae - Elm Family	Tree, large 40' - 60'	inconspicu-ous, small, greenish. May - June	Berry (drupe), orange-red to purplish-black. July-Aug.	Full sun, part shade	Rocky or alluvial soils along streams, in woodlands & thickets.	Sands, loams, and clays. Prefers rich soils, but will tolerate wide range. Well-drained, mesic to xeric; drought tolerant once established.	X	X	X	X	X	X	X	X	X	X	Fast-growing shade tree adapted to most soils. Very drought tolerant. Yellow autumn color. Deciduous.	Fruit eaten by bluebirds, robins, cardinals, mockingbirds, cedar waxwings, thrashers, & sparrows. Good nest & cover tree, esp. for neotropical migrants. Larval food plant for Question Mark, Mourning Cloak, Pale Emperor, Snout & Hackberry butterflies.
Fraxinus pensylvanica Green ash	Oleaceae - Olive Family	Tree, large 30' -80'	inconspicu-ous m & f yellowish catkins & spikes. April - May	Samara Sept. - Oct.	Full sun, part shade	Alluvial woods & swamps along rivers & streams, swales & depressions in prairies	Acid sands, sandy loams & heavy limestone clays. Needs moisture; poor drainage O.K.	X	X	X	X	X	X	X	X			Fairly fast-growing & long-lived shade tree. Brilliant yellow autumn color. Deciduous.	Excellent cover and nesting tree. Cardinals, finches, red-winged blackbirds relish fruit. Foliage browsed by cottontails and white-tailed deer. Larval host plant for Two-tailed tiger swallowtail and Tiger swallow-tail.

Gleditsia triacanthos Common Honeylocust	Leguminosae - Legume Family	Tree, large 50' - 100'	inconspicuous m & f perfect or imperfect flowers. May - June	Legume Sept. - Oct.	Full sun, part shade	Prefers rich deep soils of Eastern 1/3 of Texas.	Loams & clay, Needs moisture, mesic.	X	X	X	X	X	X	X				Heavily thorned tree with pretty leaves. Deciduous.	Good protective cover and nesting tree. Sweet pulp of young pods eaten by deer, fox & gray squirrels, rabbits and deer. Bees & butterflies attracted to nectar. Good honey tree. Larval host plant for Silver-spotted skipper.
Juglans nigra Black walnut	Ulmaceae - Elm Family	Tree, large 40' - 80'	inconspicuous catkins, m & f, yellowish-green. April - May	Walnut Sept. - Oct.	Full sun, part sun	Deep, rich soils of woodlands	Limestone soils, rich in calcium. Well-drained, mesic.		X	X	X	X		X	X			Shade tree with graceful appearance and fast growth rate. Immune to pests. Deciduous.	Nuts are preferred food of squirrels which disperse seeds. Woodpeckers, jays and gamebirds also like nuts. Good cover and nest tree for birds. Larval host plant of the Banded hairstreak.
Platanus occidentalis Sycamore	Platanaceae - Sycamore Family	Tree, large 100' - 150'	inconspicuous m & f globose heads reddish, greenish. April - May	Round seed head Sept. - Oct.	Full sun, part shade	Rich bottomland soils along streams and creek bottoms	Sands, sandy loams, and clays. Well-drained, mesic.	X	X	X	X	X	X	X				Majestic shade tree. Fast-growing with pretty leaves and bark. Deciduous.	Globose fruit with seeds eaten by a variety of birds and mammals, including muskrat. Goldfinches, purple & house finches are especially fond of fruit. Good substrate for insectivorous birds.
Populus deltoides Eastern cottonwood	Salicaceae - Willow Family	Tree, large 40' - 100'	inconspicuous m & f catkins red & brown. March - June	Brown f capsules with cottony seeds May - June	Full sun, part shade	Rich bottomland soils along streams	Sands, loams, and clays. Well-drained, mesic.	X	X	X	X	X	X	X	X			Very large shade tree with fluttery green leaves. Fast-growing with excellent fall color. Easy to establish. Deciduous.	Foliage, bark, seeds & leaves important to wildlife esp. deer & rabbits. Seeds eaten by many birds, esp. grosbeaks & cardinals . Cottony seeds used to line nests. Larval host plant for Mourning Cloak, Red-spotted Purple, Viceroy & Tiger Swallowtail.
Quercus macrocarpa Bur oak	Fagaceae - Beech Family	Tree, large 60' - 80'	inconspicuous m & f catkins, red & greenish. March - April	Acorns Sept. - Oct.	Full sun, part shade	Prefers moist forests along streams & in fallow fields	Sands, loams, and clays. Well-drained, mesic.		X	X	X	X		X	X			Very graceful shade tree, widely adaptive, fast-growing for an oak. Attractive leaves, unusual acorn, drought resistant & long-lived. Deciduous.	Important source of food for several species of birds, woodpeckers, jays, game birds. Also sought after by mammals, white-tailed deer, squirrels & raccoons. Good substrate for insectivorous birds. Larval host plant for Sleepy & Juvenal's Duskywing.

Quercus muehlenbergii Chinkapin oak	Fagaceae - Beech Family	Tree, large 40' - 60'	inconspicu-ous catkins, m & f, cream to yellowish. March - June	Acorns Sept. - Oct., every 2 years	Full sun, part shade	Prefers upland forested areas	Loams, clays & limestone soils. Well-drained, mesic.				X	X		X			X	Beautiful, fast-growing shade tree. Attractive leaf shape. Bronze autumn color. Deciduous.	Sweet, edible nuts favored by many species of birds & mammals, deer, raccoons, opossums & squirrels. Good nesting and cover tree. Good substrate for insectivorous birds. Larval host plant to Horace's Duskywing.
Quercus shumardii Shumard red oak	Fagaceae - Beech Family	Tree, large 50' - 100'	inconspicu-ous catkins, m & f, greenish. March - May	Acorns Sept. - Oct., every 2 years	Full sun, part shade	Prefers moist forest & limestone upper woods	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X						Gorgeous shade tree with beautiful leaves. Red color in autumn. Fast-growing & disease resistant. Deciduous.	Acorns eaten by a number of birds & mammals. Good cover and nesting tree. Good substrate for insectivorous birds. Larval host plant for a few species of Duskywings.
Ulmus americana American elm	Ulmaceae Elm Family	Tree, large 40' - 80'	inconspicu-ous red to green flowers. Feb.-April	Samara March - June	Full sun, part shade	Prefers rich soils along streams & lowland areas	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X		X	X			Excellent shade tree turning yellow gold in autumn. Fast growing & handsome shape. Long-lived. Larval host plant to Comma, Question Mark, Mourning Cloak & Painted Lady. Deciduous.	Seeds & buds eaten by gamebirds, woodpeckers, chickadees, robins, vireos, sparrows, orioles & finches. Good cover & nest tree with plenty of insects for insectivorous birds. Deer browse leaves; squirrels, foxes & rabbits eat seeds & buds.
Ulmus crassifolia Cedar elm	Ulmaceae - Elm Family	Tree, large 30' - 60'	inconspicu-ous greenish flowers. July.-Sept.	Samara Aug. - Oct.	Full sun, part shade	Prefers woodlands, ravines & open slopes	Sands, loams & clays. Seasonal poor drainage O.K.	X	X	X	X	X	X	X	X			Good shade tree, each with a unique shape. Fast growing & long lived. Excellent yellow fall color. LHP for Mourning Cloak & Question Mark. Deciduous.	Seeds & buds eaten by gamebirds, woodpeckers, chickadees, finches, sparrows & warblers. Good nesting and cover tree with lots of insects for insectivorous birds. Deer browse leaves; squirrels, foxes & rabbits eat seeds & buds.
Diospyros virginiana Common persimmon	Ebenaceae - Ebony Family	Tree, small 30' - 40'	inconspicu-ous, m & f greenish yellow flowers on separate tree, fragrant. April - June	Berry (persimmon) August - Feb.	Full sun, part shade	Prefers dryish woods, old fields & clearings, ditch banks in East Texas. Also mud bottomlands.	Sands, loams & clays. Thrives on almost any kind of soil. Well-drained, mesic.	X	X	X	X	X			X			Good understory tree or accent tree with drooping branches & conical crown. Good erosion control plant. Deciduous.	Fruit eaten by 16 species of birds, also by skunks, raccoons, opossums gray & fox squirrels. Leaves browsed by deer.

Ilex decidua Deciduous Holly	Aquifoliaceae Holly Family	Tree, small 10' - 30'	inconspicuous m & f flowers on separate trees March - May	Drupes, orange-red on f tree Sept. - Feb	Full sun, part shade	Prefers moist areas near streams and woodlands	Sands, loams & clays. Well-drained, mesic. Seasonal poor drainage O.K.	X	X	X	X	X		X				Good understory tree or accent tree with spreading open crown, often with inclined trunk. Female trees have red berries held over winter, very ornamental. Deciduous.	Fruits are eaten by several species of birds, bobwhite, doves, robins, cedar waxwings, bluebirds, jays & mockingbirds. Squirrels, opossum, rabbits & fox eat berries too. Flower nectar & pollen attract several insects. Good nest tree.
Maclura pomifera Bois d'arc	Moraceae Fig Family	Tree, small 30' - 50'	inconspicuous m & f flowers on separate trees. April - June	Syncarp of aggregated yellow-green drupelets Sept. - Oct.	Full sun, part shade	Prefers rich soil in fields, woodlands, edges, fencerows, bottomlands, ravines & waste places.	Loams, clays. Well-drained, mesic.	X	X	X								Thorny tree with shiny bright green leaves & milky sap formerly used as living fence or hedge. "Osage oranges" are large and striking in appearance. Also good as understory tree. Good yellow fall color. Evergreen.	Excellent cover and nesting tree. Squirrels, foxes and bobwhite eat the seeds of the fruit.
Morus rubra Red mulberry	Moraceae Fig Family	Tree, small 35' - 40'	inconspicuous m & f greenish flowers. March - June	Mulberry (syncarp of aggregated red-black drupelets) April - Aug.	Full sun, part shade, dappled shade	Prefers rich soils along streams, creek bottoms & moist woodlands	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X	X		X	Handsome understory tree with polymorphic leaves, reddish black fruit and broad spreading crown. Deciduous.	Red mulberries are the prime source of spring fruit for neotropical migrant birds. 21 species devour them as soon as they ripen as do squirrels, raccoons, opossums & skunks. Larval host plant for Mourning Cloak.
Prosopis glandulosa Honey mesquite	Leguminosae - Legume Family	Tree, small 20' - 30'	Showy creamy yellow elongated spike-like racemes. May - Sept.	Legumes in loose clusters August - Sept.	Full sun, part shade	Tolerates wide range of situations, open fields, edges of woodlands, etc.	Sands, loams & clays. Well-drained, xeric.	X	X	X	X	X	X	X	X	X	X	Attractive tree with crooked, drooping branches, feathery leaves & rounded crown. Fast growing & often shrubby, forming thickets. Fixes nitrogen in the soil. Deciduous.	Good nectar plant for bees & other insects. Many species of wildlife like quail, bobwhite, doves depend on it for food & shelter from the sun. Squirrels, coyotes, skunks, rabbits &deer eat pods. LHP for Long-tailed skipper & Reickert's blue.
Rhamnus caroliniana Carolina buckthorn	Rhamnaceae - Buckthorn Family	Tree, small 12' - 20'	inconspicuous, small greenish-yellow flowers. May - June	Drupes, reddish brown August - Sept.	Full sun, part shade, shade	Prefers moist woods, fence rows, along creeks, heads of draws & canyon slopes.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X				Very attractive understory tree with pretty leaves and berries. Quite ornamental and adapted to a wide range of sites. Has good fall color & fruits borne over a long time. Deciduous.	When ripe, fruits are devoured by several species of birds, i.e. thrashers, robins, mockingbirds, cardinals, finches, etc. Flowers are good nectar source for bees, butterflies & other insects. Larval host plant

																			for Gray hairstreak.
Rhus copallina Flameleaf sumac	Anacardiaceae Sumac Family	Tree, small 15' - 25'	m & f flowers, small greenish white, on separate trees. July - Aug.	Drupes, small red, in clusters, remain after leaves fall. Sept. - Nov.	Full sun, part shade, dappled shade	Prefers fence rows, fields and bottomlands in East & East Central TX. Tolerates rocky areas.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X				A small, commonly clump-forming shrub or small tree with elegant compound leaves and showy red fruit clusters. Only trees with f flowers have fruit. Beautiful red color in the fall. Fast growing. Deciduous.	Fruit is eaten by at least 21 species of birds, Flowers attract numerous insects in spring, good nectar source for bees & butterflies. Larval host plant for Red-banded hairstreak.
Sophora affinis Eve's necklace	Leguminosae Legume Family	Tree, small 15' - 30'	Showy clusters of pinkish-white flowers. May	Legume black in color, looks like necklace, constrictions between seeds. Sept.	Full sun, part shade, dappled shade	Prefers fields, woodlands, occurs along rights-of-way of Central & north east Texas.	Sands, loams & clays. Well-drained, mesic.				X	X		X					Ornamental understory tree with pretty compound leaves and showy pink flower clusters. Fast growing. Deciduous.	Ring-tailed cats are known to eat the fruits and the foliage is browsed by white-tailed deer. The seeds are poisonous for most. Nectar of flowers attracts various bees, diurnal moths & butterflies.
Zanthoxylum clavaherculis Hercules' club	Rutaceae - Citrus Family	Tree, small 20' - 40'	Showy, greenish-yellow cymes, distinctive odor. March - April	Capsule August - Sept.	Full sun	Prefers deep heavy soils on disturbed or abandoned cropland, along fence rows.	Sands, loams, acid or neutral. Well-drained, mesic.	X	X	X	X	X	X				Aromatic small tree with interesting trunk sporting warty protuberances. Intolerant of shade. Deciduous.	Birds eat the seeds which explains why so many have proliferated under telephone wires along fence lines. Larval host plant for the beautiful Giant swallowtail
Acacia farnesiana Huisache	Leguminosae Legume Family	Ornamental small tree 15' - 30'	Showy, yellow round heads, fragrant. Feb. - March	Legume, brownish-black August - Sept.	Full sun	Prefers open areas, fields, pastures & fence rows	Sands, loams & clays. Moderately well-drained. Seasonal poor drainage O.K.		X	X	X		X	X			X	Medium-sized tree to shrub; densely branched & armed with long paired, straight spines. Rapid growth rate. Profusely flowering in early spring. In southern Texas starts flowering in late Dec. Very fragrant. Fairly drought tolerant. Deciduous.	Provides quick shade in spring. Good cover & nesting tree esp. for White-winged doves. Good nurse tree to other plants. Small mammals eat the pods. Excellent pollen & nectar source for bees & other insects. Larval host plant

																			for Marine Blue.
Aesculus pavia Red buckeye	Hippocastanaceae Horse chestnut Family	Ornamental tree or shrub 10' - 35'	Showy red/yellow tubular flowers in clusters. March	Capsule, round & leathery. Sept.	Part shade, dappled shade, shade	Prefers moist soils in forests, along streams, thickets & rocky hills	Sands, loams & clays. Well-drained, mesic. Moderate moisture.	X	X	X	X			X	X			Showy small tree or shrub with rounded crown, distinctive flower clusters and attractive palmate leaves. Blooms very early; loses leaves early. Good understory tree. Deciduous, early.	The scarlet tubular flowers are visited by hummingbirds. Butterflies are also attracted to the nectar. Seeds are poisonous, however, and not eaten by wildlife.
Cercis canadensis v. canadensis Eastern redbud	Leguminosae - Legume Family	Ornamental tree 10' - 40'	Showy magenta pea-like flowers, before leaves. March	Legumes, brownish-red, in clusters. Sept.	Full sun, part shade, dappled shade	Prefers forested sandy areas, upland woods, woodland edges & and along stream banks in Eastern Texas.	Sands, loams & heavy black clays. Well-drained, mesic. Moderate moisture.	X	X	X	X							Highly ornamental and showy small tree with spreading, flat or rounded crown. Good understory tree or accent plant. Fast growing, usually with single trunk. Deciduous.	Beautiful magenta flowers are copious early nectar source for butterflies, moths, bees, etc. Seeds are eaten by a number of species of birds; foliage browsed by white-tailed deer. Larval host plant to Henry's Elfin.
Crataegus crusgalli Cockspur hawthorn	Rosaceae - Rose Family	Ornamental tree 10' - 25'	Showy, white perfect flowers. May - June	Pome (apple-like fruit) dull red in color Oct. - Nov.	Full sun, part shade	Prefers limestone bluffs, hilltops, woods & thickets & fence rows in East Texas	Sands, loams & clays. Well-drained, mesic; moderate moisture; will tolerate dry conditions.	X		X	X	X		X				Most widespread hawthorn with strongly horizontal branches, large thorns & beautiful flowers in the spring. Has shiny leathery leaves and reddish-brown fissured bark. Deciduous.	Good protective cover and nesting tree. Flowers provide abundant nectar. Fruits are highly sought after by many species of birds & mammals including skunks, squirrels and fox. Larval host plant for some Hairstreak butterflies.
Crataegus viridis Green hawthorn	Rosaceae - Rose Family	Ornamental tree 20' - 35'	Showy, white perfect flowers. March - April	Pome (apple-like fruit) orange or red in color Sept. - Nov.	Full sun, part shade	Prefers low, wet alluvial woods, also sandy fields in East Texas & Upper Texas Coast.	Sands, loams & clays. Medium to high moisture. Seasonal poor drainage O.K.	X	X	X	X	X		X				Medium-sized tree forming a broad rounded crown, serrated dark green shiny leaves, with bark that shreds into small scales. Often thornless. Deciduous.	Beautiful white flowers with yellow stamens attract bees & butterflies. Red orange haws disappear quickly, highly prized by several species of birds & mammals. Good cover & nesting tree. Larval host plant for some Hairstreaks.

Prunus mexicana Mexican plum	Rosaceae - Rose Family	Ornamental tree 15' - 35'	Showy, white perfect flowers, fragrant. Feb.-April	Plum, red-purple Sept. - Oct.	Full sun, part shade	Prefers river or creek bottoms, hardwood slopes & hillsides, & prairies.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X		X				Medium sized, single-trunked ornamental tree with broad crown and satiny silver bark with dark fissures. Excellent accent plant with heavenly fragrance when in bloom. Deciduous.	Early spring clouds of white flowers are wonderful nectar source, attracting bees, butterflies & diurnal moths. Gamebirds, songbirds & several species of mammals feast on the ripe plums. Larval host plant for Tiger swallowtail.
Prunus munsoniana Munson plum	Rosaceae - Rose Family	Ornamental tree 15' - 25'	Showy, white perfect flowers, fragrant. March	Plum, red or yellow with white dots Sept. - Oct.	Full sun, part shade	Prefers limestone ledges & slopes; also grassy thickets.	Sands, loams & clay (esp. those with high limestone content.). Well-drained, mesic.				X	X		X				Thicket-forming ornamental shrub or small round-topped tree with bright lustrous green leaves and smooth thin bark. Deciduous.	Spring flowers with copious nectar attract butterflies, bees & other insects. Plums are relished by several species of birds and small mammals.
Prunus serotina v. serotina Black cherry	Rosaceae - Rose Family	Ornamental tree 60' - 100'	Showy racemes of white perfect flowers, fragrant. March - April	Cherries, small purple black, sweet or tart. June - Oct.	Full sun, part shade	Prefers eastern woodlands, thickets, fencerows & areas along roadsides.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X							Attractive ornamental with decorative flowers, copious fruits, shiny green leaves & grayish brown horizontally striped bark. Easy to grow. Other varieties available for all regions of Texas except South TX. Deciduous.	Copious fruits are eagerly devoured by a wide variety of wildlife including 33 kinds of birds, raccoons, opossums, squirrels & rabbits. Foliage is not browsed by deer. Larval host plant to some Hairstreak species.
Sambucus canadensis American elderberry	Caprifoliaceae Honeysuckle Family	Ornamental shrub or small tree 15' - 30'	Showy white 4-8' flower clusters. June - Sept.	Berries, blue-black Sept. - Nov.	Full sun, part shade	Prefers wet soils in low places esp. along streams & swamp edges.	Sands, loams & gravelly clays. Hydric-mesic. Tolerates poor drainage.	X	X	X	X	X		X				Attractive erect shrub with white flower pompoms which prefers moist conditions in alluvial soils. Has attractive pinnate leaves. It loves extra water and will grow fast if well supplied. Can stand a certain amount of drought, though. Persistent.	Flowers are an excellent source of nectar for bees, butterflies, diurnal moths & other insects. Fruits are eaten by several species of birds, including gamebirds & songbirds. Small mammals also relish the ripe fruit. Leaves are browsed by deer.
Ungnadia speciosa Mexican buckeye	Sapindaceae - Soapberry Family	Ornamental tree or large shrub 15' - 30'	Showy clusters of pink-magenta flowers cloak branches, before leaves come out. Fragrant. March - May	Capsules (tripartite leathery "buckeyes"), brown-black Oct. - Nov.	Full sun, part shade	Prefers rocky areas in canyons, slopes & ridges & along fencerows.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X		X			X	Showy, small, shrubby often multi-trunked ornamental with irregular shape. Spectacular pink blossoms in spring. Good understory tree, prefers at least half a day in sun. Has pretty yellow fall color also. Deciduous.	Splashy pink flowers are a good nectar source for bees, butterflies, diurnal moths. Good honey plant. Sweet seeds eaten by a few species of birds and mammals, though poisonous to humans. Larval host plant for Henry's Elfin.

Viburnum rufidulum Rusty black-haw viburnum	Caprifoli-aceace - Honeysuckle Family	Ornamental tree or large shrub 20 - 30'	Showy creamy-white clusters of flowers. March - May	Berries, bluish-black (drupes). Sept. - Oct.	Full sun, part shade	Prefers moist soils along streamsides, in open woods & thickets.	Sands, loams & clays, esp. limestone soils. Well-drained, mesic.	X	X	X	X	X		X	X		X	Small, single-trunked, ornamental with broad crown. Attractive as understory tree, also beautiful in the open. Leaves very glossy, turning red, mauve or orange in fall. Slow growing, staying shrub size for a long time. Deciduous.	Flowers are good nectar source for bees, butterflies & other insects. Fruits relished by several kinds of birds & small mammals. Robins, cedar waxwings, cardinals, bluebirds & mockingbirds love fruit, as do squirrels, opossum, raccoons & rabbits.
Juniperus virginiana Eastern red-cedar	Cupressacea e Cypress Family	Conifer 30' - 60'	inconspicu-ous m catkins, f cones, appearing on separate trees. March - May	Cones, berry-like, bluish, sweet & resinous when ripe Aug. - Dec.	Full sun, part shade, dappled shade	Prefers dry hillsides, old fields, pastures, areas along fence rows.	Sands, loams & clays. Well-drained, mesic. Tolerate dry land.	X		X	X	X			X	X		Evergreen tree of variable shape, with scalelike or appressed leaves. Foliage is dense and aromatic. Often planted as an ornamental. Long-lived and slow-growing. Evergreen.	Dense-foliaged tree is excellent cover and nesting tree. Bluebirds, mockingbirds, robins, cedar waxwings, thrashers, warblers, finches & sparrows relish fruit, esp. in winter. Opossum also eat fruit. Larval host plant to Olive hairstreak.
Taxodium distichum Bald cypress	Taxodiaceae Bald Cypress Family	Conifer 45' - 100'	inconspicu-ous 5'-long drooping clusters of m cones. F cones at branch tips. March - April	Cones, wrinkled, rounded, 1-inch in diameter. Sept. - Oct.	Full sun, part shade	Prefers moist soils in swamps, river bottoms, forests along streams.	Sands, loams & clays. Hydric - mesic. Seasonal poor drainage O.K.	X	X	X	X		X	X				Large conifer with feathery, deciduous, needle-like leaves. Fast-growing with reliable bronze fall color. Long-lived tree often used as ornamental. Spanish moss (good nesting material) festoons branches. Deciduous.	Excellent cover & nesting tree. Seeds eaten by many different kinds of birds, esp. waterfowl & sandhill cranes. Squirrels, & many other forms of wildlife eat seed cones. Good foraging substrate for insectivorous birds.
Amorpha fruticosa False indigo	Leguminosae - Legume Family	Shrub 5' - 10'	Showy purple flower spikes with yellow anthers. April - May	Pods, clustered, small & brown. July-Aug.	Full sun, part shade	Prefers low areas at the water's edge, along streams.	Sands, loams & clays. Mesic, seasonally poor drainage O.K.	X	X	X		X	X					This moisture loving shrub is notable for its beautiful flowers, attractive leaves & airy form. Relatively fast growing. Deciduous.	Flowers are a good nectar source for bees, butterflies & other insects. Leaves are browsed by deer. Larval host plant for Dogface butterfly, Gray hairstreak, Silver-spotted skipper, Hoary edge skipper.
Callicarpa americana American beautyberry	Verbenaceae - Vervain Family	Shrub 3' - 9'	Small clusters of white or pink flowers at nodes. May - July	Berries, magenta, in clusters at nodes Aug. - Nov.	Part shade, dappled shade.	Prefers moist soils of canyons and bottomlands, woods & thickets.	Sands, loams & clays. Likes rich soils. Well-drained, mesic.	X	X	X	X	X		X				Open, much branched shrub with showy magenta berries. Has mounding form. Likes to be watered during dry periods. Deciduous.	Fruits are favored by several species of birds, i.e.., bobwhite, mockingbirds, cardinals, thrashers, robins, finches & towhees. Raccoons, opossum & gray fox also relish berries.

Cephalanthus occidentalis Buttonbush	Rubiaceae - Madder Family	Shrub 5' - 20'	Showy, creamy white round heads. June - Sept.	Capsule clusters, round & dark brown Aug. - Nov.	Full sun, part shade	Prefers moist soils near swamps, ponds, along streams & stream margins.	Sands, loams, clays. Likes limestone soils. Mesic/hydric. Moderate to high moisture. Seasonally poor drainage O.K.	X	X	X	X	X	X	X	X	X	X	Shrub or small tree growing in low areas, often with swollen base. Leaves opposite & whorled. , variously shaped. Bright yellow anthers around white flower balls create a halo effect. Highly ornamental. Suitable for bog or pond area. Deciduous.	Flowers attract hordes of bees, butterflies & other insects. Fruits are highly favored by more than 25 species of birds, including waterfowl, cardinals, finches, sparrows, etc.
Forestiera pubescens Elbowbush	Oleaceae - Olive Family	Shrub 5' - 10'	Showy yellow bracts appear before leaves, early in spring. Feb.	Berries, bluish-black (drupes). June - Oct.	Full sun, part shade, dappled shade	Prefers open pastures, brushy prairies, woodlands & thickets	Sands, loams, & clays. Well-drained soils, mesic to semi-dry.				X	X		X				Straggling, irregularly shaped shrub. Though not beautiful, this is the first shrub to bloom in spring. Opposite softly fuzzy leaves and blue-black berries. Deciduous.	Yellow flowers appear early in spring providing early nectar source for bees, butterflies & other insects. Berries are eaten by several species of birds & small mammals. Leaves are browsed by white-tailed deer.
Rhus aromatica Fragrant sumac	Anacardiaceae Sumac Family	Shrub 3' - 8'	inconspicuous yellow flowers appearing before leaves. Feb. - March	Berries, red May - June	Full sun, part shade, dappled shade.	Prefers limestone outcrops, rocky slopes, prairies, & mesquite plains.	Sands, loams & clays. Likes limestone soils. Well-drained, mesic.	X	X	X	X	X	X	X	X	X	X	Aromatic shrub with pretty leaves & early flowers. Tends to form thickets & is irregularly branched. Deciduous.	Early flowers provide early nectar source for insects like bees, butterflies & moths. The red berries are one of the earliest summer fruits making it popular with several species of birds & small mammals. Larval host plant to Red-banded hairstreak.
Salvia greggii Autumn sage	Lamiaceae - Mint Family	Shrub 2' - 4'	Showy magenta red flowers, also comes in white, pink or coral. April - Dec.	Nutlets June - Dec.	Full sun, part shade	Prefers rocky soils in central, south & west Texas.	Sands, loams & clays. Likes limestone soils, esp. Well-drained, mesic-xeric.				X		X	X			X	Aromatic showy shrub which blooms prolifically spring, summer & fall. Adaptable to other areas of the state where not native. Good as ground cover or hedge. Really needs good drainage. Persistent (almost evergreen).	Abundant flowers provide copious nectar which is attractive to bees & especially hummingbirds. Ruby-throats can't seem to get enough. Provides food over the long hot summer for them when other plants have waned.

Yucca arkansana Thread-leaf yucca	Agavaceae - Agave Family	Succulent. 2' leaves 3'- 6' flower stalk	Showy panicles of creamy-white flowers. May - June	Capsules August - Sept.	Full sun, part shade	Prefers prairies, limestone outcrops & rocky areas	Sands, loams & clays. Well-drained, xeric.			X	X	X	X					Very striking accent plant, magnificent when in bloom. This plant is the most flower-like of all the yuccas. Leaves are pale green edged with fine, curly white hairs. Tips are armed with healthy spines. Can tolerate shade. Evergreen.	Elegant waxy flowers emit their fragrance at night attracting moths which pollinate them. Flowers are edible and popular with white-tailed deer. Larval host plant to Yucca giant skipper.
Yucca pallida Pale-leaf yucca	Agavaceae - Agave Family	Succulent. 1' leaves 2'- 4' flower stalk	Showy panicles of creamy-white flowers. May - June	Capsules August - Sept.	Full sun, part shade	Endemic to Blackland Prairies & adjacent limestone slopes.	Clays. Well-drained, xeric.					X						Very striking accent plant, beautiful when in bloom. Leaves are a pale blue-green and only 1-foot tall. Tips are armed with healthy spines. Flower stalk not very tall. Evergreen.	Waxy white flowers emit their fragrance at night attracting moths which pollinate them. Flowers are edible and popular with white-tailed deer. Larval host plant to Yucca giant skipper.
Bignonia capreolata Cross-vine	Bignoniaceae Catalpa Family	Vine. Climber to 50'	Showy, tubular flowers, red on outside, yellow on inside. March - April	Capsule with winged seeds August - Sept.	Full sun, part shade, dappled shade, shade	Prefers cool moist soils of woodlands, pinelands, also creek bottoms.	Sands, loams & clays. Moderate to high moisture. Seasonal poor drainage O.K.	X	X	X	X							Beautiful flowering vine clinging to bricks, stones & fences as well as other shrubs & trees. Profuse flowers when in bloom. Tolerates pollution well. Persistent.	Striking orange & yellow tubular flowers are highly attractive to butterflies and especially the Ruby-throated hummingbird. Bloom time coincides with migration when other sources of nectar are scarce, helping this little mite on the way.
Campsis radicans Trumpet-creeper	Bignoniaceae Catalpa Family	Vine. Climber "to the sky"	Showy orange tubular flowers in dense clusters. June - Sept.	Capsule with winged seeds Sept. - Nov.	Full sun, part shade	Tolerates a variety of soils throughout Eastern half of Texas	Sands, loams & clays. Mesic; moderate moisture; poor drainage O.K.	X	X	X	X	X	X	X				Striking vine adapted to nearly every soil type. Excellent for hiding ugly structures. Sometimes can do too well & needs to be cut back. Persistent.	This is premier plant to attract hummingbirds. Both Ruby-throat and Black-chinned hummers are highly fond of it. Copious nectar sustains these beauties. The plant is also an excellent nectar source for the larger butterflies.
Clematis crispa Blue jasmine	Ranunculaceae Buttercup Family	Vine. Climber to 10'	Showy lavender bell-shaped flowers with flared edges. March - June	Achenes August - Sept.	Part shade, dappled shade	Prefers moist soils in low woods.	Sands, loams & clays. Will tolerate gumbo. Mesic-hydric. Poor drainage O.K.	X	X	X	X							Very elegant flowers. Works well on a lattice but does not climb high. Can sprawl over low structures such as planter boxes or patio pots. Deciduous.	Lavender blue flowers attract many kinds of insects including butterflies. Several species of birds eat the ripe achenes.

Lonicera sempervirens Coral honeysuckle	Caprifoliaceae Honeysuckle Family	Vine. Climber to 40'	Showy orange red tubular flowers in clusters. March - Dec.	Berries, red April - Jan.	Full sun, part shade	Prefers moist fertile soils of East Texas, woods & thickets	Sands, loams & clays. Mesic-hydric. Poor drainage O.K.	X	X	X	X	X						A beautiful everblooming vine that grows well & is well-behaved. Likes morning sun & afternoon dappled shade. Needs extra water when getting established, but not later. Persistent.	Ruby-throated and Black-chinned hummers are attracted to this vine spring, summer and fall, esp. during migration. Orioles also sip nectar, as do butterflies. Fruit-eating birds relish the succulent red berries in the fall. LHP of Spring Azure.
Parthenocissus quinquefolia Virginia creeper	Vitaceae Grape Family	Vine. Climber & ground cover	inconspicuous greenish flowers. May - June	Berries, blue-black Sept. - Nov.	Full sun, part shade, dappled shade	Prefers rich soils of woodlands & thickets & rocky banks in eastern half of TX.	Sands, loams, clays. Tolerates gumbo soils. Well-drained, mesic.	X	X	X	X	X		X				Very attractive vine with lush green palmate leaves. Vigorous climber well able to cloak walls, columns, etc by fastening on to masonry. Also good ground cover. Striking red-orange fall color. Deciduous.	Many species of birds compete for the blue-black berries including woodpeckers, kingbirds, great-crested flycatchers, titmice, cardinals, mockingbirds, bluebirds, warblers & sparrows.
Passiflora incarnata May-pop	Passifloraceae Passionflower Family	Vine. Climber to 6', also ground cover	Showy Pink-purple flower. April - Sept.	Ovoid fruit with seeds. June - Oct.	Full sun, part shade, dappled shade	Grows in old fields, along roadsides & streams & woodland edges in Eastern 1/3 of TX.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X						This healthy climber is graced with an unbelievable intricate & eye-catching flower. It uses its tendrils for climbing & is often found sprawling over the ground, thus serving as excellent ground cover. Dormant in winter.	These beautiful vines are larval food plants for the Zebra long-wing, Gulf Fritillary & Julia butterflies. Several species of birds dine on the ripened fruits.
Rosa setigera Prairie rose	Rosaceae Rose Family	Vine. Climber from 9' - 15'	Showy rose-pink flowers. May	Rosehips, red. July-Aug.	Full sun, part shade	Prefers openings and post oak woodlands	Sands, loams & clays, esp. calcareous soils. Well-drained, mesic.	X		X	X	X						Luscious rose-red blossoms gradually fade to white, leaving all shades in between in a tapestry of pinks. Shiny leaves turn reddish in the fall. This vine has no thorns. Fruits are bright red and highly decorative. Deciduous.	Several species of birds devour the red fruits including cardinals, mockingbirds, bluebirds, woodpeckers, Great-crested flycatchers, catbirds & thrashers.
Andropogon gerardi Big blue stem	Poaceae Grass Family	Grass 3' - 6'	Flowering spikelets of green to golden-tan in form of turkey foot. Aug. - Nov.	Seeds Sets seed shortly after flowering	Full sun	Prefers moist soils of meadows & prairies in the eastern 1/2 of state	Sands, loams & clays, acid or calcareous, mesic; moderate moisture.	X	X	X	X	X	X	X	X	X	X	This prairie perennial can be used as meadow grass with wildflowers, pocket tallgrass prairie or garden accent. Dramatic component. Rich, deep soil with moisture present. Erosion control. Best at bottom of slope. Warm-	Provides good cover & food for many species of wildlife. Grass parts used as nesting & denning material. Larval host plant of Delaware Skipper, Dusted Skipper, Bunchgrass Skipper, Large Wood Nymph, Cobweb, Clouded

																			season bunch grass. Winter dormancy.	& Beard grass skippers.
Bouteloua curtipendula Sideoats grama	Poaceae Grass Family	Grass 2' - 6'	Spikelets, yellowish, arranged down along stem. May - Oct.	Seeds June - Nov.	Full sun, part shade, dappled shade	Tolerates a variety of open places throughout state. Does well in disturbed areas. Not as common in eastern forests.	Sands, loams & clays, both limestone & igneous soils. Well-drained, mesic-xeric.	X	X	X	X	X	X	X	X	X	X		Our state grass is a strong perennial and works well as a garden accent. Competes well with short grasses but not tall-grass prairie grasses. Great choice for wildflower meadow garden. Warm-season perennial bunch grass. Dormant in winter.	Provides good grazing for wildlife and an abundance of bird seed for seed-eating birds of several varieties. Food available spring, summer & fall. Grass parts used as nesting & denning material. Larval host plant for Dotted skipper & green skipper.
Elymus canadensis Canada wildrye	Poaceae Grass Family	Grass 3' - 5'	Flowering spikelets green turning gold, with long awns. March - June	Seeds May - Sept.	Full sun, part shade, dappled shade	Prefers shaded sites along fence rows, woods borders & moist ravines throughout state. Absent in southern part of South TX.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X	X	X	X		This tufted grass with attractive seed heads does best in shady areas with adequate moisture. Cool-season tufted perennial.	Provides good early food for many species of birds & small mammals that eat grain. Grass parts, leaves, stems, & spikelets used as nesting & denning material. Larval host plant for Zabulon skipper.
Muhlenbergia lindheimeri Big muhly	Poaceae Grass Family	Grass 2' -5'	Flowering spikelets silvery green to golden tan. July - Aug.	Seeds Sept. - Nov.	Full sun, part shade	Prefers limestone uplands near streams	Calcareous clays & limestone soils. Well-drained, mesic.				X	X	X	X					This is a highly attractive bunch grass. Serves as a striking accent plant in any garden. Plant sports silvery golden plumes in the fall. Warm-season perennial.	Big muhly is a good forage grass for wildlife. Birds readily eat the ripe seeds. Grass parts are used for nesting & denning material.
Panicum virgatum Switchgrass	Poaceae Grass Family	Grass 3' - 6'	Flowering spikelets green turning rich gold. Aug. - Sept.	Seeds Oct. - Nov.	Full sun, part shade	Prefers seasonally moist, open areas throughout Texas.	Sands, loams & clays. Moist. Seasonal poor drainage O.K.	X	X	X	X	X	X	X	X	X	X		Gorgeous tall-grass can be used as dramatic accent plant. Turns deep, rich golden color in fall. Has airy, filigreed seedhead. Can also be used in small pocket prairie. Does great in Houston, loves the extra water. Warm-season perennial bunch grass.	Provides fair grazing for wildlife, seeds sought after by seed-eating birds. Excellent sparrow food in winter. Provides good protective cover and nesting & denning material. Good place for butterflies to get out of the wind. LHP for Delaware skipper.

Paspalum floridanum Florida paspalum	Poaceae Grass Family	Grass 3' - 6'	Flowering spikelets green, arranged in two rows. Aug. - Nov.	Seeds Sept. - Dec.	Full sun, part shade	Prefers grasslands, open woodlands & cutover woodlands in eastern Texas.	Sands, loams & clays. Moist. Seasonal poor drainage O.K.	X	X	X	X	X							Perennial with interesting green flower head. Warm-season perennial.	Provides fair forage for wildlife. Parts of plants used for nesting & denning material.
Poa arachnifera Texas bluegrass	Poaceae Grass Family	Grass 1' - 2'	Flowering spikelets bluish-green to mauve. April - May	Seeds May	Full sun, part shade	Grows in prairies and openings of woods	Sands, loams & clays. mesic	X	X	X	X	X	X	X	X	X			This is an absolutely beautiful grass, in both color & shape of flower head. Two color forms are blue-green and copper mauve. Cool-season perennial.	Provides fair grazing for wildlife & seeds for sparrows & other granivorous birds & small mammals. Grass parts usd as nesting & denning material.
Sorghastrum nutans Indiangrass	Poaceae Grass Family	Grass 3' - 8'	Flowering spikelets a deep yellow. Oct. - Nov.	Seeds Nov. - Dec.	Full sun, some shade O.K.	Prefers moist rich soils of tall-grass prairies of central & coastal TX	Sands, loams & clays. Likes calcareous soils. Mesic, likes moisture.		X	X	X	X		X					This gorgeous grass was major component of tallgrass prairie. Striking accent plant or member of pocket tallgrass prairie. Does well in a naturally moist rich swale area. Warm-season perennial bunch grass. Dormant in winter.	Fairly good grazing for wildlife when green. Seed-eating birds and small mammals eat ripe seeds. Stems, leaves used as nesting & denning material. Provides excellent protective cover for wildlife. Larval host plant of Pepper-and-salt skipper.
Schizachyrium scoparium Little bluestem	Poaceae Grass Family	Grass 2' - 5'	Flowering spikelets bluegreen to silvery gold. Aug. - Dec.	Seeds Sept. - Dec.	Full sun, part shade	Prefers woods openings, rocky slopes of pastures & rangeland, along forest borders and prairies throughout Texas.	Sands, loams & clays, Well-drained, mesic.	X	X	X	X	X	X	X	X	X	X		Wide-ranging bunchgrass, a dominant of the tallgrass prairie. Tolerant of wide variety of moisture & drought. A symphony of beautiful color changes through the year from blue-green to coppery gold in the fall. Warm-season perennial. Dormant in winter.	Provides fairly good grazing for wildlife. Good cover grass, grass parts provide denning & nesting material for birds & mammals. Larval host plant for Dusted skipper, Delaware skipper, Dixie skipper, Cross-line skipper & Cobweb skipper.
Tripsacum dactyloides Eastern gammagrass	Poaceae Grass Family	Grass 3' - 8'	Flowering spikelets yellow & cornlike. July - Sept.	Seeds April - Nov.	Full sun, part shade, dappled shade	Prefers low moist grassland sites in eastern portion of state.	Sands, loams & clays. Mesic, likes extra moisture. Seasonal poor drainage O.K.	X	X	X	X	X		X					Forms very dense clump useful for buffer or areas of separation. Likes more shade & moisture than most grasses. Also dramatic accent plant. Can be grown in pure stands as pasture grass. Warm-season perennial bunch grass.	Good protective cover for small birds & mammals. Grass parts provide nesting & denning material. Provides very good forage for wildlife. Larval host plant to the Bunchgrass skipper.

Aquilegia canadensis Wild columbine	Ranunculaceae Buttercup Family	Wildflower 1' - 3'	Showy red & yellow tubular flowers. March - May	Follicle with seeds May - July	Part shade, dappled shade, full shade	Prefers moist, shaded canyons growing in & around rock of cliff faces & boulders.	Sands & loams; likes limestone based soils. Well drained mesic, likes extra moisture.	X		X	X	X		X				A hill country native that grows well in gardens where the soils are rich in organic matter & well-drained. Likes shade & extra moisture. Perennial.	Wild columbine is a wonderful hummingbird plant. Flowers also attract other varieties of insects.
Aster ericoides Heath aster	Asteraceae Sunflower Family	Wildflower 4" - 30"	Showy pale bluish-white flowers. Oct. - Nov.	Achenes Nov. - Dec	Full sun, part shade	Prefers open situations throughout much of north central & southeast Texas, including the Plains country & parts of East, South & West Texas	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X	X	X	X	This profusely blooming fall aster grows into a much-branched erect or reclining or arching plant. The numerous flowers provide an extravagant fall show. Narrowly lanceolate leaves are attractively elegant. Perennial.	Heath aster provides abundant fall nectar for bees, butterflies & other insects foraging in the late fall. Many seed-eating birds dine on the ripe achenes. Its shrubby aspect provides good cover for small sparrows & finches. LHP of Pearly crescentspot.
Echinacea purpurea Purple coneflower	Asteraceae Sunflower Family	Wildflower 1' - 2'	Showy pink to purple-rose flowers. April - May	Achenes June - Aug.	Full sun, part shade	Prefers rocky open woods & thickets in extreme north east Texas, but grows well in blackland prairie.	Sands, loams & clays. Well-drained, mesic.-xeric.	X		X	X							This showy coneflower has several close relatives that freely hybridize with one another. Colors range from pink to white to a rose-purple. The flower stays attractive for a long time. Perennial.	Purple coneflowers provide copious nectar to bees & butterflies in your garden. Ripe achenes are eaten by small seed-eating birds.
Erythrina herbacea Coralbean	Leguminosae - Legume Family	Wildflower (Shrub in South TX) 6' - 15'	Showy coral red tubular flowers. May - Dec.	Pods with poisonous red seeds Oct. to Dec.	Full sun, part shade	Prefers sandy woods on coastal plain, but will grow elsewhere.	sands, loams & clays. Well-drained, mesic.		X	X	X	X						Striking shrubby wildflower dies back in winter like a perennial in all areas but south Texas. Flamboyant summer flowers are highly ornamental. Seeds are also attractive, though extremely poisonous. Perennial.	Elegant tubular flowers have copious nectar & are highly attractive to the Ruby-throated hummingbird. Seeds, though highly appealing visually, are poisonous and not eaten by wildlife.
Eupatorium serotinum Late boneset	Asteraceae - Sunflower Family	Wildflower 2' - 5'	Showy off-white flower heads. Sept. - Nov.	Achenes Nov. - Jan.	Full sun, part shade	Prefers open places, woodland edges, near ponds.	Sands, loams & clays. Mesic, likes moisture.	X	X	X	X	X						This late blooming shrubby wildflower with opposite leaves and much-branched, flat-topped terminal flower clusters, often forms colonies. Perennial.	Masses of off-white flowers is an excellent nectar source for migrating monarch butterflies & other late foraging insects. Plants provide good protection for butterflies on windy days. Many species of sparrows &finches eat the ripe achenes in winter.

Lobelia cardinalis Cardinal flower	Campanulaceae Campanula Family	Wildflower 6" - 6'	Showy red tubular flowers, fragrant. May - Oct.	Capsules with seeds June - Nov.	Full sun, part shade, dappled shade	Prefers moist soils in open places along streams, meadows & along roadsides; also about ponds & springs, & near swamps where the shade is not too dense.	Sands, loams, clays & limestone based soils. Moist soils, poor drainage O.K.	X	X	X	X	X	X	X	X	X	Cardinal flower cannot be equalled for sheer visual impact, planted in dense stands in a shady part of the garden. In peak bloom they create an incredible spectacle. Bright scarlet flowers are clustered on racemes as long as 18". Perennial.	Cardinal flower is a premiere hummingbird plant and will not fail to draw in any Ruby-throats passing through your area.
Malvaviscus drummondii Turk's cap	Malvaceae - Mallow Family	Wildflower, shrub in South TX 4' - 9'	Showy red flowers. May - Nov.	Berry-like fruit, red, flattened August - Sept.	Part shade, dappled shade, shade	Prefers moist woodlands, wood margins, streamsides, river edges in shady conditions. Low grounds.	Sands, loams & clays. Likes limestone soils, tolerates gumbo. Hydric-mesic, likes moisture.	X	X	X	X	X	X	X			A good ornamental for shady situations. Forms colonies in shady spots. Serves as good ground cover. Best pruned back after 2 years. Perennial.	Attractive red flowers are very popular with hummingbirds. Butterflies, diurnal moths & other insects are also attracted to the flowers. The bland fruit is eaten by several species of birds & small mammals.
Penstemon cobaea Giant foxglove	Scrophulariaceae Figwort Family	Wildflower 1' - 2 1/2'	Showy large tubular pale violet flowers with nectar guides. April - May	Capsules with seeds June - July	Full sun, part shade	Prefers open areas, meadows, prairies, pastures & roadside areas	Sands, loams, clays & limestone outcrops. Well-drained, mesic.		X	X	X			X	X	X	Giant foxglove is, as its name implies, our largest-flowered penstemon. In full boom, gorgeous flowers open, covering two thirds of the flower stalk. This is a beautiful choice for a wildflower meadow or pocket prairie. Loves limestone soils. Perennial.	Giant foxglove is highly attractive to bees, especially the larger varieties such as bumblebees and carpenter bees who eagerly forage for the nectar & the pollen. Larval host plant of the Dotted checkerspot.
Salvia coccinea Scarlet sage	Lamiaceae - Mint Family	Wildflower 2' - 4'	Showy red tubular flowers. May - Dec.	Calyx with nutlets June - Dec.	Full sun, part shade, dappled shade	Prefers sandy soils in thickets, chaparral, on edges of open woods from East to South Texas.	Sands, loams, clays & caliche-type soils. Mesic, seasonal poor drainage O.K.	X	X	X	X	X	X	X			Scarlet sage can thrive in any part of the state. It is not very cold-hardy, however. Oddly, it looks better if planted in dry, shady areas with poor soil. In rich soils with lots of water it gets very tall, coarse & slightly unattractive. Perennial.	Scarlet sage is another excellent hummingbird plant & will draw in the hummingbirds of your area, including any migrants passing through in spring & fall. Bees & other insects are also attracted to the nectar, despite the red flower color.

Viguiera dentata Golden-eye	Asteraceae Sunflower Family	Wildflower 3' - 6'	Showy yellow daisy-like flowers. Oct.	Achenes Nov.	Full sun, part shade	Prefers dry caliche soils of the Texas Hill Country & chalky cuestas of North Central Texas, Blackland Prairies & to a less extent in the Trans-Pecos.	Sands, loams, clays & limestone soils. Well-drained, mesic.				X	X		X			X	This open busy perennial thrives at sunny edges of woods & tends to grow in large colonies. Extremely drought-tolerant, it can be absolutely magnificent in full bloom. Perennial.	Golden-eye provides a great deal of nectar to bees & butterflies foraging in the fall. Ripe achenes are relished by several species of small seed-eating birds. Also provides good protective cover. Larval host plant of the Bordered patch butterfly.
Castilleja indivisa Indian paintbrush	Scrophulariaceae Figwort Family	Wildflower 6" - 12"	Showy orange to red bracts. March - May	Capsules with seeds May - July	Full sun, a little shade O.K.	Prefers fields, meadows, prairies & roadside areas in Eastern portion of the state including the Coastal plains	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X				Indian paintbrush is an excellent choice for a pocket prairie or meadow garden. Grows very well when planted with native grasses. Looks great when interspersed among masses of bluebonnets & showy evening primrose. Annual.	Insects of several varieties are attracted to the small flowers. Hummingbirds will also feed from them, attracted to the red-orange bracts that surround them. Larval host plant of the Buckeye.
Chamaecrista fasciculata Partridge pea	Leguminosae Legume Family	Wildflower 6" - 12"	Showy yellow flowers. June - Oct.	Legume with seeds Aug. - Nov.	Full sun, part shade	Prefers sandy soils in old fields, open woodlands & pastures in Eastern half of the state & coastal plains	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X					Partridge pea offers bright yellow splashes of color from June to October. Flowers open early in the morning, often closing up later in the day. Good border plant. Also does well in unattended natural areas. Annual.	Partridge pea attracts bees, butterflies and ants. Ripe seeds are eaten by a number of species of gamebirds as well as songbirds. Larval host plant for Cloudless giant sulphur, Orange sulphur & Sleepy orange butterflies.
Coreopsis tinctoria Golden wave	Asteraceae Sunflower Family	Wildflower 1' - 4'	Showy yellow daisy-like flowers with brown centers. March - June or later depending on rains	Achenes May - Aug.	Full sun, part shade	Prefers seasonally moist soils in the eastern portion of the state, but grows throughout.	Sands, loams, clays; either calcareous or acid. Mesic, seasonal poor drainage O.K.	X	X	X	X	X	X	X				Great profusions of this golden yellow flower blanket roadsides & meadows, like undulating waves of a golden ocean. Annual.	Golden wave attracts a wide variety of insects, especially bees & butterflies who sip nectar from the disk flowers. Ripe achenes are sought after by many species of seed-eating birds, especially the Painted Bunting.
Eustoma grandiflora Texas bluebells	Gentianaceae - Gentian Family	Wildflower 1' -2'	Showy blue-purple flowers. June - Oct.	Capsule with seeds Aug. - Nov.	Full sun, part shade	Prefers damp prairies, pond edges, open fields & banks along streams throughout much of Texas	Sands, loams & clays. Mesic, seasonal poor drainage O.K.	X	X	X	X	X	X	X	X			Texas Bluebell, otherwise known as Bluebell Gentian is a showy wildflower that responds favorably to good soils, extra water & a little fertilizer. Leaves are pale greenish blue & very attractive also. Annual.	Texas bluebell is very attractive to several kinds of insects, especially bees & butterflies.

Lupinus texensis Texas bluebonnet	Leguminosae Legume Family	Wildflower 8" - 16"	Showy blue and white pea-like flowers in racemes, fragrant. March - May	Legume May - July	Full sun, a little shade O.K.	Prefers open fields, meadows & prairies, also roadside areas throughout much of the state from Corpus Christi to Abilene.	Sands, loams, clays & limestone soils; really likes calcareous soils. Well-drained, mesic to xeric.	X	X	X	X	X	X	X	X			Our state flower, this Texas endemic cloaks meadows, prairies & roadsides come spring in an ocean of blue. An incredible sight that dazzles all newcomers to the state. Bluebonnets take a little work to get established and depend on the fall rains. Annual.	Bluebonnets are attended by bees & other insects who forage on the nectar & pollinate the plants. Plants let the bees know a particular flower has been pollinated by turning from white to dark red at the center of the banner. LHP of hairstreaks & elfins.
Phlox drummondii Drummond phlox	Polemoniaceae Phlox Family	Wildflower 6" - 20"	Showy red or magenta flowers about 1 inch across. March - June	Seeds 1 to several May - Aug.	Full sun, part shade, dappled shade	Prefers grasslands & open meadows & woodlands in neutral to acid soils	Sands, sandy loams, acid to neutral. Well-drained, mesic.	X	X	X	X	X		X				Drummond phlox has five recognized subspecies, each of which is highly attractive in a garden. The plant is very easy to grow and provides splashes of beautiful red to magenta to pink spring color depending on the subspecies you purchase. Annual.	Drummond phlox attracts myriads of insects in the spring that forage for nectar.
Rudbeckia hirta Brown-eyed Susan	Asteraceae Sunflower Family	Wildflower 1' - 2'	Showy yellow ray flowers with dark brown centers, May - Sept.	Achenes July - Nov.	Full sun, part shade, dappled shade	Prefers open prairies, grasslands & woodland meadows in the eastern two-thirds of the state.	Sands, loams & clays. Well-drained, mesic.	X	X	X	X	X	X	X	X			Black-eyed Susans provide a lush splash of color in your meadow garden or pocket prairie. It does especially well if the rains are good or with a little extra watering. It will grow well in both partially shady areas & the sun. Annual.	Bees, butterflies & many other kinds of insects forage for nectar from these flowers all summer. In the fall when the flowers have good to seed, numerous seed-eating birds forage on the ripe achenes.

Learn About Whitetails

by Robert L. Cook
Updated and revised by Horace G. Gore, 1989

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Exploration and settlement of the American frontier would have been extremely difficult without the white-tailed deer. Early colonists and explorers utilized the meat and skins of these animals extensively, and deer hides later served as a medium of exchange between trappers, frontier scouts, Indians and traders.

Deer were even more important to the American Indians prior to settlement of the nation, providing clothing and food. Deer were also an important factor in the folklore and religion of native tribesmen.

Indiscriminate slaughter by commercial meat and hide hunters and ignorance of the deer's habitat requirements almost caused its extermination near the end of the 19th century. It was reported, for example, that an early Texas trader operating in Indian country at Trading House Creek (near present site of Waco) shipped approximately 75,000 deer skins from 1844 through 1853.

Public concern for survival of the species brought about a series of protective measures by the Texas Legislature near the turn of the century. A five-month closed season during

which deer could not be hunted was enacted in 1881. The bag limit was established at six bucks per season in 1903 and was reduced to three bucks per season in 1907.

The first hunting licenses were sold in Texas in 1909. In 1919, six game wardens were hired to patrol the entire state.

Additional interest and protection by landowners, sportsmen and law enforcement personnel helped deer populations increase steadily during the 1930s and 1940s. Statewide trapping and restocking programs established deer herds in previously uninhabited areas. Sales of hunting licenses increased dramatically—382,249 in 1955, 571,058 in 1964 and over one million in 1972.

The white-tailed deer is now the most numerous big game animal in Texas and in the United States. Aesthetically and emotionally, the whitetail holds a place of distinction in the hearts and minds of many Texans.

Research and management projects concerning the whitetail and its habitat requirements are conducted by wildlife biologists of the Texas Parks and Wildlife Department, federal agencies, many universities and several private research establishments in Texas.

Research activities by the wildlife biologists of the Texas Parks and Wildlife Department are 75 percent funded from federal excise taxes on firearms and ammunition. Deer are of primary importance on several of the 119 wildlife management areas (900,000 acres) operated by this department. Research activities also are conducted on National Wildlife Refuges, National Forests and Department of Defense lands. The Texas Parks and Wildlife Department game warden field force now numbers some 460 officers. These highly skilled and trained officers provide law enforcement services essential to continued survival of the whitetail.

The whitetail is one of the most researched, observed, sought after, cussed and discussed of all wildlife species in Texas. Few of us, however, are aware of the basic principles which rule this majestic animal's life. Following are some of the most frequently asked questions about white-tailed deer in Texas.

How many kinds of deer are there in Texas?

The Texas white-tailed deer, *Odocoileus virginianus texana*, occurs almost statewide. There were several subspecies of whitetail in the state years ago. However, due to expanding-overlapping ranges and restocking efforts in recent times, the subtle differences between subspecies have been lost except for the isolated population of Carmen Mountain white-tailed deer, *Odocoileus virginianus carminus*, in the Big Bend National Park area. Although found almost statewide in brushy or wooded areas, the heaviest deer populations are located in the central one-third of the state. The mule deer, *Odocoileus hemionus*, is a different species which occurs primarily west of the Pecos River and in parts of the High Plains of the Texas Panhandle.

How many deer are there in Texas?

Texas has more white-tailed deer than any other state. Population estimates in recent years range from three to four million. Current census data indicate that there are more than four million whitetails in Texas. Population estimates vary from year to year, depending upon reproduction, survival and losses due to malnutrition and disease.

How many white-tailed deer are legally harvested by sportsmen in Texas each year?

An estimated 500,000 whitetails are harvested by sportsmen in Texas annually—more than any other state.

Isn't that too many?

No. Current harvest rates account for only about ten percent of the herd annually. Research indicates that about 20 percent of most populations should be removed annually by sportsmen. Biologically sound harvest rates and habitat management programs are necessary in Texas to prevent waste due to overpopulation, to achieve maximum utilization of this valuable natural resource and to insure the whitetail's continued survival. For example, since the initiation of the program in 1953, more than two million antlerless or doe deer have been harvested from the established deer herds in the state.

How are deer counted?

Several methods of estimating deer numbers are used in Texas:

1. The walking deer cruise line. During the fall months, wildlife biologists walk census lines which have been placed in representative deer habitat and count the deer observed. This method is used extensively in Texas, and there are several hundred such deer census lines in the state.
2. Counts from fixed-winged aircraft. This method is used in areas of the South Texas brush country. Observers count deer seen on strips of deer habitat of known width and length.
3. Track count method. Counting deer tracks on selected sites during late summer is a method frequently used in heavily wooded areas of East Texas.
4. Spotlight counts. Counting deer at night with the use of spotlights along pasture roads or lightly traveled public roads is a method biologists have recently put into use. It is an excellent census method in areas with low deer populations. **Caution:** Biologists always notify all landowners along their spotlight census routes. They drive vehicles clearly marked "Texas Parks and Wildlife Department" and "Deer Census." Any other spotlighters should be reported to the local game warden.
5. Several other deer census methods are used by Parks and Wildlife Department personnel. Counts from helicopters and late evening counts from vehicles are good deer census techniques.

What do deer eat?

Deer eat mostly browse (leaves, twigs, young shoots of woody plants and vines) and forbs (weeds and other broad-leafed flowering plants). They eat some grass, but only when

Each summer the whitetail grows a new set of antlers. When the breeding season begins, the velvet (above) is shed and the antlers become hard and polished.

it is green and succulent. Sheep, goats and foreign big game species compete directly with the whitetail for preferred deer foods. Deer food shortages usually occur during late summer and winter months. Adequate forage is usually available during spring and fall seasons. A variety of foods and habitat types is essential to good deer production and survival.

The following plants are examples of some good native deer foods in Texas which are readily taken by deer when and where they are available.

Browse: oak leaves and acorns, yaupon, greenbriar, prickly pear and fruit, hackberry, mulberry, rattan or supplejack, sumac, mesquite beans and dried leaves, hawthorns, poison oak, American beautyberry, wild cherry and plum, wild grape, honeysuckle, dogwood, elm, blackberry and dewberry, gum elastic (chittum), acacias (catclaw), ephedra, walnut, guayacan, wild chinaberry, kidneywood, Brasil and other condalias.

Grasses: rescue grass, Texas wintergrass, Ozarkgrass, fall witchgrass, panic grasses, sedges and rushes.

Forbs: bundle flower, euphorbia(s), whorled nodviolet, bayflower, oxalis, woolcywhite, tickclovers, filaree, clover, verbena, arrowleaf sida, wild lettuce, wild onions, old man's beard, wildbean, snoutbean, lespedezas, spiderwort, vetches (milkvetch, etc.) lamb's quarters, plantain, groundcherry, pigweed or carelessweed and partridge peas.

How long do deer live?

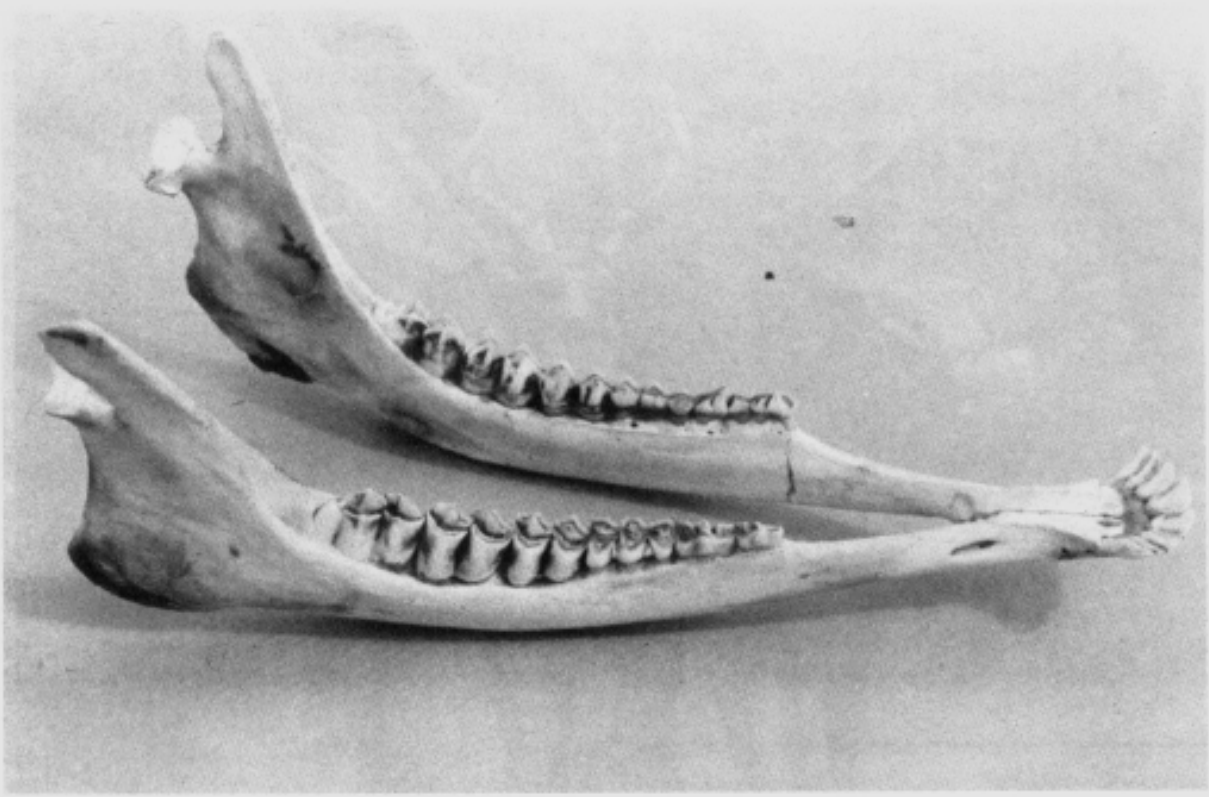
Deer in controlled situations have been known to live 15 to 20 years. It is unusual, however, for a deer in the wild to live more than 10 years, because its teeth usually wear out during the eighth or ninth year.

How can the age of a deer be determined? Is the number of antler points one method?

Deer age is determined by tooth replacement and tooth wear of the premolars and molars (back teeth) of the lower jaw. Unlike sheep, deer cannot be aged by their front teeth, and age cannot be determined by antler characteristics.

Does a buck deer keep the same set of antlers each year?

No. A buck grows a new set of antlers (not horns) each summer. The size of the antlers depends primarily upon the quality and quantity of food the buck eats and his age. The more nutritious the food and the more there is of it during the antler-growing season, the better his antlers will be. With favorable conditions, antler size and spread will increase with deer age. After the sixth year, however, antlers usually decline in size due to the deer's inability to properly chew and digest food.



By noting tooth replacement and tooth wear of the premolars and molars of the lower jaw, biologists determined that this deer was 1½ years old.

What happens to the antlers each year?

Buck deer shed their antlers following the mating season each year. Antler shedding is triggered by the cessation of production of a hormone which also terminates the breeding season. Most bucks in Texas shed their antlers during late January and February. Shed antlers quickly deteriorate or are eaten by rodents and other animals for their calcium content. New antlers start growing and become noticeable "in velvet" during May and June. Good nutrition during this period is critical for good antler growth.

Shouldn't spike bucks be protected since they are young and will be the breeding bucks of the future?

Not necessarily. Most spike bucks are young deer, but if range conditions are poor, there may be spikes of any age. If a herd contains many spikes, the deer probably did not have sufficient quality forage during antler-growing season (May-August). It would serve no logical purpose to protect the spike buck. Research conducted on the Kerr Wildlife Area has shown that all young spike bucks do not develop into the same quality of buck as do most yearling bucks with forked antlers. Some young spikes will produce very good antlers later in life, but the chances for massive antlers is not as good as with forked antlered yearlings. Spikes should be harvested based on the intensity of management desired by each landowner or group of hunters. Spikes should never by protected from hunting. The idea that the removal of spikes is a cure-all for antler development has little merit.

When is the breeding season?

The breeding season for white-tailed deer in Texas ranges through the fall and winter months from about the first of September through mid-January. The peak breeding activity occurs in mid-November in Central Texas and late December in South Texas.

What is a good buck-doe ratio?

The buck-doe ratio in most of Texas is about one buck per three to five does (adult deer) which is satisfactory for good production and hunting. This ratio is not a major problem in Texas deer herd management at this time. An adequate harvest of antlerless deer would help maintain a good ratio of both sexes. It is recommended that game managers and landowners strive for a ratio of 2.5 does per buck.

Won't the deer become smaller due to inbreeding if we don't bring some new blood lines?

No. The deer of Texas are direct descendants of isolated deer herds of many years ago. Inbreeding may occur in the wild, but it apparently is no problem. New blood lines are quickly absorbed into established genetic pools and no improvement in quality is noticed. Inferior quality or small deer result from poor range conditions or insufficient preferred forage and will not be improved by bringing in new bucks.

Does the Texas Parks and Wildlife Department restock deer?

Yes, but only in approved areas judged as potentially good deer habitat which presently have few or no deer. The deer trapping and restocking program was initiated in 1938 by the Game, Fish and Oyster Commission, predecessor of the Texas Parks and Wildlife Department. Since that time, more than 30,000 deer have been released in 160 Texas counties.

How many fawns will a doe have?

Normally, a doe deer in Texas will have her first fawn, which is usually a single, when she is two years old. Thereafter, if food conditions are adequate, the doe should normally have twin fawns almost every year until her sixth or seventh year, when the reproductive rate will begin to decline. Triplet fawns are uncommon, but do occur. Quadruplets have been reported.

The gestation period for deer is seven months.

According to reproductive studies, "old barren does," or does that have never produced fawns, are uncommon and are no problem to deer herd management. The key to maximum production is an adequate supply of nutritious natural food.

Are more female fawns born than male fawns.?

No. Male and female fawns are born in approximately equal numbers.

What are the most serious threats to deer herds in Texas?

1. Habitat destruction such as land clearing, root plowing, improved grass pastures, subdivisions, new lakes, expanding cities, etc.
2. Poor range or inadequate food supplies due to overgrazing by domestic livestock and overpopulations of deer, resulting in large-scale deer die-offs.
3. Disease and parasites.
4. Illegal hunting.

What are some of the most important limiting factors affecting white-tailed deer?

Rainfall is an important limiting factor. Extended periods of severe drought during the late summer and fall are especially harmful to fawns, yearlings and very old deer. Coyotes are a limiting factor in South Texas and in portions of Southeast-Central Texas. However, natural predators, such as coyotes, bobcats or eagles presently pose no serious threats to established deer herds of Texas. Efforts to control these predators are usually expensive and ineffective with regard to white-tailed deer.

What about hunting?

Legal hunting can be a limiting factor but is not currently a threat to deer populations. In fact, regulated hunting is the best way to crop the deer herd annually, much like a farmer-rancher would crop his herds of domestic livestock. Properly controlled and regulated, hunting is the most reasonable and humane method of maintaining and utilizing the extensive deer populations of Texas.

Will deer move great distances?

Not normally. A deer chased by dogs may run several miles, but will often circle and end up close to home. During the breeding season, some bucks will trail female deer out of their normal home range but will later return. Movement studies and radio-tracking research in Texas indicated that most deer spend their lives within about 1.5 miles of their birthplace.

What can I do to help the deer, increase deer numbers or improve the quality of deer?

1. Learn about the habitat requirements of deer. Become familiar with preferred deer foods in your area or the area where you vacation or hunt. Support practices which create good wildlife habitat and prevent destruction of existing habitat.
2. Landowners and operators should make every effort to provide adequate habitat and forage for deer and other wildlife. Competition by domestic sheep and goats should be reduced in some cases. Both sexes of deer should be reasonably, but adequately, harvested each year from well-established herds.
3. Sportsmen should obey state laws and those rules established by landowners. Sportsmen should not abuse the land on which they hunt, trespass where they do not have permission, take "sound shots" or misuse a firearm.
4. Everyone should cooperate with law enforcement officers responsible for protection of our wildlife. Violations should be reported immediately to the nearest game warden of the Parks and Wildlife Department, or to Operation Game Thief at 1-800-792-GAME.
5. Landowners and hunters can provide a significant service to the game management programs of Texas by completely and accurately providing harvest data. Whether it is solicited by mail questionnaire or in person by biologists in the field, at check stations or cold storage facilities, valid harvest information is vital to the formulation of effective hunting regulations. These regulations will allow the maximum harvest of surplus animals without endangering the broodstock necessary to replenish those populations.

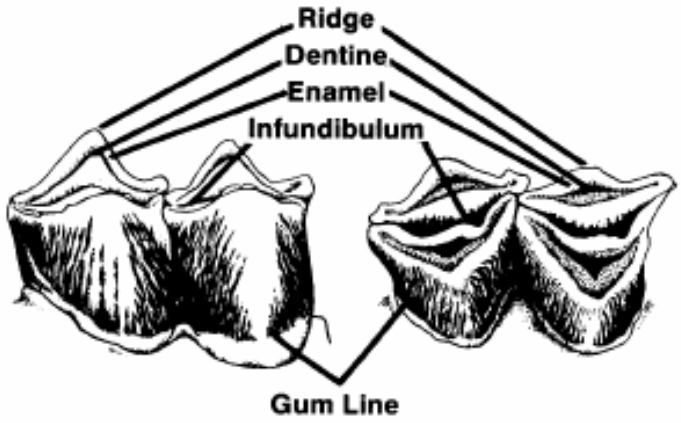
Would it help to feed the deer some supplemental feed?

If deer take large quantities of supplemental feed (corn, etc.), there probably is a shortage of their natural preferred foods. The best solution to the problem is to improve availability of natural foods. Obviously, this cannot be achieved quickly and will result only from proper range management practices (grazing moderately, rotation grazing systems, etc.). If artificial feeding is necessary, deer should be supplied high-quality (14 to 16 percent protein) 3/16" pellets instead of corn, which is about eight percent protein. Marked improvement in body size and antler development should not be expected from artificial or supplemental feeding.

Researchers in Texas and other states have worked many years to obtain answers to some of the many questions concerning the white-tailed deer, its requirements and management. Continued research will reveal additional necessary information about this and other wildlife species. The well-being and continued survival of the whitetail in Texas, however, is dependent primarily upon the interest and concern of sportsmen, landowners and the conservation-minded public of our state.

How To Age Deer

GENERAL ANATOMY OF LOWER MOLAR



SIDE VIEW **THREE-QUARTERS TOP VIEW**

Age of a deer is determined by tooth replacement and wear on molars and premolars of the lower jaw. As a deer grows older, certain portions of its teeth are worn enough to show definite differences from the teeth of other age classes.

A deer has only six jaw teeth, although they appear to have many more. The teeth are broken into two distinct categories: the premolars, which are numbered 1, 2, and 3, and the molars, which are numbered 4, 5, and 6.

Deer are aged in fractions because they are born around July and are killed during the hunting season.

1½ year old: (*long yearling*): The long yearling deer is the most easily recognized of all age classes. The first three jaw teeth are milk teeth, which will be replaced around two years of age. These are worn smooth as a long yearling, while the last three teeth remain sharp. The number 3 tooth has three cusps in the milk tooth stage, but only two cusps appear on the replaced tooth. Fawns in their first season will show little evidence of wear on their milk teeth.

2½ year old: The first three jaw teeth have been replaced by permanent teeth and all molars are sharp. The dentine of the first molar (tooth 4) is not as wide as the enamel which surrounds it.

3½ year old: The dentine in the first molar (tooth 4) is now as wide or wider than the enamel which surrounds it, and this is not true of the second molar or tooth 5.

4½ year old: The dentine of the first and second molars (teeth 4 and 5) is as wide or wider on both teeth, but not in tooth 6.

5½ year old: The dentine of all molars (teeth 4, 5, and 6) is now as wide or wider than the enamel surrounding it.

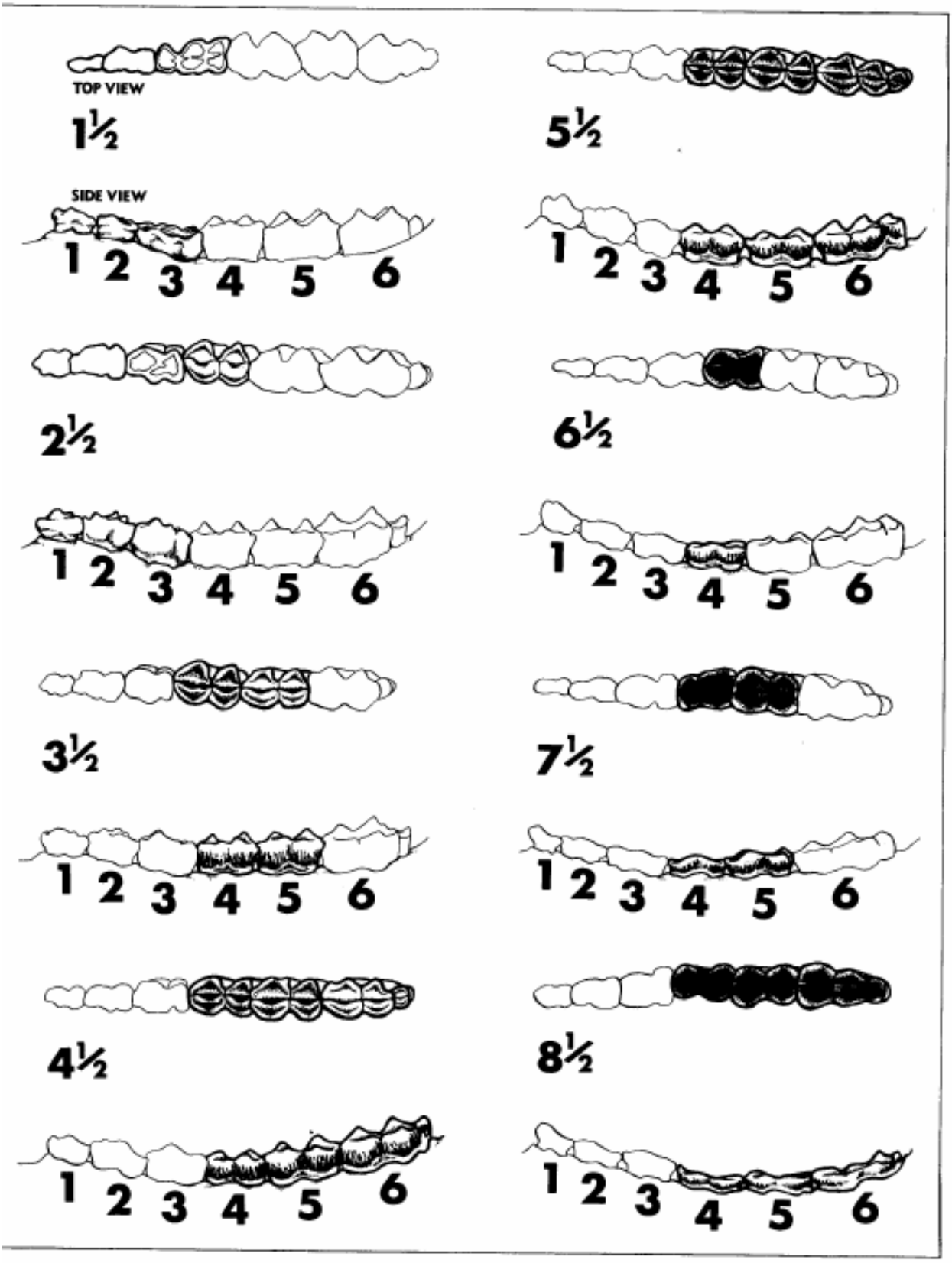
6½ year old: The first molar (tooth 4) is worn smooth, but teeth 5 and 6 are not smooth.

7½ year old: The first and second molars (teeth 4 and 5) are worn smooth, or tooth 5 may still have a small ridge left.

8½ year old: All molar teeth are worn smooth (teeth 4, 5, and 6), but tooth 6 may still have a small ridge left.

Older than 8½ year old: Unable to determine, because characteristic formations have all been worn smooth.

The primary factor governing antler formation is food supply. As deer grow older and their teeth wear flatter, food becomes harder and harder to chew. Body condition will drop and, simultaneously, so will antler development.


TOP VIEW
1½
SIDE VIEW
1 2 3 4 5 6
2½
1 2 3 4 5 6
3½
1 2 3 4 5 6
4½
1 2 3 4 5 6
5½
1 2 3 4 5 6
6½
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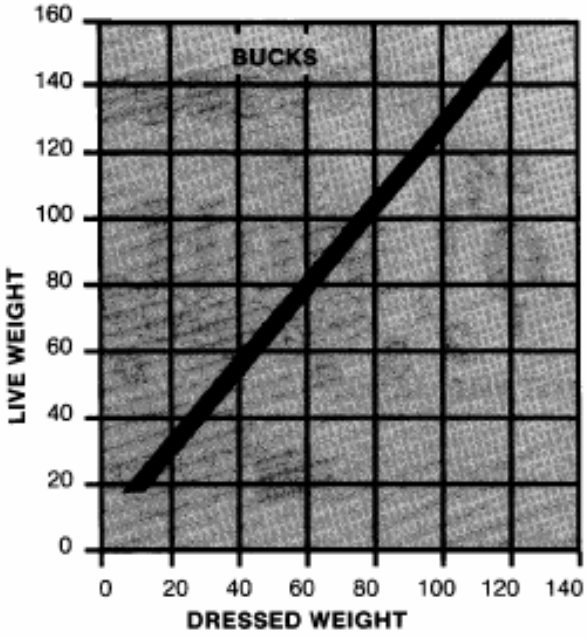
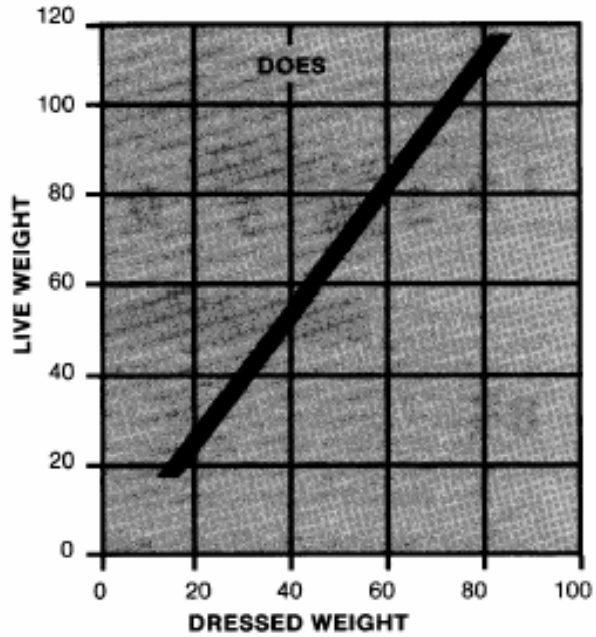
8½
1 2 3 4 5 6



Find dressed weight of buck in figures at bottom of chart and trace line up to diagonal. From intersection, trace line to scale at left and read live weight. Reverse this procedure to determine dressed weight of live animal.

Does are lighter than bucks so a different chart must be used. As above, find dressed weight of doe in scale at bottom, trace up to diagonal, then from intersection trace line to left and read estimated live weight.



The Way to Weigh

by Charles Ramsey
and
Melvin J. Anderegg

A PICKUP with two hunters drove up to the deer check station on the Kerr Wildlife Management Area. Both hunters climbed out, and walked around to the back of the truck and began unloading a couple of deer.

The first deer, a small doe, was tossed upon the table in the check station. Area personnel field dressed the deer and recorded descriptive measurements and weights. Then the doe was loaded back into the truck.

The second deer, a large buck, was lifted onto the table and the process of measuring and recording was repeated. Since the buck was already field dressed, only a dressed weight was taken—106 pounds field dressed. How big was that deer on the hoof?

This question has been repeated so many times at the check station that two graphs were prepared to help with the answer. These graphs represent the weights taken from approximately 200 deer in good body condition killed on the Kerr Wildlife Management Area. Since these deer were typical of the Edwards Plateau, the graphs will be applicable for deer taken within the Hill country. Although not as accurate, they are also good guides for deer taken from other areas of the state.

Dressed weight means "field dressed" with head, hide, and feet left on the carcass.

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PWD-BK-7100-7-12/89

Appendix Y

Pesticides and Brush Control
Texas Department of Agriculture

Pesticide Registration and Safety

The U.S. Environmental Protection Agency (EPA) and the Texas Department of Agriculture (TDA) register all pesticides used for brush control in the state of Texas. The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Food Quality Protection Act (FQPA), and Federal Food, Drug and Cosmetic Act (FFDCA) all regulate the use of pesticides in Texas to some degree. However, FIFRA and Texas pesticide laws and regulations are primarily involved in the registration process of brush control herbicides.

To be eligible for registration and use in Texas, pesticide products must first undergo a rigorous testing protocol required by EPA and then be registered federally. The testing protocol is extensive and must address issues such as efficacy and toxicity to non-target species. The vast majority of pesticide products that are registered in Texas are subject to over 140 scientific or toxicological tests in order to receive and maintain EPA product label approval, and subsequent Texas registration. Automatic approval does not occur for use of a pesticide in Texas if it is approved by EPA. Pesticides must meet state use and registration regulations in addition to strict EPA standards. The exact number of tests that must be performed for a pesticide to be allowed in Texas varies with its end-use, but it is extensive whatever the case. EPA evaluates a plethora of scientific studies before registering a product and uses a series of safety factors to determine the appropriate use patterns considering worst-case exposure scenarios.

Native Texas wildlife, especially threatened and endangered species, are given further consideration when performing risk assessments for the special use of pesticides in many brush control projects. Various classes of species are specifically targeted for detailed assessment, namely the chemical effects on amphibians and reptiles, birds, fish and invertebrates. The environmental fate of most compounds used in brush control is also carefully reviewed in order to protect water supplies. Factors such as degradative processes, absorption and mobility, field dissipation, as well as local ground and surface water concerns are considered in risk assessments, especially during special use considerations such as a FIFRA Section 24(c) allowances as discussed below.

Toxicity Category	Herbicide / Substance	Oral LD_{50}	Equivalent Human Dose
I Severe Danger	Botulinus	0.00001	1 teaspoon or less
	TCDD (a dioxin)	0.1	
	Parathion	13	
	Strychnine	30	
	Nicotin	50	
II Moderate	Caffeine	200	1 teaspoon to 1 ounce
	2,4-D	375	
III Slight (caution)	Formaldehyde	800	1 ounce to 1 pint
	Aspirin, Vitamin	1700	
	Bleach	2000	
	Table	3750	
	Diuron	3750	
	Glyphosat	4320	
IV Very Slight	Imazapy	>5000	More than 1 pint
	Diesel	7380	
	Kerosen		
	Sugar		

Table 1: The equivalent human dose is that physical amount of the compound that would contain the oral lethal dose 50 (LD_{50}) amount.

In reality and for all practical purposes of assessment, the amount of pesticide that a sensitive species must be exposed to and cause a harmful effect is very unlikely to be seen with any use of a pesticide product (Table 1). Even when these species may encounter these registered pesticides in a natural setting, most of these chemicals have relatively low toxicity or similar toxicity to that of many household or natural materials (Table 2).

Table 2: Overall toxicity rating based on the LD_{50} and the dermal response rating are from 1 to 5, with 5 being the least severe

COMMON NAME	TRADE NAME	ORAL LD50 mg/Kg	TOXICITY RATING	DERMAL RESPONSE RATING
nicotine	for comparison	50-60	2	-
paraquat	Surefire	120	3	3
caffeine	for comparison	200	3	-
diquat	Diquat	230	3	4
2,4-D	various brands	600	4	4
tebuthiuron	Spike	644	4	4
MSMA	various brands	1,800	4	4
Aspirin	for comparison	1,240	4	-
hexazinone	Velpar	1,690	4	4
dicamba	Banvel	2,900	4	4
prometon	Pramitol	2,980	4	-
atrazine	various brands	3,080	4	5
pendimethalin	Pendulum	3,277	4	4
Table salt	for comparison	3,320	4	-
diuron	Direx, Karmex	3,400	4	4
bromacil / diuron	Krovar	4,260	4	5
glyphosate	Roundup	4,320	4	5
sulfometuron methyl	Oust	>5000	5	4
imazapyr	***Arsenal***	>5000	5	4
imazapic	Plateau	>5000	5	5
prodiamine	Endurance	>5,000	5	4
simazine	Princep	5,000	5	4
bromacil	Hyvar	5,200	5	4
chlorsulfuron	Telar	5,545	5	5
picloram	Tordon	8,200	5	4
oryzalin	Surflan	10,000	5	4
norflurazon	Predict	>10,000	5	4
fosamine	Krenite	24,000		4

FIFRA Section 24(c) Special Registration

A FIFRA Section 24(c) is designed to expand a currently registered product label in the state of Texas for a documented special local need (SLN). A SLN means an existing or imminent pest problem within Texas for which TDA, based upon satisfactory supporting information, has determined that an appropriate federally registered pesticide product is not sufficiently available. Documentation of need for the 24(c) registration in the form of letters from producers, grower organizations, experiment station personnel, and/or extension service personnel, must be provided to EPA. Research and/or test data, or summaries supporting efficacy and safety must be submitted. In addition, data documenting expected residue levels (when appropriate, mainly when food or feed crops are involved) must also be supplied with the application packet to EPA. Prior to issuing a Section 24(c), EPA and TDA determine that use of the product for which registration is sought will not cause unreasonable adverse effects

on man or the environment when used in accordance with labeling directions or widespread and commonly recognized practices. Endangered and threatened species are especially considered when evaluating special uses of pesticides. The U.S. Fish and Wildlife Service, Texas Parks and Wildlife Department and TDA are in regular contact concerning the well being of all native Texas species.

The Texas Department of Agriculture obtained a FIFRA Section 24(c) Special Local Need registration to use *Arsenal®* (active ingredient imazapyr) to control saltcedar to conserve water and protect native habitats.

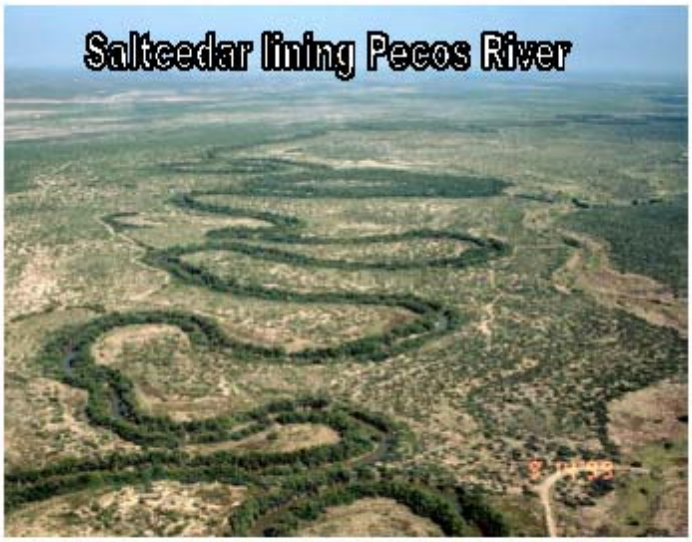
In fact, in several cases, saltcedar is being controlled with *Arsenal®* to enhance wildlife habitat. The Canadian Municipal Water District is planning to control salt cedar beginning in September 2004 along the Canadian River. This effort is being made to stop the spread of salt cedar, which is estimated to consume almost 70,000 acre feet of water each year in the river basin, and to enhance habitat for the Arkansas River Shiner. In addition, U.S. Fish & Wildlife Service and Panhandle Water Conservation District officials have proposed a joint project to finance the control of salt cedars along the Canadian River to enhance habitat for the Arkansas River shiner.

In another instance, the U.S. Fish & Wildlife Service and Fort Worth Zoo requested that TDA change the restriction on the use of *Arsenal®* in Salt Creek in Culberson County to enhance habitat for the endangered Pecos Gambusia. Additionally, the Colorado River Municipal Water District has worked with U.S. Fish & Wildlife and the Texas Parks and Wildlife Department to use *Arsenal®* along the Colorado River to preserve habitat for the endangered Concho water snake and the endangeredTexas poppy-mallow. The Concho water snake is not affected by *Arsenal®* because this chemical generally only affects plant species. The Texas poppy-mallow is not affected by the saltcedar spraying because its habitat is not near saltcedar due to different soil preferences between the two plant species. Additionally, GIS mapping is done before helicopter spraying of *Arsenal®* to pinpoint Texas poppy-mallow habitat.

Saltcedar (*Tamarisk*) Control in Texas

Saltcedar (*Tamarix spp.*) was introduced into the southwestern United States in the early 1800s from Eurasia as an ornamental shrub that aided in erosion control. A mature saltcedar may consume up to 200 gallons of water per day and is a problem for most of the western United States. Saltcedar trees occur in almost all of the water bodies of west Texas including the Pecos, Brazos, Canadian, Colorado, Rio Grande and Red rivers, and their tributaries.

Saltcedar has the ability to change its physical environment giving it a competitive advantage over native trees and shrubs. This occurs through increased surface soil salinity, lowered soil water potential and increased fire frequency. This invasive increases surface soil salinity by absorbing salts from deeper soil layers and groundwater and transporting these salts to their leaves, subsequently releasing the salts back into the surrounding soils through accumulation of leaf litter. The high tolerance for salt that saltcedar possesses allows for a competitive advantage. Increased soil salinity inhibits germination and growth of most other plant species.

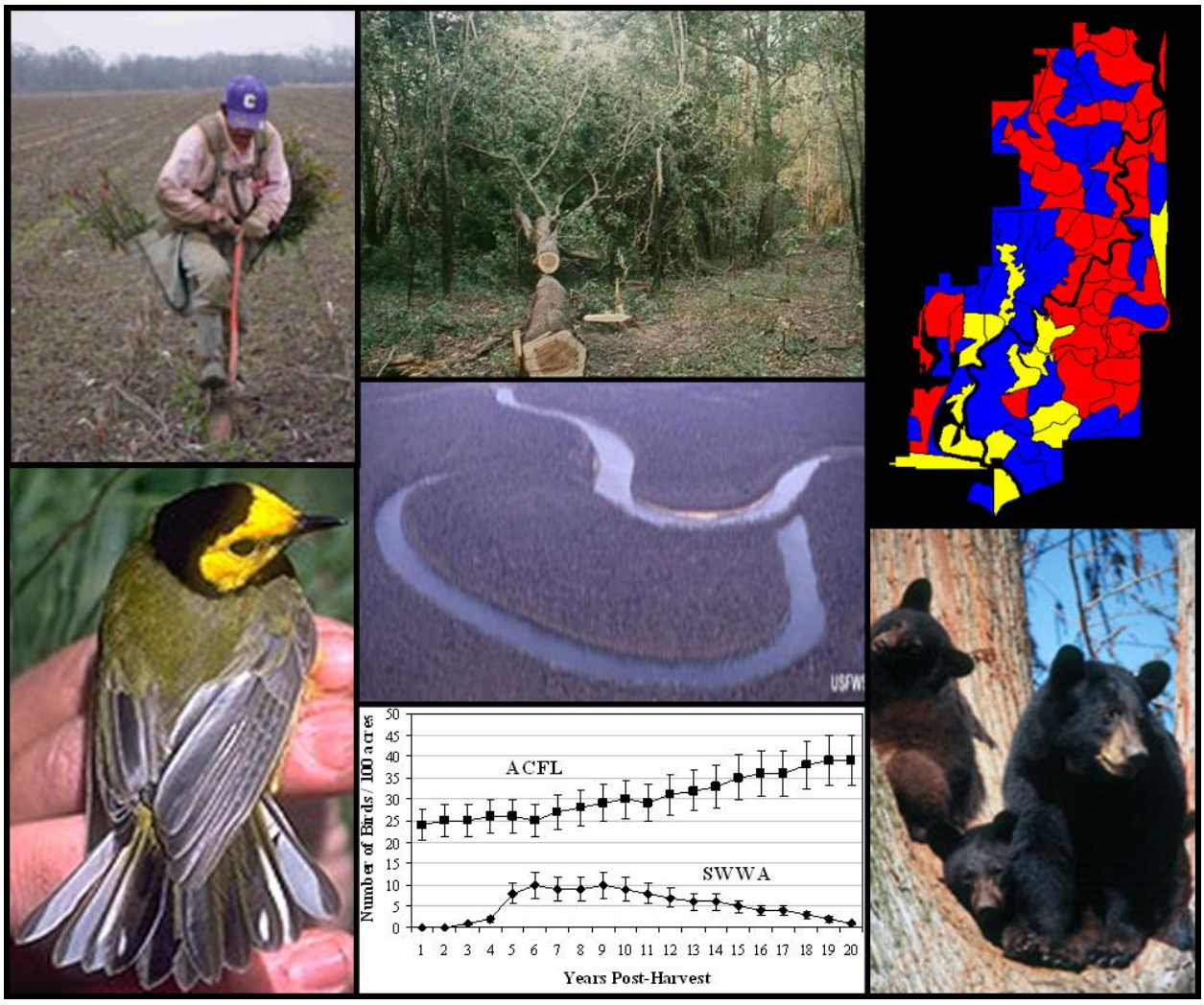


The Texas Department of Agriculture is leading the Texas Riparian Invasive Plant (TXRIP) Taskforce in its endeavors to combat the spread of invasive riparian plants, especially saltcedar. This Taskforce is composed of almost every major state and federal agency with a mandate on this issue. TXRIP joins the US

Tamarisk Coalition, the US Department of Interior, and the US Department of Agriculture in addressing this serious national problem. All scientifically tested methods for saltcedar control are assayed for use in control programs, including biological, chemical, and mechanical options.

Recent applications of federally approved herbicides, including *Arsenal*®, has proven to be a very effective and safe tool to control saltcedar in selected segments of Texas waterways. This has spurred an interest in using this means of control in other infested water systems.

Restoration, Management, and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat



FINAL REPORT -- 2007

Lower Mississippi Valley Joint Venture

Forest Resource Conservation Working Group

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Lower Mississippi Valley Joint Venture

Forest Resource Conservation Working Group

--- Final Report ---

Restoration, Management and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat

Edited by: Randy Wilson, Kenny Ribbeck, Sammy King and Dan Twedt

Version 5.2

--- June 2007 ---

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EXECUTIVE SUMMARY

The **conservation objective in the Mississippi Alluvial Valley is to provide forested habitat capable of supporting sustainable populations of all forest dependant wildlife species.** However, forest loss, fragmentation, and hydrological change has markedly altered habitat conditions within bottomland forests such that some species of concern (e.g., ivory-billed woodpecker (*Campephilus principalis*), Louisiana black bear (*Ursus americanus luteolus*), and some migratory songbirds) have been severely impacted. To provide habitat for these and other priority wildlife species, **we advocate forest conditions that are conducive to the continued viability of this suite of priority wildlife species.**

Forest-dependent (silvicolous) wildlife is responsive to habitat conditions at multiple spatial scales (e.g., **landscape quality** and **site quality)**. To address this issue, we define ***Desired Forest Conditions*** as those forested landscapes that meet both Desired Landscape Conditions and Desired Stand Conditions. Traditional forest management has focused on production of forest products (i.e., lumber or pulp) through silviculture that promotes optimal growth and vigorous health of economically desirable tree species. Often these traditional silvicultural methods are not optimal for silvicolous wildlife. Indeed, quality habitat for priority wildlife species likely requires some sacrifice in timber production and the retention of less healthy trees. Even so, **commercially viable, wildlife-oriented silviculture (i.e., Wildlife Forestry)** employing variable retention harvests can be used in conjunction with forest restoration, regeneration, and natural processes to achieve Desired Forest Conditions within bottomland hardwood forests.

To address landscape scale habitat needs of priority wildlife species, we advocate local **landscapes of >10,000 acres that are extensively forested** in a matrix of large blocks of contiguous forest and closely associated smaller forest fragments. Where possible, forest corridors should link these forested landscapes. Within each landscape, **5-30% of the forest area should be passively managed** (i.e., set-aside as "unmanaged" controls). However, to ensure development of "Desired Stand Conditions" **≥70% of forest area should be actively managed using Wildlife Forestry silviculture**. Regeneration harvests of areas >7 acres

(i.e., clear-cuts) should be restricted to ≤10% of local landscapes and management should ensure the availability of some (≤5% of area) early successional (i.e., shrub-scrub) habitat.

Size, structure, and composition of forest vegetation are important parameters for predicting the suitability of forest habitat for priority silvicolous wildlife. Many **priority wildlife species favor structurally diverse and species rich forests which harbor large trees and frequent canopy gaps.** These conditions provide suitable habitat for foraging and cover within all dimensions of the forest and provide a desirable blend of regeneration, maturity, and senescence of forest trees. **Distribution and abundance of suitable forest habitat is largely dependent on disturbance.** Historically, disturbances resulted from flood, fire, tornadoes, etc. Under current conditions however, many former disturbances are spatially and temporally restricted. Reduced levels of disturbance acting in concert with unsustainable forest management practices have resulted in homogeneous, closed canopy forests with little structural diversity or understory vegetation. **We advocate the use of wildlife forestry silvicultural practices to induce disturbance within bottomland hardwood forests and thereby stimulate development of Desired Stand Conditions.**

The habitat conditions that result from wildlife forestry silvicultural prescriptions will vary among sites and forest types. For many forests, **desired stand conditions are:** an average of **60-70% overstory canopy cover** which is heterogeneously distributed, a **basal area of 60-70 ft^2 per acre**, and **60-70% stocking**. Desired **midstory and understory cover are between 25-40%, respectively.** At least 2 dominant trees (emergents) per acre should be retained. Some cavity trees (small and large) as well as **dead and/or stressed trees should be retained**. These stems will eventually contribute to coarse woody debris which should average >200 ft^3 per acre. To ensure future merchantability of stands, **shade-intolerant regeneration should be present on 30-40% of the area.**

Extensive forest restoration in the Mississippi Alluvial Valley has advanced progress towards desired landscape conditions. However, previous restoration methods may not readily result in desired stand conditions. Therefore, **we recommend that future restoration efforts place greater emphasis on the geomorphic setting and hydrologic conditions of the site,** as well as

on **plant multiple tree species at densities of 435 seedlings per acre** combining shade-intolerant, early successional, and shade-tolerant species with **hard-mast producing trees accounting for 30-60% of stock**. Plantings, and natural colonization, **should result in an average of >300 trees per acre within 3 years** – preferably in a **matrix of high stem density patches and gaps** with sparse stem density.

We advocate improving forest management and restoration prescriptions through adaptive management. As such, it is imperative that the impact of forest management decisions be evaluated with regard to habitat conditions and wildlife response. **We recommend extensive inventories of forest within local landscapes (e.g., a refuge or management area) to assess existing habitat conditions** and aide in formulating and prioritizing silvicultural treatments. **To assess forest change and region-wide progress towards desired forest conditions, we recommend use of a regional continuous forest inventory (CFI) network** that is monitored at 5 to 10 year intervals. Finally, **we recommend the design and implementation of coordinated monitoring programs to evaluate wildlife use of forest stands following prescribed wildlife forestry treatments** to ensure hypothesized wildlife responses are achieved.

PREAMBLE

The history of bottomland forest conservation and management in the Mississippi Alluvial Valley (MAV) is in many respects one of exploitation and conversion of an internationally significant forest resource to agricultural land uses. Yet it is also one of dedicated natural resource managers and forest landowners, both public and private, seeking to better understand the art, science, and practice of bottomland hardwood forest management to provide habitat for the wildlife species that depend upon it for their existence.

This document has been prepared to further the conservation goals and objectives of the Lower Mississippi Valley Joint Venture (LMVJV). The LMVJV is a self-directed, non-regulatory partnership that exists for the purpose of implementing the national and international plans of the North American Bird Conservation Initiative. Its members include private, state, and federal conservation organizations that by virtue of mission or legislated authority share in the commitment to conserving wildlife species and their habitats. The LMVJV partnership operates on the basis of a population-based, multi-scale conservation framework that emphasizes an adaptive approach to ecosystem management. The focus of this conservation framework is on the development and refinement of goals expressed as measurable biological outcomes that are linked across multiple spatial scales. The LMVJV partnership focuses primarily on the MAV and West Gulf Coastal Plain (WGCP) Bird Conservation Regions (Fig. 1) as defined by the North American Bird Conservation Initiative. Within both of these regions, forest restoration and management is central to achieving the goals and objectives of Joint Venture partners.

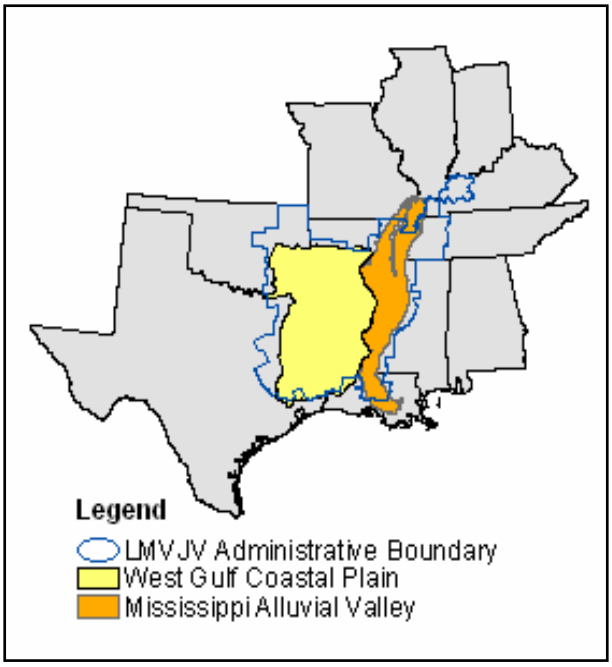


Figure 1. Administrative boundary of the Lower Mississippi Valley Joint Venture and Bird Conservation Region therein.

More specifically, this document is a product of the LMVJV's Forest Resource Conservation Working Group. This Working Group was chartered by the LMVJV Management Board to serve as the technical forum for Joint Venture partners on matters pertaining to the reestablishment and management of forest resources with a specific mission to "*ensure the conservation actions and programs of Joint Venture partners reflect reforestation and forest management prescriptions and practices that sustain populations of priority birds and other forest-dependent wildlife in concert with sustainable forestry*." The Working Group draws its participants (Appendix 1) from both the forestry and wildlife disciplines and includes members experienced in on-the-ground management and applied research.

PURPOSE OF DOCUMENT

Over the last 18 years, Joint Venture partners have established objectives for conserving, restoring, and managing bottomland hardwood forests in the context of two overarching goals: (1) conserve and restore the ability of the MAV and WGCP to sustain birds of national and international conservation concern; and (2) maintain and restore the wetland functions and values associated with forested floodplains. In addressing these goals, information on forest restoration and management is integral to the progressive refinement of Joint Venture goals and objectives.

To provide the LMVJV partnership with information on the restoration and management of bottomland forests, this document is intended to meet three specific needs: (1) to define desired forest conditions that result from management of bottomland hardwood forests where the primary objective is the conservation of wildlife; (2) to provide technical recommendations for the restoration of bottomland hardwood forest on areas that have been converted to non-forested land uses (e.g., agriculture) that reflect the cumulative knowledge and experiences of land managers and researchers from the past decades of active reforestation; and (3) to recommend protocols and procedures for coordinated inventory and monitoring of forest resources on public lands managed for wildlife conservation such that restoration and management can be implemented in an adaptive manner.

The recommendations contained within this report were developed to specifically address issues surrounding restoration, management, and monitoring of forest resources in the MAV. However,

the working group believes that these recommendations are applicable to other bottomland hardwood systems across the southeastern United States provided users consider differences in geomorphology, soils, and hydrology where applicable.

USE AND REFINEMENT OF TECHNICAL RECOMMENDATIONS

This document provides technical guidance for the restoration and management of bottomland hardwood forests where conservation of wildlife resources is a central purpose and objective. As such, the document integrates habitat conditions for priority wildlife with technical recommendations for the restoration and management of bottomland hardwood forests. To achieve these habitat conditions requires managers to reassess traditional methods of silviculture, placing greater emphasis on retaining and promoting forest structure and senescence to benefit priority wildlife.

We envision these recommendations will aid on-the-ground managers and program managers responsible for managing forest resources in implementing forest management strategies for wildlife conservation. Furthermore, we anticipate that these recommendations will be instructive to private landowners targeting wildlife conservation as part of their overall land stewardship objectives; especially on lands under conservation easement. To that extent, all data are presented in English units throughout the document but tables with equivalent metric data are presented in Appendix 3.

These recommendations are not intended to be regulatory or administratively prescriptive, or to conflict with partner's ability to meet overarching (legislative or proprietary) mandates. Because these recommendations reflect the collective technical judgment and experiences of many biologists, foresters, and researchers, they have been developed with the expectation of being incorporated into the forest management programs and forest conservation efforts of LMVJV partners. Finally, although these recommendations reflect our current knowledge and experience, refinement and modifications are expected as we increase our knowledge, understanding, and experience in the science of bottomland hardwood forest restoration and management.

CHAPTER I

THE MISSISSIPPI ALLUVIAL VALLEY

INTRODUCTION

The MAV is located along the course of the Mississippi River, including portions of 7 states (Illinois, Missouri, Kentucky, Tennessee, Arkansas, Mississippi, and Louisiana), extending south from Cairo, Illinois to the Gulf Coast of Louisiana. The Mississippi River flows southward through the central United States and drains roughly 41% (approximately 79 million acres) of the conterminous United States (Klimas et al. 2004, Gardiner and Oliver 2005). The MAV is made up of 6 drainage sub-basins including the St. Francis, Western Lowlands, Arkansas Lowlands, Yazoo, Boeuf, and Tensas Basins, with major tributaries to the Mississippi River including the St. Francis, Arkansas, White, Bayou Bartholomew, and Yazoo Rivers (Saucier 1994). The rich alluvial soils of this 25-million acre floodplain have historically supported vast expanses of mixed-species, deciduous forests (Gardiner and Oliver 2005), known as the bottomland forests of the MAV.

The MAV was formed by geologic downwarping, and shaped by riverine processes of erosion and sediment deposition. The valley is bounded by older, higher uplands and is characterized by deep alluvial fill that overlies deeper Coastal Plain formations. A combination of alternating braided stream and meandering stream processes during the Pleistocene and Holocene Periods shaped the MAV into a broad and complex network of natural communities related to varying elevations, hydrologic regimes, soils, and vegetative types (Saucier 1994).

The MAV is a highly productive environment as a result of abundant water and the substrate of alluvial deposits high in mineral and organic nutrients. Bottomland hardwood systems are described as among the most productive and diverse ecosystems in North America (Klimas et al. 2004). They are maintained by the natural hydrologic regime of alternating wet and dry periods and historically these forests served as an integrated system linked by flood waters to import, store, cycle, and export nutrients (Wharton et al. 1982, Klimas et al. 2004). These bottomland hardwood forests contain a diversity of overstory species, are characteristically rich in woody

vines and shrubs and may feature an understory with large monocots such as cane (*Arundinaria gigantea*) and palmetto (*Sabal minor*) (Wharton et al. 1982, Klimas et al. 2004, Gardiner and Oliver 2005). Natural regeneration within bottomland hardwood stands is typically initiated by localized damage to overstory trees such as single tree snapping or wind throw (Johnson and Deen 1993, King and Antrobus 2001), periodic catastrophic fire or windstorm damage or prolonged growing season flood inundation (Dickson 1991). Seasonally wet oak-hardwood woodlands reach an 'old-growth' condition with a multi-layered overstory and tree age ≥150 years. Reproduction occurs in openings created by dead trees or wind throws (Kennedy and Nowacki 1997) and down woody debris is rapidly decomposed by high temperatures and humidity (Harmon et al. 1986). Forest types are associated with distinctive landforms resulting from the interaction of species specific physiological requirements of vegetative components and site characteristics (Gardiner and Oliver 2005).

A gradient of increasingly fine soil textures (coarse sands to fine clays) from high-energy to low-energy deposition environments has resulted in characteristic soil types often associated with distinctive landforms. Finer soils have higher soil organic matter content, increasing cation exchange capacity, and decreasing permeability (Smith and Klimas 2002, Klimas et al. 2004). The bottomland hardwood forests have historically included a wide range of species and community types which can tolerate inundation or soil saturation for at least some portion of the growing season (Wharton et al. 1982), resulting in a complex mosaic of community types that reflect differences in the alluvial and hydrologic environment (Smith and Klimas 2002).

GEOMORPHOLOGY

By considering the relationships between landform (geomorphology) and source, duration and frequency of inundation (hydrology), we can better understand the composition and functions of wetland communities. This approach is known as hydrogeomorphic (HGM) classification and assessment. It was developed to quantify the loss of wetland functions caused by wetland destruction and the potential gain of wetland function resulting from wetland restoration (Brinson 1993). Guidebooks have been produced to facilitate hydrogeomorphic analysis of sites across the MAV (Smith and Klimas 2002, Klimas et al. 2004). For portions of Arkansas, this approach has been extended by using maps of geomorphology (Saucier 1994) and flood

frequency created by the U. S. Army Corps of Engineers and sometimes augmented by soil maps to delineate the distribution of wetland communities across entire landscapes (Klimas et al. 2004, 2005). Such maps display both existing naturally vegetated wetland communities and restoration potentials of currently cleared wetlands.

Across the MAV, meandering streams and rivers (primarily during periods between glacial advances) have created distinct riverine landforms including point bars with alternating well-drained ridges and poorly-drained swales; high, well-drained natural levees; and poorly-drained backswamps. As the rivers have cut off bends and abandoned channels, they have created meander scar or oxbow lakes that gradually fill to form shallow sloughs. During glacial advances and particularly glacial retreats, the major rivers, particularly the Mississippi and Ohio, became sediment-rich and changed to braided-stream configuration. Under these conditions they left unsorted deposits of mixed particle sizes, often on relatively featureless plains, referred to as glacial outwash. As a result of varying relationships among stream gradient, sediment load, channel patterns and later removal of deposits, glacial outwash deposits remaining today are often at higher elevations than currently active floodplains, and form high terraces that are seldom or never flooded (Saucier 1994; Figure 2).

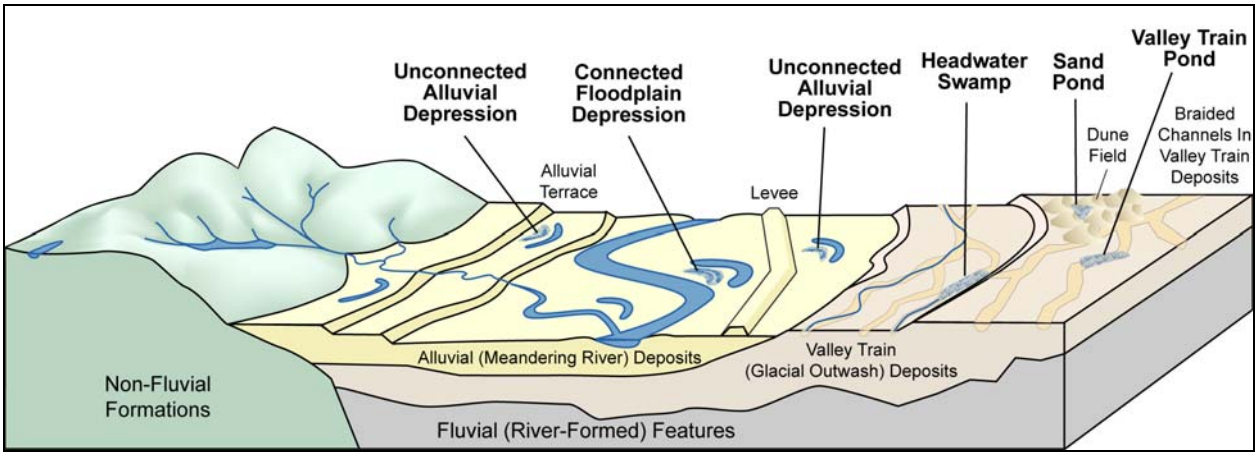


Figure 2. Placement of hydrogeomorphic depressional communities within the Mississippi Alluvial Valley (Adapted from Klimas et al 2004, by Elizabeth Murray, Arkansas Muti-Agency Wetland Planning Team).

Hydrologic processes underlie the natural plant communities of the MAV (Hodges 1997). In its pre-European settlement condition, the relatively flat MAV landscape as a whole was subject to

various combinations of: (1) prolonged, extensive ponding during the winter wet season of most years; (2) localized, short-term ponding due to precipitation events at any time during most years; (3) headwater inundation of tributary basins due to precipitation in most years; (4) backwater flooding of tributary basins during flood events on the Mississippi River; and (5) occasional large-scale inundation over most of the valley due to overbank flow of the Mississippi River (Smith and Klimas 2002, Klimas et al. 2004).

TREE DISTRIBUTION

Within a given stream bottomland, similar variations of topography and hydrology tend to occur, however there can be differences with an area. Streamside point bars and natural levees in riverine overbank areas flood frequently (usually more often than every five years) by flowing, headwater floods. Soils on these sites are relatively sandy and well-drained, and plant communities vary with micro-site characteristics. Black willow (*Salix nigra*) and cottonwood (*Populus deltoides*) typically dominate newly-deposited sand bars. American sycamore (*Platanus occidentalis*), sugarberry (*Celtis laevigata*), American elm (*Ulmus americana*), cedar elm (*Ulmus crassifolia*), along with green ash (*Fraxinus pennsylvanica*) become more abundant on slightly older and higher sites. In a hydrogeomorphic classification these 'first bottom forests' (Figure 3) are referred to as riverine overbank wetlands.

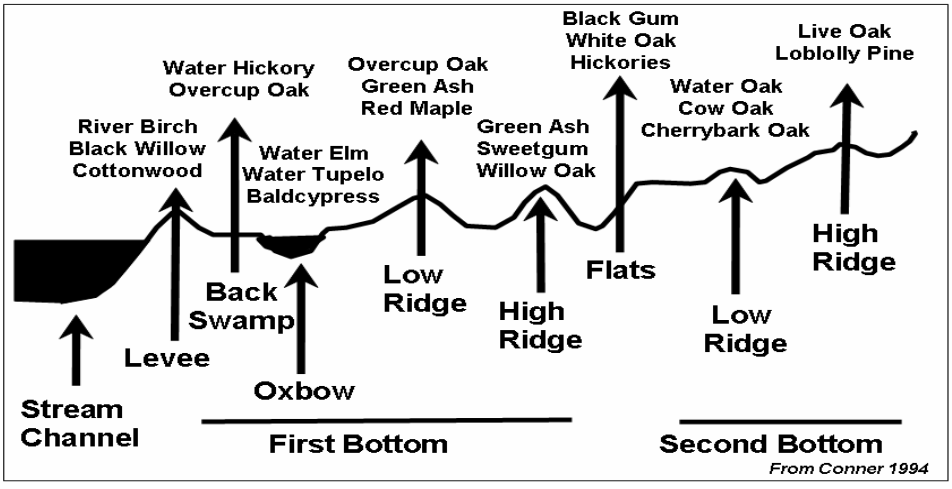


Figure 3. Distribution of tree species along hydrologic gradient (from Conner 1994).

In contrast, riverine backwater areas, often consisting of low backswamps behind natural levees, are typically flooded more frequently than every five years by sluggish or still waters. Overcup oak (*Quercus lyrata*) and bitter pecan (a.k.a., water hickory - *Carya aquatica*) are the typical dominant species on these sites, but occasionally species of higher sites such as Nuttall oak (*Quercus nuttallii*) or willow oak (*Quercus phellos*) may be found on drier parts of these sites.

Depressions, such as those formed by abandoned river or stream channels (e.g., oxbows, Figure 3) can hold water permanently or semi-permanently and be dominated by baldcypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*). Large oxbow lakes may have expanses of open water with a lacustrine fringe of baldcypress and water tupelo. If depressions are flooded by an adjacent river more frequently than every five years they are classed as connected depressions, otherwise they are called unconnected (Figure 2; Klimas et al. 2004).

Higher bottomlands are typically classed as flats (second bottom, Figure 3). These flats are usually flooded by the river less frequently than every five years, and are therefore hydrologically influenced more by precipitation. Forests of these sites are typically dominated by willow oak, cherrybark oak (*Quercus pagoda*) and swamp chestnut (a.k.a. cow oak - *Quercus michauxii*), pin oak (*Quercus palustris*) and/or Nuttall oak.

The hydrology of glacial outwash terraces (valley train deposits, Figure 2) is primarily affected by precipitation rather than flooding by an adjacent stream. Terrace wetlands (alluvial deposits, Figure 2) typically exhibit flat terrain that has poor surface drainage, and are underlain by soils with poor internal drainage. Therefore, these terrace wetlands are characteristically different in composition, structure and function than floodplain wetlands. There is little storage of water in the shallow soils, so these sites are often extremely wet during the winter and spring and extremely dry during summer and fall, a hydropattern referred to as hydroxeric. During the dry season these wetlands burn frequently, leading to a more open tree canopy and increased herbaceous ground cover, which consequently further increases fire frequency. Tree species adapted to low wetlands may germinate on these sites during wet cycles, and tree species adapted to high wetlands or uplands may germinate during dry cycles, so the tree species composition can be very diverse. Thus, fire and drought conditions add to the diversity of these sites.

Therefore forests of outwash plains (valley train deposits [Figure 2] or second bottoms [Figure 3]), although they are considered hydrogeomorphic flats and are sometimes referred to as flatwoods, are quite different from those of floodplain flats (alluvial deposits [Figure 2] or first bottoms [Figure 3]). Wet flatwoods may be dominated by willow oak and dry flatwoods by post oak, but these may also be intermixed.

ANTHROPOGENIC IMPACTS

Anthropogenic effects began as early as 5,000 ybp when Native American cultures permanently or semi-permanently resided in the MAV. These cultures likely modified the landscape by clearing and burning the vegetation and through subsequent cultivation (Gardiner and Oliver 2005). Even so, early European explorers to the area, prior to 1700, described it as a vast and largely pristine wilderness with scattered Native American communities and clearings (King et al. 2005). A dramatic reduction in Native American populations from the 1500's through the 1700's muted Native American anthropogenic impacts on the landscape, resulting in abandoned agricultural fields regenerating with forest and cane. Impacts from the new European populations at this time included clearing of lands for small farms, largely along natural levees and point bar deposits which provided well drained and fertile soils and access to river travel routes (Fredrickson 2005, King et al. 2005).

As settlements became established, land clearing and alteration of hydrology increased in scope and intensity. Local communities cleared, ditched, and drained lands for agriculture and utilized the river systems for travel and transport. The late 1800's brought the railroad system to the MAV and made large scale commercial timber harvest, market hunting, and settlement possible (Smith and Klimas 2002, Fredrickson 2005, King et al. 2005). Following the great flood of 1927, the United States Congress passed the 1928 Flood Control Act, which placed flood control under Federal authority. Consequently, landscape-scale flood control of the Mississippi River was initiated by the U.S. Army Corps of Engineers and has ultimately resulted in over 3,700 miles of levees on the Mississippi River and its tributaries (IFMRC 1994).

Improved flood control, drainage, and technology increased acreage suitable for agriculture. These activities, combined with a spike in soybean prices, resulted in unprecedented land

clearing activities across the MAV in the 1960's and1970's. By the time Congress passed the Farm Bill legislation in the late 1980's which introduced "swampbuster" provisions to slow wetland conversions, the forested landscape of the MAV had been reduced to a highly fragmented 20% of its former extent (Creasman et al. 1992, Haynes 2004). Subsequent legislation authorized the Wetland Reserve Program and other private land conservation programs that encouraged restoration of bottomland forests. According to Haynes (2004), these new conservation programs, combined with the land acquisition and reforestation activities by numerous state and federal agencies, resulted in approximately 450,000 to 550,000 acres of bottomland hardwood restoration in the MAV.

The modern MAV forests are a highly fragmented patchwork interspersed across a predominantly open, agricultural landscape. This patchwork is weighted with increasing density of forested lands southward within the seven state area, with 94% of the remaining forested lands within Arkansas, Louisiana and Mississippi. Forested fragments throughout the MAV tend to be small and finely dispersed (circa 38,000 discrete patches of forest), with larger fragments centralized along the major river systems (Twedt and Loesch 1999).

Forest loss has occurred disproportionately, with well drained and higher sites converted first and maintained through the present; these lands are now the prime agricultural lands of the MAV. Lower, poorly drained sites were converted last, if at all. In recent years some of these areas have been allowed to revert or have been restored to forested lands. Even with vast acreage of reforestation, the landscape supports less forest than historically, with forest communities adapted to poorly drained sites occupying a greater percentage of the landscape than they historically did. Thus, overall habitat for forest-dependent wildlife species has not only decreased dramatically but habitat for species that use well-drained community types (e.g., sycamore/sugarberry/elm/ash and cane thickets of natural levee fronts and point-bar deposits, and Nuttall/willow/cherrybark/swamp chestnut oaks of seasonally flooded forests) is limited beyond its historic representation in the forest landscape. More than a century of commercial timber harvest has also influenced forest composition, as commercially preferred species such as baldcypress and oaks were removed disproportionately, leaving forests heavy in shade-tolerant and low commercial value tree species (Conner and Sharitz 2005, Fredrickson 2005).

Additionally, the remaining forests are impacted by anthropogenic change to their formative systems. Modifications to hydrology (e.g., levee systems, ditching and draining, land leveling, flood control, and hydropower dams) altered the processes that structure these communities and determine wetland function (Fredrickson 2005, King et al. 2005). Increased drainage associated with agricultural areas, cessation of seasonal sheet flooding outside of levees, increased depth and duration of flooding inside of levees, and increased river slope and power are profound resultant changes to the hydrologic system (Biedenharn et al. 2000, Gardiner and Oliver 2005). Levee systems have altered the timing, duration, depth, frequency, and velocity of flood events and have functionally disconnected remnant bottomland forests from the natural processes of flooding and sediment deposition which maintained them. These changes in hydrologic and depositional processes affect factors such as nutrient and sediment recharge and distribution, and subsurface water availability and aquifer recharge. Such modifications to the form and function of the land subsequently affects plant and animal distributions, as species respond to change and thrive only in areas suitable to their biological needs.

SUMMARY

The once vast expanse of bottomland forests in the MAV are now a shadow of their historic presence. The human forces exerted in the MAV, particularly since European settlement, have changed the system and the remaining forested habitat. Restoration and maintenance of bottomland hardwood forests in the MAV are important to maintain their biological integrity and recover wildlife populations that are held in trust for future generations of Americans. Recognition of the natural forms and functions of bottomland forests in the MAV, as well as understanding the tremendous changes that have occurred, sets the stage for wise planning, restoration, and stewardship of these forests in the future.

CHAPTER II

PRIORITY WILDLIFE SPECIES AND HABITAT OBJECTIVES

PRIORITY WILDLIFE SPECIES

Alteration of the forest condition within the MAV has impacted the wildlife species that are dependent upon these forests. Fragmentation has resulted in smaller forest fragments that suffer more human perturbations (e.g., livestock, non-biodegradable refuse, buildings, etc.) than do larger fragments (Rudis 1995) and have high edge to area ratios with little interior forest that is far from agricultural and urban influences. Although some large tracts of bottomland forest remain in the MAV, they are often dominated by flood-prone forest types (Rudis 1995, Twedt and Loesch 1999). As a result, species that are dependent upon large expanses of bottomland forest at a landscape scale and complex forest structure within forest stands have declined.

Forest-dependent wildlife species that are of conservation concern within this ecoregion have been identified through Regional, National, and International conservation planning. For example, species specific plans have been developed for the recovery of threatened and endangered species such as Louisiana black bear ([*Ursus americanus luteolus*], U. S. Fish and Wildlife Service 1995) and ivory-billed woodpecker (*Campephilus principalis*], U. S. Fish and Wildlife Service 2006). Conservation plans for more relatively abundant species that are of conservation concern have been addressed via habitat conservation plans: birds (Twedt et al. 1999, Rich et al. 2004), reptiles and amphibians (Gibbons et al. 2000, Semlitsch 2003, Bailey et al. 2006), and bats (North American Bat Conservation Partnership 2006, Mississippi Department of Wildlife, Fisheries, and Parks 2005; Anderson 2006). Other species remain abundant, such as mallards (*Anas platyrhynchos*), wood ducks (*Aix sponsa*) and American woodcock (*Scolopax minor*), but are of management concern for annual harvest (North America Waterfowl Management Plan 1986, 2004; Kelly and Rau 2006). Not surprisingly, nearly all of these species are dependent upon large expanses of bottomland forest at a landscape scale and complex forest structure within forest stands for all or part of their annual life cycle. We believe these priority species may function as umbrellas for other bottomland wildlife species, wherein meeting their habitat needs provides habitat for many other species.

Louisiana Black Bear

The Louisiana black bear was listed as a threatened species under the Endangered Species Act due to extensive habitat reduction and fragmentation and declining populations (U. S. Fish and Wildlife Service 1992). Clearing of forest for agriculture has fragmented and reduced the area of suitable habitat by more than 80% in the MAV (U. S. Fish and Wildlife Service 1995). Because bears occupy large home ranges, landscape considerations are especially important. Forest area, connectivity, and juxtaposition are all important factors as each influences movement patterns of black bears and their ability to secure mates and food, as illustrated through the successes experienced in the Louisiana black bear repatriation efforts in Louisiana and Mississippi to date.

Within forest stands, black bears benefit from diversity in forest species and structure. Forage is provided via numerous hard mast [e.g., oaks and sweet pecan (*Carya illinoinensis*] and soft mast [e.g., pawpaw (*Asimina triloba*), mulberry (*Morus* spp.) and plum (*Prunus* spp.)] producing trees as well as fruiting understory plants and shrubs such as blackberries and dewberries (R*ubus* spp.), Hercules club (*Aralia spinosa*), pokeweed (*Phytolacca americana*), elderberry (*Sambucus canadensis*) and palmetto. Black bears use large, >36 inch diameter at breast height (dbh) trees with visible cavities that occur along rivers or other water bodies as den sites (Black Bear Conservation Committee 2005). Excavated and natural depressions under tree roots, stumps, and fallen logs are also used as den sites and daybeds, particularly in areas that are not subject to flooding. Additionally, dense understory that limits visibility, such as that provided by cane, palmetto, or thickets of shrubs and saplings, also provide ground den sites and serves as important escape cover.

Ivory-billed Woodpecker

The rediscovery of the ivory-billed woodpecker in Arkansas (Fitzpatrick et al. 2005) brought a heightened awareness of bottomland hardwood forests in the MAV and across the southeastern United States. Available literature on habitat characteristics favored by the ivory-billed woodpecker creates the impression that it was associated with expansive patches of "virgin" or uncut forests with a relatively high proportion of very large and old trees that supported a high proportion of dead and dying stems. However, the importance of virgin uncut forests may be only part of the equation based upon reviews and new interpretations of the older literature.

Large patches of standing dead and/or dying wood appear to be an important habitat component, thus forests that have recently experienced large catastrophic events (e.g., storms, drought, fire), including silvicultural treatments, are likely of importance to this species. Based on this interpretation, the ivory-billed woodpecker may be more appropriately described as a species that requires forest disturbance of substantial size to complete its lifecycle (Hunter et al. unpublished data).

Although little is known about the specific habitat requirements of ivory-billed woodpeckers, Tanner (1942) suggested that the species requires vast acreages of habitat to meet its annual needs due to its foraging behavior of (presumably) feeding extensively on wood-boring beetle larvae found within recently dead trees (≤ 1-3 years). Most foraging activity (84%) occurred on 12-36 inch dbh sweetgum (*Liquidambar styraciflua)*, Nuttall oak, and sugarberry trees (Tanner 1942).

Forest Interior Songbirds

Occupancy and vital rates (e.g., nest success) of songbirds within bottomland forests are influenced by both vegetation characteristics within forest stands (Heltzel and Leberg 2006) and by landscape conditions (Robinson et al. 1995). As with the Louisiana black bear, loss of bottomland hardwood forest and fragmentation due to land conversion for agriculture has presumably led to the decline of some songbirds (Andrén 1994). In small patches, forest birds are subjected to: (1) more competition with other species (Kerpez and Smith 1990), (2) increased parasitism from brown-headed cowbirds (*Molothrus ater*; Robinson and Wilcove 1994), (3) increased likelihood of predation (Andrén and Angelstam 1988; Marzluff and Restani 1999), (4) greater disturbance from human activities (Knight and Gutzwiller 1995), and (5) increased isolation and inhibition of dispersal (Doak et al. 1992; Matthysen and Currie 1996).

Although specific habitat requirements vary among species, silvicolous bird species share broad overlapping habitat requirements. For example, many of the priority forest interior songbirds (e.g., Swainson's warbler (*Limnothlypis swainsonii)*, cerulean warbler (*Dendroica cerulea*) require complex vertical and horizontal structure for nesting and foraging. For example, Hamel (2000) suggested that for nest sites and foraging substrates, cerulean warblers need canopy gaps

intermixed with dominant, shade-intolerant trees with expansive, long-limbed crowns that overtop large, individual, shade-tolerant trees. Similarly, "classic" Swainson's warbler habitat is found in canebrakes associated with canopy gaps within bottomland hardwood forests (Meanly 1971). More recent research suggests that this species exploits disturbance gaps that are characterized by high densities of saplings, shrubs, and vines for nest sites in the absence of cane (Graves 2001, 2002, Somershoe et al. 2003, Bednarz et al. 2005). Unfortunately, many of the extant bottomland forests in the MAV have homogeneous closed canopies with little vertical or horizontal diversity.

Waterfowl

Use of forested wetlands by waterfowl species is dynamic, varying among seasons, and flood conditions with the availability of water, food, and cover (Reinecke et al. 1989). Priority waterfowl include mallards, wood ducks, hooded mergansers (*Mergus cucullatus*), gadwalls (*Anas strepera*), green-winged teal (*A. carolinensis*), and ring-necked ducks (*Aythya collaris*). Fredrickson and Heitmeyer (1988) reviewed the habitat use and requirements of these species: some species (e.g., mallards) use forested wetlands in the MAV only during migration and winter, whereas residents (e.g., wood ducks) are present year-round. Because hard mast from forests (i.e., acorns) is an important source of energy (Kaminski et al. 2003), flooded red oaks are especially important. However, other forested and shrub wetlands provide aquatic invertebrates (Heitmeyer 1988, 2006) and herbaceous seeds (Kaminski et al. 2003) as well as protective cover. Wood ducks and hooded mergansers require relatively large cavities for nesting with future cavities dependent upon large or stressed trees, especially American sycamore, oaks, elms, and baldcypress. Samaras of red maple (*Acer rubrum*) and elms are important foods for wood ducks in spring.

In the past, managers attempted to obtain more benefits from forested wetlands for waterfowl and hunters by constructing greentree reservoirs to ensure flooding occurred. However, several decades of experience has shown that early flooding, annual flooding, and delayed spring drawdown can result in decreased acorn production, increased tree mortality, and gradual replacement of seasonally flooded oak stands with species that are more water-tolerant but produce less food for waterfowl. Fredrickson et al. (2005) address the ecology and management

of greentree reservoirs, but we note current guidelines for management recommend alternate year and variable flooding. Construction and operating costs combined with degradation of forested wetlands argue against developing new greentree reservoirs. Acknowledging the potential benefits of GTRs, we recommend proper management following recommendations of King and Frederickson (1998).

American Woodcock

Unlike most of its shorebird relatives, the American woodcock is a bird of forested habitats. As such, forest loss has likely contributed to the species' declining population trends (Krementz and Jackson 1999) resulting in it being listed as species of high concern within the U. S. Shorebird Conservation Plan (Brown et al. 2001). Found within the MAV mostly during winter, this species favors young, second-growth hardwoods (e.g., clear cuts) and "mature" hardwood stands with a relatively open canopy for diurnal cover (Roberts 1993). These habitats are typically characterized by high densities of saplings, shrubs, cane, and/or vines that facilitate predator avoidance. Conversely, nocturnal habitat of American woodcock tends towards open fields where they forage and conduct courtship activities (Krementz and Jackson 1999). Because American woodcock use temporally distinct habitats, specific landscape characteristics (i.e., juxtaposition of habitats) are required for this species.

Reptiles and Amphibians

Amphibians and reptiles have received little attention in the MAV and very little is known about their population status or habitat requirements. Over the last several years amphibians and reptiles have experienced worldwide population declines that have been related to numerous factors, including disease and pathogens, global climate change, invasive species, commercial trade, and interactions of multiple factors (Hayes and Jennings 1986, Blaustein et al. 1994, Lips 1998, Wake 1998, Alford and Richards 1999, Carey et al. 2001, Gibbons et al. 2000). Amphibians need both terrestrial and aquatic/wetland habitats within close proximity of each other to complete their life cycle (Beebee 1985, Hecnar and M'Closkey 1996, Pope et al. 2000, Semlitsch 2005). In general, reptiles have relatively large home ranges and they have diverse habitat needs that can include forest, wetland, and aquatic habitats (Dundee and Rossman 1989, Ernst and Ernst 2003). Thus, providing wetland/forest complexes at appropriate spatial scales is

important for the conservation of these species (Petranka and Holbrook 2006). At a local scale, wetland management should address hydroperiod requirements and the development of diverse wetland plant structure. For many reptiles and amphibians, abundant coarse woody debris in bottomland hardwood forests and wetlands is an important habitat component and should be a target of forest management.

Bats

Several species of bats, including two species of concern – the southeastern myotis (*Myotis austroriparius*) and Rafinesque's big-eared bat (*Corynorhinus rafinesquii*) – utilize hollow trees for roost sites (Cochran 1999, Hoffman 1999, Gooding and Langford 2004, Loeb and O'Keefe 2006). Rafinesque's big-eared bat frequently uses hollow water tupelo trees that are characteristic of older baldcypress / water tupelo forests (Mirowsky 1998, Cochran 1999, Hoffman 1999, Gooding and Langford 2004). Although other species of trees, including baldcypress, may be used as roost trees, water tupelo and blackgum (*Nyssa sylvatica*) appear to be most important to this species in the MAV (Cochran 1999, Lance et al. 2001, Gooding and Langford 2004). Southeastern myotis have been found roosting in sweetgum, Nuttall oak, and water hickory (Wilf 2004). Gooding and Langford (2004) found that the average size of water tupelo trees used as roosts in Northeast Louisiana was 47 inches in diameter (4. 5 feet above ground) while Cochran (1999) found roost trees in Arkansas to average 61inches in diameter (4. 5 feet above ground). Rafinesque's big-eared bats in several studies were associated with mature bottomland hardwood forest, abundant roost trees, and relatively close proximity to permanent water (Cochran 1999, Lance et al. 2001, Gooding and Langford 2004). These results suggest that protection of existing (large) roost trees, regeneration of water tupelo and blackgum for future roost trees, and management for mature bottomland hardwood forests are important for this species (Gooding and Langford 2004, Wilhide et al. 2005). However, it is worth noting, that Menzel et al. (2001) found Rafinesque's big-eared bats roosting in abandoned structures in upland habitats, and males commonly foraged among sapling stage pines. Thus, our understanding of habitat needs and the short- and long-term effects of forest management on this species is incomplete.

HABITAT OBJECTIVES

Within any restoration program, it is useful to establish objectives at suitable scales (Gardiner et al. 2002, Wilson et al. 2005). The use of a hierarchical approach may be required for wetland restoration, because no wetland can maximize all potential functions. The functions and values of wetlands are scale-dependent, thus the area, spatial distribution, and type of wetlands that support one taxonomic group or wetland function may not be sufficient to support another taxonomic group or wetland function (Laughban et al. 2005). For example, site location and restoration techniques necessary to enhance water quality may be very different from those necessary to enhance breeding songbird habitat.

One of the first attempts to quantify forest habitat objectives for the MAV was within the framework of the landmark North American Waterfowl Management Plan (1986). Specifically, the Lower Mississippi Valley Joint Venture Management Board (1990) recommended restoration of historic forested wetlands for wintering waterfowl and other wetland functions. However, this plan did not recommend specific locations nor did it suggest any particular spatial distribution based on the assumption that waterfowl distribute themselves on the wintering grounds under an ideal-free distribution. That is, wintering waterfowl are not area dependent and can exploit any resource made available to them.

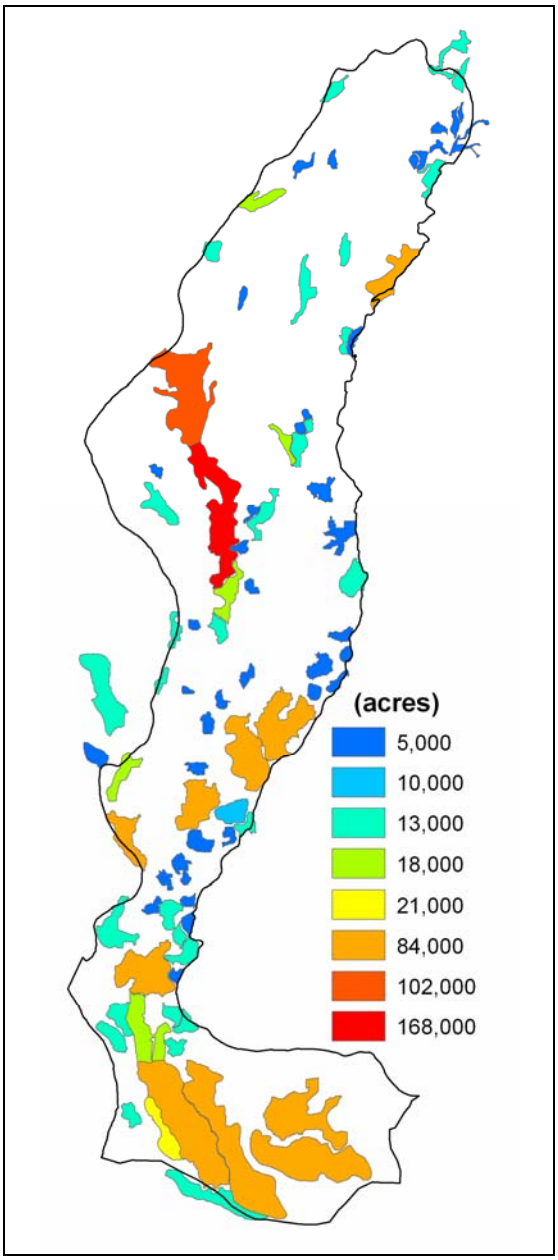
Similarly, the Partners In Flight (PIF) Bird Conservation Plan for the MAV (Twedt et al. 1999) suggested that sustainable source populations of breeding songbirds required >3.7 million acres of forested wetlands. In contrast to recommendations for waterfowl, songbird conservation planning efforts recommended that forest be distributed among 101 patches [13 patches >100,000 acres, 36 patches >20,000 acres, and 52 patches >10,000 acres] distributed among 87 local landscapes (i.e., Bird Conservation Areas). Specific geographic locations were identified based on extant forest conditions and expert opinion on forest restoration potential (Figure 4).

Several biological assumptions were made in the development of the PIF conservation goals. It was assumed that silvicolous bird populations in forest cores (>3,280 ft from "hostile" edges) are relatively free from deleterious edge effects of predation and nest parasitism (Batary and Baldi 2004). Similarly, local landscapes that were >60% forested were assumed to be conducive to

successful reproduction of silvicolous birds (Robinson et al. 1995). Finally, forest core areas >5,200 acres were assumed to support self-sustaining (i.e., source) populations of >500 pairs of birds when they occur at high densities whereas core areas of >13,000 acres were required for species distributed at low densities.

Small, isolated forest patches attract few forest breeding birds (Robbins et al. 1989, Mancke and Gavin 2000) and often support low reproductive rates for breeding birds (Burke and Nol 2000, Nott 2000). Thus, restoration that increases the area of forest core and increases the proportion of forest within local landscapes is strongly encouraged (Twedt et al. 2006). Recent studies on avian productivity within reforested areas of the MAV support the merit of this approach (Twedt et al., unpublished data). By prioritizing reforestation proximate to existing forest (Huxel and Hastings 1999), restricting reforestation to within 6 mi of existing forest cores (Robinson et al. 1995), and targeting areas that increase forest in local (124 mi^2) landscapes to 70%, about 50 target areas have been identified that would result in the creation of forest cores >5,000 acres and 50 additional areas that target creation of forest cores >12,500 acres. A geographic information system (GIS) data layer developed from this decision support model for forest bird conservation (Twedt et al. 2006) depicts these restoration priorities at 100 ft (30 m) resolution (Figure 5, online at: http://www.lmvjv.org/GIS_data.htm).

Habitat objectives for birds overlap broadly with conservation recommendations for bats and bears. Rafinesque's big-eared bats are reluctant to cross large open areas (Clark 2000), making fragmented habitat unsuitable for this species. Black bears have large home ranges of up to 26 square miles (Marchinton 1995, White 1996, Anderson 1997, Benson 2005). Thus high levels of landscape connectivity are needed to allow movement of bats and bears among forest patches. To mitigate detrimental effects associated with small forest patches and sparsely forested landscapes, some reforestation programs have focused on establishment of corridors among forest patches (Sieving et al. 2000) and buffering forest patches to increase their size and interior area (Marzluff and Ewing 2001). Specifically, habitat restoration for the Louisiana black bear has utilized conservation priority areas (Figure 6) to target reforestation near existing blocks of bottomland hardwood forest and to reestablish forested corridors that connect inhabited areas within the southern portion of the MAV.



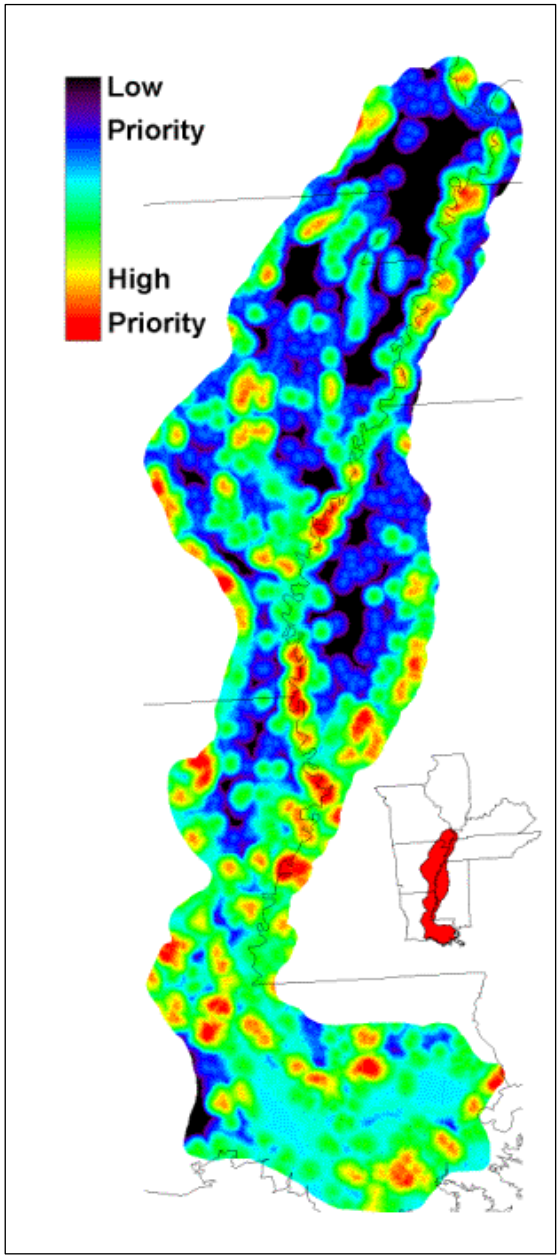


Figure 4. Geographic locations (Bird Conservation Areas) identified for potential forest restoration based on extant forest conditions and expert opinion (Twedt et al. 1999).

Figure 5. Forest restoration priority areas intended to create larger forest core area and more forested landscapes within the Mississippi Alluvial Valley (Twedt et al. 2006)

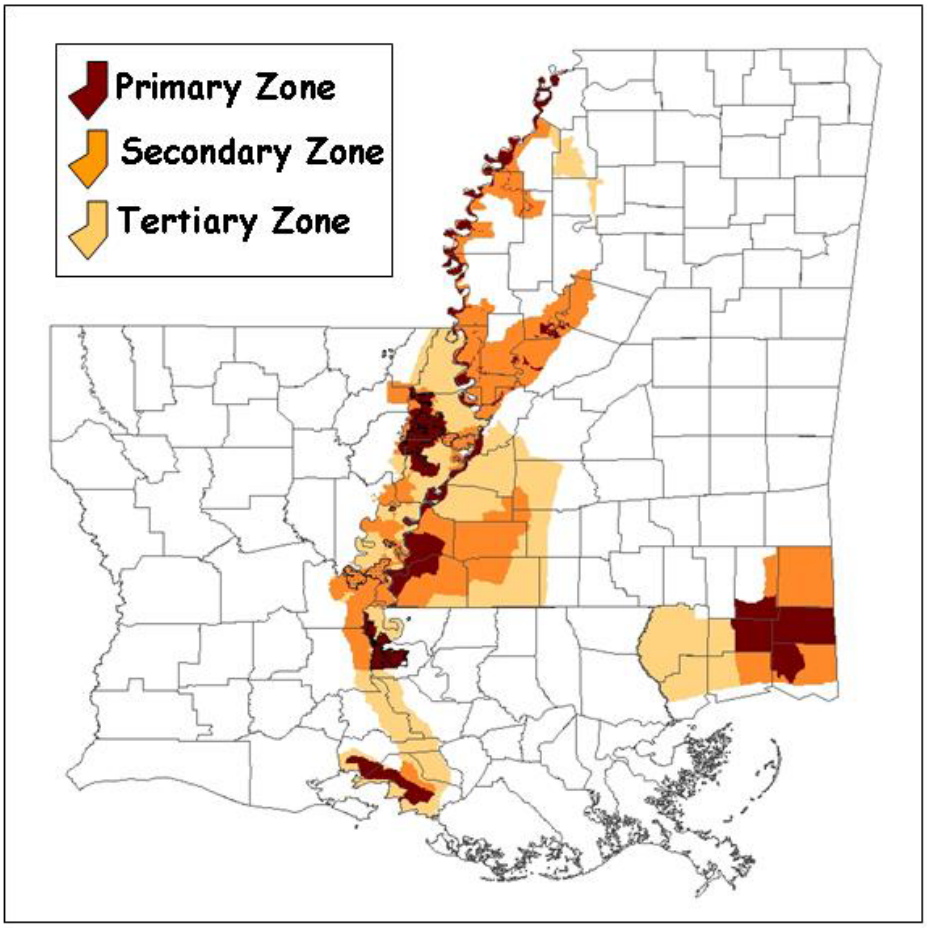


Figure 6. Conservation priority areas designed to facilitate forest restoration in support of Louisiana black bear conservation in the Mississippi and Louisiana.

DESIRED LANDSCAPE CONDITIONS

The continuity and juxtaposition of forested habitat within and among local landscapes has been shown to influence vital demographic rates (Robinson et al. 1995) and occupancy rates (Robbins et al. 1989) of many forest interior species. Undesirable landscape characteristics (e.g., forest edge) can result in poor reproduction of some silvicolous species within forest stands that are otherwise structurally suitable. Furthermore, many forest species benefit from a matrix of habitat types (e.g., shrub-scrub, complex canopy forests, etc.) within an appropriate spatial scale to fulfill all or part of their life cycle needs: bears (Weaver et al. 1990, Anderson 1997, Van Why 2003, Benson 2005), American woodcock (Krementz and Jackson 1999), and wood thrush (*Hylocichla mustelina*)(Vega Rivera 1999).

Landscape level management is difficult when ownership is distributed among many parties with diverse and often conflicting management objectives. In some areas of the MAV, government entities and large private ownerships (e.g., timber companies) own a substantial percentage of existing forested area. Even so, management on adjacent private lands may impact management decisions on public lands because landscape conditions influence suitability of habitat for priority wildlife. It should be noted that this does not imply a need for regulation of habitat conditions on private lands but many private landowners may choose to implement our recommendations for management of bottomland hardwood forest stands (Chapter III).

To address landscape scale habitat needs of priority wildlife species in the MAV, we advocate that local landscapes (≥10,000 acres) be extensively forested with large contiguous patches of forest (Table 1). However, we recognize that these conditions could benefit landscapes smaller than 10,000 acres. We also recognize that current stand conditions may not be optimal for priority wildlife species, as they are deficient in structural heterogeneity. To achieve greater structural diversity likely requires disturbance – one way to achieve this disturbance is through silvicultural manipulations. Therefore, we recommend 70 – 95% of forests within these landscapes be under active silvicultural management to insure regeneration and development of desired habitat conditions. The remaining 5 – 30% of forests would be under passive management (e.g., set-asides, wilderness, etc.). Within the forests under active management, we recommend a small proportion (<5%) of this area should be in shrub-scrub habitat. However, no more than 10% of any local landscape should be in large (>7 acre) regenerating forests (i.e., clearcuts less than 1/3 their site dependant height [Table 1]).

Managers should strive to ensure that 35 – 50% of all forested habitat is within desired stand conditions at any point in time (Figure 7, Table 2). If these landscape conditions are achieved, habitat conditions should reflect a sustainable continuum with (1) habitat conditions that warrant management, (2) habitat conditions that reflect optimum stand conditions, and (3) habitat conditions that are not optimal but for which management is not warranted. These landscape characteristics are designed to ensure that within and among local landscapes, a matrix of habitat conditions is available to fulfill the annual requirements of priority species, as well as, to guarantee a sustainable supply of habitat through time.

Table 1. Desired landscape (forest) conditions within the Mississippi Alluvial Valley. See Glossary for definition of terms.

Habitat Type	Percent of Area	Description
Forest Cover	70 – 100 %	Large (>10,000 acre) contiguous forested areas are desired. At any point in time, a minimum 35% and optimum 50% of the forest should meet the desired stand structure conditions (Chapter III, Table 2).
Actively Managed Forest	70 – 95 %	Forests that are managed via prescribed silvicultural treatments to meet desired stand conditions.
• **Regenerating Forest**	≤10 %	Forest regeneration on areas > 7 acres (e.g., clearcuts where >80% of overstory has been removed) or forest restoration on agricultural lands (i.e., reforestation). However, achieving increased forest cover via reforestation overrides the 10% limitation.
• **Shrub/Scrub**	≤5 %	Thamnic woody vegetation (hydric or mesic) within bottomland forests, including forests in early seral (successional) stages.
Passively Managed Forest	5 – 30 %	Forest areas that are not subjected to silvicultural manipulation (e.g., no-cut, wilderness, set-aside, and natural areas).

Although passively managed forests in the MAV are currently limited in area, we believe these areas are important as they serve as experimental controls against which to measure results of silvicultural treatments. To serve as appropriate controls, passively managed areas should be representative of various forest types and topographic positions. Thus, these passively managed areas should not be limited to small, linear areas (e.g., streamside management zones) or locations that are "inoperable" due to their hydrology (e.g., swamps). We suspect that the older seral stages of passively managed forests will exhibit a diverse forest structure. However, the lack of widespread, extensive flooding, river meandering, large fires, and other disturbances have altered processes that were once important and necessary to maintain diverse forest tree species. Furthermore, natural regeneration process in general are unpredictable, sporadic, of limited scope, and favor shade-tolerant species, thus habitat conditions within passively managed forests

may be inconsistent (Johnson 1988, Johnson and Deen 1993, Battaglia and Sharitz 2005). Additionally, extended periods of time may be necessary to achieve diverse older seral conditions. Thus, we believe forest management is warranted to facilitate the achievement of conditions similar to those within diverse older seral forests.

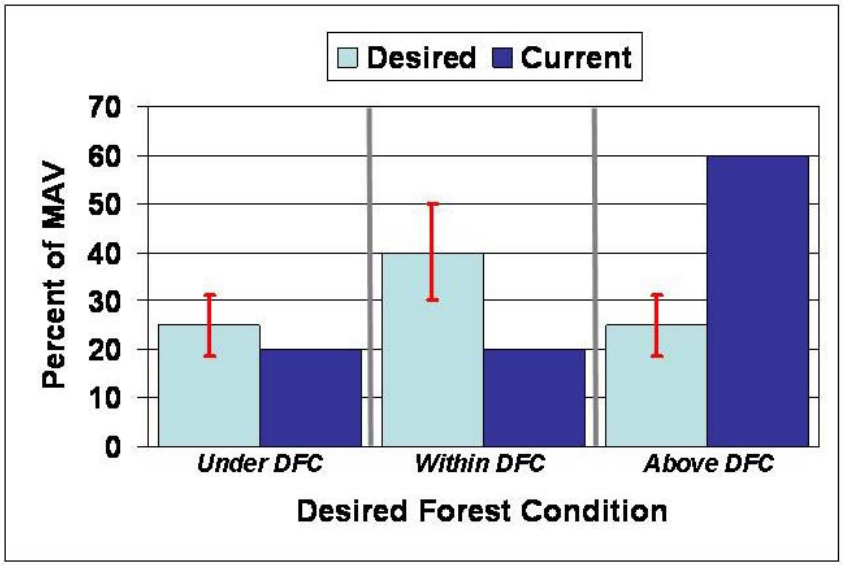


Figure 7. Hypothetical distribution of current and desired forest condition (Table 2) within bottomland hardwood forest stands in the Mississippi Alluvial Valley. Note desired conditions contain error bars representing the range of acceptable values.

To provide habitat for species requiring larger patches of early successional habitat (Annand and Thompson 1997), up to 5% of local landscapes may be maintained in early successional, shrub-scrub habitat. Various thamnic habitats are found within bottomland forests (Thompson and DeGraaf. 2001) but semi-permanent, hydric shrub habitat (e.g., buttonbush [*Cephalanthus occidentalis*] and swamp privet [*Forestiera acuminata*]) generally support different wildlife species than does mesic shrub habitat with herbaceous groundcover (Hunter et al. 2001). Some species such as Bell's vireo (*Vireo bellii*) and painted bunting (*Passerina ciris)* may require larger patches of shrub-scrub to maintain their populations. If shrub-scrub habitat is of high importance and limited availability in a local landscape, we recommend focused, active management to achieve these conditions. On hydric sites shrubby conditions may persist for many years whereas conditions on most mesic sites are ephemeral and will likely require

periodic disturbance (e.g., mowing, burning, etc.) to be retained. Alternatively, early successional habitat can be temporally and spatially distributed across landscapes via prescribed silviculture such as that achieved on large (>7 acres) forest regeneration areas (i.e., clearcuts). However, ≤10% of any local landscape should be comprised of these large regenerating forest areas that are <1/3 of their site-dependent forest height. The limited area within each landscape coupled with this height constraint should; (1) insure reproductive sustainability of regenerated forest, (2) minimize predation and brood parasitism rates sometimes associated with these forest conditions, (3) alleviate concerns regarding widespread clearcutting on public lands, and (4) allow managers the flexibility to use clearcuts to achieve management objectives.

SUMMARY

Priority wildlife species within the MAV are often dependent on habitat characteristics obtained from extensive forest conditions, forest connectivity, higher site forests and forest disturbance events. The extensive manipulation of bottomland forests within the Mississippi Alluvial Valley since European settlement, and especially since the advent of a stronger national flood control policy and ensuing agricultural development, have resulted in a serious degradation of those habitat characteristics. The remaining sub-quality habitat has effectively resulted in declining populations of many wildlife species associated with these forest resources, thus heightening our awareness and accelerating their stature to “priority”.

Characteristics exhibited in mature bottomland hardwood forests also provide particular habitat variables important to many priority species such as dens, cavities, canopy gaps, species diversity, vegetative diversity, and natural senescence. However, the MAV forest resources have historically been extracted for forest products with only slight consideration for their regeneration and even less for wildlife habitat. More recent awareness of the importance of these forest resources to our nation has encouraged sustainable management of these forests for wildlife as well as forest products.

Chapter III

MANAGEMENT OF BOTTOMLAND HARDWOOD FORESTS

INTRODUCTION

For forest dwelling wildlife, the size, structure, and composition of forests are as important as the abundance and spatial distribution of forests within the landscape. To ensure hard mast production for consumption by Louisiana black bear and some species of waterfowl, it is important to maintain some proportion of forest stands in oaks or sweet pecan. However, for large woodpeckers, such as the ivory-billed woodpecker, large-diameter senescent trees are a key habitat component. Additionally, large (>36 inch) diameter trees are important for bats and the Louisiana black bear, especially baldcypress, water tupelo, blackgum and overcup oak for den and roosting sites (Hightower et al. 2002, Benson 2005, Cochran 1999, Hoffman 1999, Gooding and Langford 2004). Clearly, when manipulating habitat within stands managers must consider a variety of habitat factors (e.g., size, structure, and composition) to address the habitat needs of priority species.

Moreover, within-stand successional patterns results in a shifting mosaic of patches of various ages and sizes across the landscape. At any given point in time, a particular stand may not provide desired conditions, but at a different stage of stand succession it may be crucial for providing habitat for priority wildlife species. Ideal habitat conditions for any given species are transient and the presence and abundance of species will vary temporally according to the successional stage of the stand and the surrounding landscape. In forested systems, the timeframe necessary to achieve desired conditions within a stand for a given species may be decades. Thus strategic long-term planning is necessary to achieve forest habitat goals.

HISTORIC IMPLEMENTATION

The distribution and abundance of suitable habitat often depends upon the temporal and spatial characteristics of disturbance (Hobbs and Huenneke 1992). In bottomland hardwood forests of the MAV, disturbances include tornadoes, hurricanes, ice storms, floods, fire, and wind throws, as well as the size, type, frequency, and abundance of timber harvest (King et al. 2005). Little

quantitative data are available on disturbance regimes in the MAV, but the system of levees, channelization, and other activities that have restricted the meandering of the Mississippi River and its major tributaries have markedly reduced the frequency of large-scale disturbances. The effects of altered disturbance regimes and the loss of bottomland hardwood forests have affected the structure and composition of bottomland hardwood forests (Chapter I). Over the last century, activities detrimental to forest habitat have included clearing land for agriculture and homesteads and indiscriminate, large-scale clearcutting and high-grading of forests to exploit their timber resources. More recently, sound silvicultural practices have been utilized in management of the MAV forests, targeting sustainable timber production (King et al. 2005). Concomitant with this push for sustainable forestry has been a desire to relate forest management actions to habitat needs of priority fish and wildlife species. Indeed, even as the area of bottomland hardwood forest has diminished, the proportion of these lands being managed primarily for wildlife has vastly increased. Ideally, wildlife management in bottomland hardwood forests should follow an ecosystem approach, focusing on wildlife species of conservation concern and the implementation of management activities at multiple spatial scales.

On private lands, the 1990 Farm Security and Rural Investment Act which authorized the U. S. Department of Agriculture's Wetland Reserve Program (WRP) placed increased emphasis on wildlife habitat. The voluntary WRP provided financial incentives to restore wetlands through retirement of lands from agricultural production. According to the act, the Secretary of Agriculture "*... in consultation with the Secretary of the Interior, shall place priority on acquiring easements based on the value of the easement for protecting and enhancing habitat for migratory birds and other wildlife*" (United States Congress 1990). This program has greatly altered the landscape of the MAV, as over 680,000 acres have been enrolled in WRP as of September 30, 2005 (King et al. 2006). Although easements have targeted restoration of forest and wetland cover to retired agricultural land, some easements have included tracts of extant bottomland forest. As the legislative language mandated that any management on WRP lands enhance habitat for migratory birds and other priority wildlife, the USDA Natural Resource Conservation Service identified forest management activities that were compatible with this objective. Similarly, state and federal wildlife resource agencies have mandates to protect,

restore and enhance habitat for fish and wildlife species (Pittman-Robertson Wildlife Restoration Act, as amended through P. L. 106-580, 29 December 2000).

Although it has long been recognized that forest management, including some component of passive management, impacts wildlife habitat, only recently have forest management objectives been articulated that explicitly address priority wildlife needs in bottomland forests. Specifically, the Natural Resource Conservation Service in conjunction with the U. S. Fish and Wildlife Service and input from researchers, practicing foresters, and wildlife biologists addressed habitat needs through the development of *General Guidelines for Hardwood Forest Management to Improve Wildlife Habitat* (B. Strader, unpublished manuscript, U. S. Fish and Wildlife Service, Jackson, Mississippi) and *Wetland Reserve Program – Forest Land Compatible Use Guidelines* (Anderson et al. 2004). These documents provided forest metrics that identified habitat conditions presumed to be favorable for priority wildlife species. However, some foresters and biologists raised concerns pertaining to the long-term sustainability of forests using these recommended forest metrics. To facilitate and further these discussions, the LMVJV Forest Resource Conservation Working Group took on the challenge of refining these forest management guidelines to better reflect habitat needs of priority wildlife species and long-term forest sustainability. Specifically, the objective was to develop recommendations to clearly articulate desired forest conditions that meet the habitat requirements of priority wildlife species at multiple spatial scales.

DESIRED STAND CONDITIONS

Forests within suitable landscapes (Chapter II) should provide vertical and horizontal structural diversity in terms of tree species, size and age classes, and growth forms (e.g., trees, shrubs, and vines) within a heterogeneous forest canopy comprised of gaps and a complex layering (i.e., desired stand conditions, Table 2). As many forest interior wildlife species flourish under habitat conditions associated with these complex forest structures, we emphasize the need to increase the availability of these forest conditions. Although little empirical data exist upon which to draw (Mitchell and Beese 2002), we believe that desired stand structures can be achieved via the use of silvicultural practices (Beggs 2004).

Table 2. Desired stand conditions for bottomland hardwood forests within the Mississippi Alluvial Valley.

Forest variables [1]	Desired stand structure	Conditions that may warrant management
Primary Management Factors		
Overstory canopy cover	60 – 70 %	>80%
Midstory cover	25 – 40 %	<20% or >50%
Basal area	60 – 70 ft^2 / acre with ≥25% in older age classes[2]	>90ft^2 / acre or ≥60% in older age classes
Tree stocking	60 – 70 %	<50% or >90%
Secondary Management Factors		
Dominant trees[3]	>2 / acre	<1 / acre
Understory cover	25 – 40%	<20%
Regeneration[4]	30 – 40% of area	<20% of area
Coarse woody debris (>10 inch diameter)	≥200 ft^3 / acres	<100ft^3 / acre
Small cavities (<10 inch diameter)	>4 visible holes / acre **or** >4 "snag" stems ≥4 inch dbh **or** ≥2 stems >20 inch dbh	<2 visible holes / acre **or** <2 snags ≥4 inch dbh **or** <1 stem ≥20 inch dbh
Den trees/large cavities[5] (>10 inch diameter)	1 visible hole / 10 acres **or** ≥2 stems ≥26 inch dbh (≥8 ft^2 BA ≥26 inch dbh)	0 visible holes / 10 acres **or** <1 stem ≥26 inch dbh (<4 ft^2 BA ≥ 26 inch dbh)
Standing dead and/or stressed trees[5]	>6 stems / acre ≥10 inch dbh **or** ≥2 stems ≥20 inch dbh (>4 ft^2 BA ≥ 10 inch dbh)	<4 stems ≥10 inch dbh / acre **or** <1 stem ≥20 inch dbh (<2 ft^2 BA ≥ 10 inch dbh)

Table 2. Continued.

[1] Promotion of species and structural diversity within stands is the underlying principle of management. Management should promote vines, cane, and Spanish moss within site limitations.

[2] "Older age class" stems are those approaching biological maturity, (i.e., senescence). We do not advocate aging individual trees but use of species-site-size relationships as a practical surrogate to discern age.

[3] Dominants (a.k.a. emergents) should have stronger consideration on more diverse sites, such as ridges and first bottoms.

[4] Advanced regeneration of shade-intolerant trees in sufficient numbers (circa 400/acre) to ensure their succession to forest canopy. Areas lacking canopy (i.e., group cuts) should be restricted to <20% of stand area.

[5] Utilizing BA parameters allows the forest manager to maintain this variable in size classes that are most suitable for the stand instead of using specific size classes noted.

By focusing management actions on forest stand conditions, managers are able to ensure that prescribed treatments address habitat needs of priority wildlife. Within a forest stand, managers historically have used a set of primary forest metrics (e.g., basal area, tree stocking) to define forest management needs in terms of forest density, health (Nebeker et al. 2005) and economic quality. We have employed these primary forest metrics and a suite of additional (secondary) forest metrics (e.g., tree cavity and standing dead tree densities) to guide managers in discerning the need for forest treatments to sustain important wildlife habitat characteristics (Table 2). These forest metrics are listed as *primary* or *secondary management factors* based on their presumed impact on forest structure and contribution to wildlife habitat needs, as well as the perceived ability of management to impact these conditions.

Recognizing that it is impractical to identify exact values for these metrics, each management factor is represented by a range of values, as well as, the extent of deviation from these desired conditions that may warrant prescribed forest management. It should be noted that prescribed management actions may temporarily result in stand conditions below the recommended range of

stand conditions. This condition will maximize the time that stand conditions are maintained within a recommended range by accounting for the vegetative response in some systems and allowing for the full range of values to be experienced post-treatment.

We advocate use of silvicultural prescriptions that result in: (1) reduced basal area and tree stocking; (2) multi-layered canopies; and (3) increased midstory development, thereby addressing primary management factors. Additionally, secondary management factors can be addressed through management by ensuring that prescribed treatments promote the development of dominant trees, cavity retention, understory development, and shade-intolerant regeneration.

Achievement of desired stand conditions is dependent upon a multitude of factors including but not limited to site index, frequency and duration of flooding, and existing stand condition. As such, we acknowledge that there is no "silver bullet" prescription. Instead, we envision a range of desirable stand conditions that are broad enough to accommodate different management objectives, while maintaining sufficient rigidity to guide management towards stand conditions beneficial to priority wildlife species.

Attaining desired stand conditions requires disturbance. Disturbance may be initiated by land managers through silvicultural treatments that address appropriate change in primary management factors. For example, stands with basal area of >90 ft^2/acre should be reduced to a basal area of 60-70 ft^2/acre. Although there is not a one-to-one relationship, this reduced basal area should concurrently target a reduction in canopy cover to 60 – 70%. Canopy cover of <50% should be avoided except within areas that target regeneration of shade-intolerant trees. Similarly, we caution against use of traditional harvest prescriptions designed to solely optimize timber production, recommending instead prescriptions wherein trees are retained to meet ecological objectives, especially provision of habitat for priority wildlife (Mitchell and Beese 2002).

IMPLICATIONS FOR PRIORITY WILDLIFE SPECIES

Management should favor the creation of a naturally diverse canopy, as well as floristic diversity within the forest midstory and understory. Furthermore, we caution against the tendency to

harvest primarily trees of higher economic value and managers should likewise guard against favoring retention of species based solely on their economic value at harvest.

Diverse tree species composition in bottomland hardwood forest is important because it can provide heterogeneous vertical structure, a variety of hard and soft mast, and greater insect abundance. Evidence of avian dependence on specific tree species is sparse (Gabbe et al. 2002), but some species such as baldcypress, American sycamore, sweetgum, and willows (*Salix* spp.) have indications of substantial use. Most tree species exhibit unique phenologies of seasonal development. As such, they have different temporal development of flowering and fruiting (Reynolds-Hogland et al. 2006). Additionally, trees attract different insects (primarily as hosts for insects that consume their leaves) at different times. Some insects are unique to specific tree species. Because most birds are insectivorous during the breeding season, maintaining diversity of tree species likely buffers against "boom and bust" cycles in the insect forage base available to birds. Additionally, some tree species are more prone to cavity development or they may be closely linked with the distribution of specific wildlife species (e.g., *Nyssa* spp. and Rafinesque's big-eared bats (Burns and Honkala 1990, Mirowsky 1998). A diverse forest also supports trees that mature and senesce at different rates thus allowing for more continuous input of snags, canopy gaps, and coarse woody debris (Harmon et al. 1986, King and Antrobus 2005).

To maintain and encourage vertical structure development, treatments should leave 2 to 4 trees/acre of species and individuals that will maintain or rapidly attain dominant crown positions. Because of their propensity to become dominant or emergent trees, residual species should include oaks, baldcypress, cottonwood, and sweetgum. These future emergent / dominant residual trees should be identified before marking timber for harvest such that subsequent timber harvest can be used to encourage lateral growth via increased sunlight and/or encourage vertical growth via competition with neighboring residual trees.

Tree size is also an important component of forest structure. Stem size is influenced by a variety of factors including tree age, the species of tree, site productivity, the amount of competition and other factors. Analysis of forest inventory data from 1991-1995 revealed 56% of bottomland hardwood forests in the MAV had <20% of their basal area occupied by stems with >20 inch

diameters (Rudis 2001a). A general, but often false, assumption is that large trees are older than smaller trees. Data from bottomland hardwood forests do not unequivocally support this assumption, particularly when comparing among different species or among different sites (S. King unpublished data). In central Louisiana for example, willow oaks that were 33 – 67 years old developed large diameters relative to other species that attained similar or even smaller diameters at greater age [green ash (70-88 years), bitter pecan (82-90 yrs), overcup oak (66-170 yrs) (K. Ribbeck, personal observation).

Tree size is important to a number of wildlife species. For example, large diameter trees are the only trees suitable for black bear den sites and preferred roost trees for Rafinesqe's big-eared bats. Furthermore, Tanner (1942) found that ivory-billed woodpeckers foraged disproportionately more on larger stems relative to their presence in the forest. A total of 35% of observed foraging occurred on stems $\geq$24 inch in diameter even though stems in that size class accounted for only 5% of stems in the forest. Thus, large tree size is included within the primary management factors as a percentage of older age class trees within the basal area metric and is also considered in the secondary management factors within three different categories (Table 2). Although we believe it desirable to retain large diameter, older age class trees, excessive representation of these trees (>60%) will likely impede regeneration of shade-intolerant species, especially oaks (Hodges 1989).

In addition to large trees, cavities are important to many wildlife species for roosting, denning, and nesting sites. Trees containing or likely to develop cavities are recommended for retention within stands. Care should be taken to minimize damage to cavity trees during harvest operations. When possible, prescribed treatments should retain 4 to 6 cavity or cavity-potential trees (e.g., unsound culls) per acre. The availability of several suitable cavity trees within a given area is important to bats, especially females with young, which tend to frequently switch roost sites. Additionally, some of the stressed and/or dying trees that traditional silviculture would remove to improve forest health, should be retained for recruitment of future cavities.

Although reduced canopy stimulates beneficial development of herbaceous understory, reduction of the canopy to <50% may cause displacement of many forest birds and extensive colonization

by shrub-scrub birds. At this disturbance intensity, nest success of canopy and midstory nesting species will likely decline for several years. However, failure to reduce the overstory to <80% canopy cover will likely result in rapid canopy closure and negligible increases in the abundance of high priority species that depend on the forest understory (e.g., Swainson's warbler). A reduction of the forest overstory to 60% -70% canopy cover will likely improve long-term habitat conditions for understory bird species but not cause dramatic changes in the overstory bird species composition within bottomland forests.

Silvicultural treatments could also be used to influence species composition and improve growing conditions on restored sites (e.g., reforested stands; Chapter IV) entering "stem-exclusion" conditions when canopy closure occurs and reduces understory vegetation. No definitive silvicultural prescriptions currently exist to guide stand development towards desired stand conditions or to promote wildlife habitat (Meadows 1996). However, Goelz (1995) provides stocking recommendations for timber production under an even-aged management scheme that may provide a foundation for management decisions. This guide is based on hypothetical stocking levels provided by Putnam et al. (1960) for bottomland hardwood stands but no residual stocking levels have been experimentally validated. Alternatively, management actions (e.g., group cuts) could be undertaken within these stands to ensure areas of sunlight penetration to the forest floor within parts of the stand. This will encourage diverse vegetation and increased horizontal structure. Additionally, these treatments should consider retention of dense areas within the plantations to allow natural senescence for deadwood development.

Because they increase vertical and horizontal cover, regeneration harvests of limited areas likely benefit many priority wildlife species. The size of openings necessary to regenerate shade-intolerant tree species, however, must be balanced against the potential negative effects of increased brood parasitism of songbird nests by brown-headed cowbirds in larger openings, the time required for harvested areas to regain forest canopies, and the even greater time required to attain desired stand structure. Because brown-headed cowbirds appear to be ubiquitous within bottomland hardwood forest patches of <25,000 acres in the MAV, increased nest parasitism within forest openings may have a negative impact on breeding birds (R. J. Cooper, University of Georgia, unpublished data). This is important, as gaps of 1 to 3 acres may be essential for

regeneration of some shade-intolerant tree species (e.g., oaks and sweetgum). Despite potential impacts on breeding birds, a small proportion (<20%) of many forest stands should target regeneration of shade-intolerant tree species through small, silvicultural induced gaps – even at the risk of slightly elevated rates of nest parasitism. However, as defined by desired landscape conditions (Chapter II), regenerating forests >7 acres should represent ≤10% of the landscape. To the extent possible, large areas of forest regeneration (i.e., clearcuts) should be positioned to create maximum benefit for species of concern while minimizing the negative impacts often associated with these large, temporary openings. We believe that limited use of larger regeneration harvests, combined with smaller openings within variable retention harvests, will provide sufficient shade-intolerant regeneration, including oaks (Oliver 2005).

An additional concern associated with large disturbances within forests is the potential for invasion by vegetation that has a negative impact on priority wildlife. Of particular concern are exotic species (e.g., Chinese tallow [*Triadica sebiferum*], trifoliate orange [*Ponicirus trifoliate*]) that may aggressively invade bottomland forests following silviculture operations and/or the abandonment of agricultural lands (Renne et al. 2000). Notably, Chinese tallow has commandeered numerous sites within the southern MAV, to the detriment of native plant species (Bruce et al. 1997). As such, managers will need to give extra consideration to the implication of disturbance within forests where these exotics are likely to invade (e.g., several years of Chinese tallow chemical control will likely be required on most Gulf Coast sites following silvicultural treatments).

Finally, some non-woody vegetation has been associated with increased use by priority wildlife species. Three centuries ago canebrakes were widespread throughout the MAV (Harper 1958). However, the canebrake ecosystem has declined by 98%, and this once prominent feature of bottomland forests is now considered a critically endangered ecosystem (Noss et al. 1995). When present in forest stands, silvicultural prescriptions should minimize damage to and encourage proliferation of cane. Creation of gaps surrounding cane patches may encourage their development by providing additional sunlight (Gagnon 2006, Appendix 2). Spanish moss (*Tillandsia usneoides*) is another vegetation component often associated with specific

bottomland forest species (Gooding 1998). Unfortunately, management actions to encourage expansion of Spanish moss are unknown.

Silvicultural treatments should optimally occur between 1 August and 28 February, but care should be taken to avoid bear denning locations during the winter (Linnel et al. 2000, Hightower et al. 2002). Disturbance should be minimized during the peak-breeding season for birds and bats -- between 1 March and 31 July (this period may differ slightly within the MAV based on latitude). However, wet ground conditions often restrict access during late fall and winter. Thus, forest management that improves habitat may be undertaken between 1 March and 31 July when the alternative is undertaking no habitat improvement actions.

The length of time between stand entries should be related to the intensity of treatment – that is, habitat enhancements persist longer in stands subjected to more intense disturbance. Thus, desired stand conditions should prevail for longer duration. Because desirable habitat conditions are likely to persist for >10 years after harvest, subsequent entry for additional disturbance should not be warranted for at least 15 years unless the original prescription recommended follow up treatments. Moreover, it is important to note that we are not promoting a specific (e.g., 15 year) "cutting cycle," instead we are recommending an "evaluation cycle". That is, every 10-15 years (based on site characteristics), the area in question will be evaluated for the need of additional treatments to maintain desired forest conditions. In many cases, the management decision will likely be to defer treatment in this area until a future time, unless the control of exotic invaders indicates otherwise.

SUMMARY

As more emphasis is placed on drawing a clearer linkage between forest management activities and habitat needs of priority forest wildlife species, it is imperative that biologists and foresters work together. To that extent, we have identified landscape and stand level parameters intended to guide and facilitate management actions that result in desired forest conditions beneficial to priority wildlife species. These parameters reflect a combination of published reports and the collective knowledge of experienced managers, thereby representing what we believe to be realistic, long-term sustainable forest conditions. Parameters are represented as a range of

values, thereby providing flexibility to modify prescriptions to meet overriding habitat needs within local landscapes and among different forest types.

Forest managers have historically emphasized maintaining forest health and productivity. However, wildlife managers recognize the benefits conferred to certain species through unhealthy or less productive components of a forest. For example, dead and stressed trees and coarse woody debris provide food for the lower organisms in the food chain (e.g., invertebrates) which in turn provide forage for subsequent links in the food chain (e.g., skinks, woodpeckers, bears, etc.). These processes also serve important functions in recycling nutrients thereby promoting sustainable forest conditions. Unfortunately, the normal practice of silviculture attempts to remove dead or stressed trees before they can be recycled within the forest system. Similarly, traditional timber harvest is undertaken, in part, to: (1) maximize the growth of retained stems; and (2) promote overall forest health. As such, we recognize that to attain our recommended desired forest conditions, land managers must alter forest management prescriptions to retain some non-merchantable forest components and maintain less than maximum sustained tree growth. Even so, we believe that these management recommendations will provide a sustainable forest that is economically viable, produces quality timber products, and maintains sustainable populations of priority silvicolous wildlife.

CHAPTER IV

RESTORATION OF BOTTOMLAND HARDWOOD FORESTS

INTRODUCTION

As early as the 1960s land managers within the MAV expressed concerns over the degradation of forested habitats due to hydrologic and geomorphic alterations to river systems and widespread clearing of bottomland hardwood forests. Although little information was available on reforestation techniques, these land managers began a trial and error process to plant trees on abandoned agricultural land (Tim Wilkins, Yazoo NWR, personal communication, Savage et al. 1989). In most cases, available land consisted of heavy clay soils that flooded too frequently to be profitable for agriculture. More serious efforts to restore forest cover on lands converted to agriculture began in the mid-1980s (Allen and Burkett 1996) when the U. S. Fish and Wildlife Service, Arkansas Game and Fish Commission, Louisiana Department of Wildlife and Fisheries and Tennessee Wildlife Resource Agency increased their tree planting efforts (Savage et al. 1989, Newling 1990). These efforts were furthered through contacts and field review meetings of the Southern Hardwood Forestry Group with input from researchers at the U. S. Forest Service's Center for Bottomland Hardwood Research in Stoneville, Mississippi (M. Blaney, personal communication). In most cases, the sole activity was to plant two or three species of trees with little monitoring of vegetation or wildlife response.

Since 1987, public agencies and private interests have reforested circa 1,000,000 acres (R. Wilson, personal communication), with suggested restoration targets of >2 million acres (Haynes 2004). Numerous state and federal agencies have contributed to these totals, but the advent of the USDA's Wetland Reserve Program greatly accelerated reforestation efforts (King et al. 2006). The 1990 Farm Bill established the WRP, a voluntary program that provides technical and financial assistance to eligible landowners to restore wildlife habitat on wetlands through planting of vegetation and limited hydrologic restoration. Haynes (2004) stated that *"The Wetland Reserve Program is perhaps the most significant and effective wetland restoration program in the world, and has provided a tremendous opportunity to restore forested wetlands"*. As of September 2004, nationwide there were 7,831 projects on 1,470,998 acres enrolled in the

Wetland Reserve Program. Through 2005, > 680,000 acres have been enrolled in Louisiana, Arkansas, and Mississippi (King et al. 2006).

HISTORICAL PERSPECTIVE

Historically, hardwood forest restoration was intended to create diverse forest habitat for wildlife and a sustainable timber harvest (Wilson and Twedt 2005). Unfortunately, most of the early restoration occurred opportunistically, resulting in isolated blocks of restored forest (i.e., little contribution to the reduction of forest fragmentation). Additionally, many of the restored sites had relatively low topography (i.e., flood–prone sites), coupled with a failure to properly match tree species with site conditions (Stanturf et al. 2001) that resulted in poor tree survival. These mismatches of tree species and site conditions are less frequent in current practice.

Despite high diversity of tree species in bottomland forests (Allen 1997), plantings on bottomland sites have historically focused only on a few species of slower-growing, hard-mast producing trees. The species selected for restoration are typically based on their mast-production, their seed dispersal method (e.g., heavy-seeded, poorly dispersed species were favored), and their value as timber. Indeed, one study (King and Keeland 1999) indicated that within the MAV >80% of all planted species have been oaks or sweet pecan, although the diversity of plantings has increased more recently.

Few guidelines exist regarding optimal planting densities (Lamb 1999). Historically, a density of 302 seedlings / acre (12 x12 ft spacing) has been used in most bottomland forest restoration in the MAV (King and Keeland 1999). Early restorations often employed direct seeding due to the low cost of acorns and sowing (Johnson and Krinard 1987, Haynes et al. 1995). However, unpredictable survival within direct seeded restorations (due to seed and/or planting qualities) has prompted greater reliance on planting bare-root seedlings despite greater cost.

DESIRED FOREST CONDITIONS

Forest restoration is the most important method by which we can achieve largely forested landscapes. However, reforestation has historically been extensive with an intent to “plant as many acres as possible,” despite a lack of clearly defined site-specific objectives linked to

succinct landscape objectives (Wilson et al. 2005). Although this approach may have been initially warranted, it fails to recognize important components of successful ecosystem restoration (e.g., succinct objectives linked to wildlife population response [Young 2000]). Obviously, the establishment of clearly defined focal areas and restoration priorities is necessary to effectively meet landscape conservation objectives (Chapter II; Table 1) (Llewellyn et al. 1996, Twedt et al. 2006). Over the last 5-10 years, conservation objectives have been used more effectively in prioritizing bottomland hardwood restoration (e.g., use of songbird [Fig. 4 and 5] and black bear [Fig. 6] decision support tools in the ranking of WRP).

Concurrently, the "one-size-fits-all" approach has often been used for restoration within sites, as evidenced by commonly planting few species (primarily oaks) at a standard density of 302 seedlings / acre (12 x 12 ft spacing). Evaluation of the subsequent development of these plantings suggests that many have failed to attain a diverse species composition or structural complexity, in the absence of additional site invasion by native species. Furthermore, it appears that many planted stems are unlikely to develop characteristics that will lead to quality timber production, thereby limiting forest management options to meet DFCs. Thus, site development following historical restoration methods appears unlikely to provide Desired Stand Conditions (Chapter III) without additional silvicultural manipulations or extended periods of time. Below we articulate recommendations for bottomland restoration that target attainment of both Desired Landscape Conditions and development of Desired Stand Conditions.

LANDSCAPE SCALE CONSIDERATIONS

Many priority wildlife species are dependent upon large, forested landscapes that harbor contiguous bottomland hardwood forests. Thus, in general, our primary landscape conservation goal is to establish and maintain extensive areas of contiguous bottomland forest within distinct local landscapes (Chapter II; Wilson et al. 2005).

Although small isolated, or long linear tracts may provide important wildlife habitat (e.g., as bear movement corridors), these sites are likely of lesser value to forest-breeding songbirds. An alternative management strategy for these sites may be to plant and maintain these areas in shrubby, early successional habitat (see below). Depending on topographic diversity, these sites

may also be important for reptiles and amphibians. Both environmental and spatial variables influence amphibian assemblages (Parris 2004, Loehle et al. 2005) but Burbrink et al. (1998) noted that patch size was less important than topographic diversity for these species.

When planning restoration at the landscape scale, sites with higher elevations should be considered as they have been underrepresented in previous restoration activities. As historic opportunity for restoration has largely been on flood-prone sites, higher elevation bottomland sites (e.g., ridges and second bottoms; Fig. 3) have rarely been restored. Indeed, most extant bottomland forests in the MAV are on lower sites (Twedt and Loesch 1999, Rudis 2001b) whereas higher elevation sites remain in agricultural production. Functionally, higher sites provide unique habitat resources that are unavailable or limited on lower sites. For example, during major flood events, many forest interior species (e.g., ground foraging songbirds, deer, turkey, etc.) must find alternative habitat when displaced from flooded forests. Furthermore, higher elevation sites often have temporary, fishless wetlands that are important for many species of amphibians (Burbrink et al. 1998).

Restoration of these higher sites should be a priority, but there are economic, social and political challenges. Economically, these sites are more productive agricultural areas and the costs of acquiring these sites will be considerably higher than marginally productive agricultural areas. Socially and politically, the loss of agricultural revenues from rural communities is a concern and will likely be met with resistance (R. Wilson, personal observation). Loss of farming activities can further impact rural communities as the need for services supporting this practice is diminished. The lag time between reforestation and forest harvesting can be hard on the local economies currently dependent on farming activities. These and other concerns must be appropriately addressed.

Opportunities may exist to gain substantial benefits from concurrent functions when they are considered in the selection process. These “secondary” functions can potentially enhance the success of restorations. For example, selecting sites for restoration that are known sediment sources or that are important sediment sinks may enhance the long-term condition of existing forests in a watershed.

Conversely, there may be conflicting landscape-based forest restoration objectives among priority wildlife species. For example, managers may have to choose between forest restorations or herbaceous moist soil intended for waterfowl. In these situations, the potential benefit of reduction in forest fragmentation will have to be balanced against maintaining non-forest habitat (e.g., moist soil units or managed agricultural areas) that benefit waterfowl and other waterbirds. The effect of landscape position on other wetland functions (e.g., carbon sequestration, water quality enhancement) and other species of wildlife (e.g., amphibians and reptiles) should also be considered.

STAND LEVEL CONSIDERATIONS

Site Limitations

Forest composition within the MAV is highly correlated with hydrogeomorphic setting (Klimas et al 2005). Thus, we suggest that forest restoration is likely to be most successful when restoration accounts for the effects of micro-topography, hydrology, soils, and geomorphic setting on plant species composition. To that extent, most, if not all restoration sites have undergone hydrological changes/alterations. Although restoration of original hydrologic conditions may not be possible because of physical land use changes and/or socioeconomic constraints, restoring or emulating local hydrologic processes through re-contouring of lands or through active wetland management is encouraged. Flooding was and is a critical component of forested wetlands with ecosystem productivity and life cycles of many organisms linked to these hydrologic processes. Thus, restorationists should evaluate opportunities for hydrologic restoration or rehabilitation prior to selecting plant species for restoration.

Differences in soils and hydrology, among and within restoration sites, mandate that for optimal tree growth and survival, species selections must be compatible with site conditions (Baker and Broadfoot 1979, Patterson and Adams 2003, Lockhart et al. 2006). On sites with varied topography (e.g., ridge and swale), matching species with site conditions should result in increased heterogeneity of species and structure (Groninger 2005). However, on sites that are often inundated, soil with uniform topography or with homogeneous soils, planting only a few site-compatible species may be warranted.

Species diversity

The high diversity of tree species found within bottomland forests (Allen 1997) provides a great variety of wildlife habitat. However, previous restoration has focused on ensuring establishment of hard-mast producing trees, primarily oaks with the assumption that diversity would result from naturally colonizing light-seeded trees. Assessment of established restorations sites has indicated that diversity is often dependent upon distance from existing forest stands (Allen et al. 1998, Battaglia et al. 2002, Twedt 2004, Wilson and Twedt 2005).

Due to limited natural invasion, including a greater diversity of tree and shrub species in reforestation plantings (i.e., mixed-species plantings) is important for successfully attaining long-term conservation goals. Mixed-species plantings have numerous benefits including greater diversity and broader temporal availability of mast and insects, greater structural diversity, higher timber quality and yield, increased non-timber and timber products, improved soil health, enhanced natural regeneration, and increased carbon sequestration (B. Lockhart, U.S. Forest Service, personal communication).

Restored forests that are diverse in woody species provide benefits to priority wildlife by distributing food and shelter resources across space and time. A stable supply of insects is important for the diverse assemblage of forest dwelling bats, all of which are insectivorous. Most migratory birds forage primarily on insects rather than mast during spring and summer, and nestlings are provisioned almost exclusively with insects, especially caterpillars. Many of these caterpillar species exhibit preferences among host tree species (Twedt and Best 2004). Thus, in forests that are depauperate in tree species diversity, some caterpillar species may be rare or absent. Furthermore, the abundance of insects and species-specific fruit (mast) production vary temporally. Black bears have an omnivorous diet that shifts in space and time to exploit available food sources (Stransky and Roese 1984, Rode and Robbins 2000, Benson and Chamberlain 2006). Thus, species rich forests buffer temporal variability resulting in a more stable supply of insects and mast.

A multitude of woody species also provides many growth forms and phenologies that provide varied and seasonally dynamic structural niches. Mixed-species stands also allow for greater structural diversity, and often at a much faster rate than would occur with plantations of

primarily heavy-seeded species (Twedt 2004). Mixed species stands can create interspecific competition that can improve timber quality, particularly of oaks, and increase management options in the future (Oswalt and Clatterbuck, 2006, Lockhart et al, 2006).

Restorations that incorporate fast-growing tree species promote rapid colonization by silvicolous birds (Twedt et al. 2002, Hamel 2003). For example, eastern cottonwood interplanted with oaks on appropriate sites have proven to be successful in achieving rapid development of vertical structure and providing economic benefits to landowners (Twedt and Portwood 1997, Gardiner et al. 2004, Twedt and Best 2004). Sweetgum interplanted with oaks have also been recommended for providing more rapid development of forest structure. In early stages, sweetgum will outgrow the oaks, but at about 25 years the oaks will attain dominance within planted stands (Lockhart et al. 2006). Additional conceptual models of compatible bottomland species, targeting improved timber quality of oaks, have been proposed for use in establishing multi-species restorations (B. Lockhart, unpublished manuscript).

Although mixed-species plantings are recommended on most sites, another method used to provide rapid height development of trees is to plant plantations exclusively of fast-growing hardwood trees. Plantation forests have been successfully used to achieve diverse forest conditions (Keenan et al. 1997, Lamb 1998). Plantations facilitate forest succession in their understories through modification of both physical and biological site conditions, changing light, temperature, and moisture conditions at the soil surface (Lugo 1997). These changes enable germination and growth of seeds transported to the site by wildlife and other vectors (Parrotta et al. 1997, Joslin and Schoenholtz 1998). That these physical changes occur within the understory implies that plantation trees have rapid development of a forest canopy. Diversification of these forests can be further hastened by "under-planting" a mixture of slower-growing and understory tree species, shrubs and vines (Twedt and Portwood 1997, Gardiner et al. 2004), although Allen et al. (2006) identified limitations to this approach (e.g., reduced survival and growth due to low light conditions). As such, these species should be included in the initial planting stock.

Regardless of how achieved, to ensure rapid colonization of a restored site by priority wildlife, trees with rapid growth characteristics must occur on the reforested site. Although there remains a perception that forest diversity, particularly colonization of light-seeded species, will result from natural colonization, it is often necessary to plant several species to ensure species diversity on restored sites. Flooding (i.e., over-topping seedlings) impacts natural colonization of trees but colonization may be restricted by distance from existing seed sources or harsh site conditions (e.g., drought) for seed establishment. When restoration sites are far (>660 ft) from seed sources, natural colonization by woody species may be sparse (Allen 1990, McCoy et al. 2002, Twedt 2004, Wilson and Twedt 2005).

There is no set number of species to be planted per field or project. Forest restoration within some ecosystems, such as rainforests in Australia (Tucker and Murphy 1997) and thamnic forests in Texas (Twedt and Best 2004), have successfully planted up to 80 species at densities of up to 1,215 stems/acre to promote restoration of diversity. While large numbers of species would be beneficial in many areas, in some cases, such as an old baldcypress brake, it might be appropriate to plant only one or two species, baldcypress and button bush. Conversely, in a field with ridge and swale topography, it might be appropriate to plant numerous species. Species found within adjacent forests can be used to guide species selection (i.e., reference sites) for restoration within site limitations. If non-traditional species are candidates for restoration, limited past demand may reduce the availability of planting stock. Thus, land managers may need to communicate planting stock needs with nurseries well in advance (>1 year) of anticipated planting dates.

Stem Density

Some forest resource managers have determined that the planting rate used by most agencies, 302 trees per acre, is sufficient to create habitat beneficial to silvicolous birds (Wilson et al. 2005). However, Stanturf et al. (2001) suggested that the standard currently used to define restoration success, 125 – 225 trees per acre at or before the third year after planting, is not sufficient to produce commercial timber and recommend survival of 250 – 450 trees / acre. Historically, it has been assumed that natural colonization of light-seeded species will ensure restored forests are both diverse and stocked at densities >250 trees / acre. However, as with diversity, natural colonization cannot be relied upon to produce densely stocked stands when

sites are far (>660 ft) from existing forests (Allen 1990, Allen et al. 1998, McCoy et al. 2002, Twedt and Wilson 2002, Twedt 2004). Thus, planting at higher densities may be required to initiate stands at high densities.

High densities of trees and shrubs provide benefits to wildlife by rapidly achieving 'forest-like' habitat conditions. Furthermore, these dense, shrub-like habitats often provide important food sources for priority wildlife, in the form of soft, fleshy fruits and small hard seeds. Wunderle (1997) found that sites with greater availability of perches, structurally complex vegetation, and food (fruit and insects) resources attract seed dispersers, thereby increasing within site diversity. Some birds of management concern (e.g., Bell's vireo, orchard oriole [*Icterus spurius*], and painted bunting) preferentially breed in shrub-scrub habitats provided by "thickets" of invading trees, whereas other priority wildlife species use these thamnic areas for post-breeding cover and foraging (Kilgo et al. 1999, Vega Rivera et al. 1999). In areas where species using shrubby habitat are high priority, mangers are encouraged to maintain thamnic habitat through periodic manipulation of vegetation (e.g., burning, disking, chaining, or mowing).

Densely stocked stands promote early canopy closure, encouraging vertical development of trees. In addition to the positive correlation between tree height and colonization of sites by silvicolous birds, high sapling densities stimulate development of dominant or emergent trees within stands due to the "shepherd tree" effect that inhibits lateral growth while encouraging apical growth (Gómez-Aparicio et al. 2004, Lockhart et al. 2006). Emergent trees within a multilayered forest canopy provide preferred nest and perch sites for some priority bird species (Hamel 2000).

However, densely stocked stands that allow little sunlight penetration to the forest floor generally harbor few priority wildlife species. Indeed, wildlife would benefit from silvicultural treatments that introduce disturbance and increase structural heterogeneity even in relatively young restored forests. Unfortunately, such silvicultural treatments are not commercially viable and thus are unlikely to occur. A potential alternative to commercial operations is via the acquisition of shared harvesting equipment (e.g., a feller-buncher) capable of felling small diameter trees.

Although the cost of such equipment could likely not be justified by a single management area, harvesting units that are regionally based and jointly operated may be feasible.

Impediments to increasing density of woody species on restored bottomland sites are both logistic and economic. Increasing the density of planted seedlings markedly increases the cost of restoration. For example, moving from 12 ft spacing (302 seedlings/acre) to 8 ft spacing (680 seedlings/acre) more than doubles the planting stock and labor required for restoration. On the other hand, an increase to 435 seedlings/acre (10ft spacing) only increases the cost by about 50% and may provide a much preferred basis for attaining DFCs. Although initial costs are higher, planting higher densities of seedlings will likely improve timber quality (e.g., merchantability), as well as enhancing wildlife habitat.

To minimize costs in some situations, the planting rate can be reduced along field margins within 100-660 feet of adjacent forests, where increased rates of natural colonization is likely. Another alternative to reduce costs is the use of direct seeding. Seeds of woody plants cost a fraction of seedlings and can be planted with relatively little time and expense (Allen et al. 2001). Furthermore, Twedt and Wilson (2002) suggested that wildlife (birds) benefit more from direct seeding acorns than from restorations of planted oak seedlings, owing to increased species and structural diversity attained within these sites. Additionally, some land managers have found that direct seeded acorns survive periods of drought or prolonged flooding whereas planted seedlings suffered high mortality under these adverse conditions. However, there are also disadvantages of direct seeding: (1) direct seeding has been proven reliable only for large seeded species, such as oaks, (2) development of direct seeded oaks is generally slower than that of planted seedlings, and (3) rodents may eat sown acorns reducing survival (Savage et al. 1996).

Other woody species and cane have been successfully restored by directly sowing seeds (Holt 1998a, 1998b, Snell and Brooks 1998, Camargo et al. 2002). Unfortunately, little information is available on the methodology or success of directly sown non-hard mast seeds on bottomland sites (Herman et al. 2003, Lof et al. 2004), although Gagnon (2006, Appendix 2) provides recommendations for cane restoration. Allen et al. (2001) and Twedt (2006a) indicated that direct-seeding of light-seeded species has been largely unsuccessful in the MAV. Where

successful restorations from direct seeding have been reported, success has often been contingent upon control of weed competition (Herman et al. 2003, Twedt and Best 2004). Weed control also benefits growth of planted trees (Ezell 1995, Ezell and Catchot 1998, Rey Benayas et al. 2005). However, weedy cover can provide beneficial habitat for many wildlife species during these early forest developmental stages. Regardless, limited financial resources and lack of personnel have prevented weed control on most restoration sites. Because of their inability to provide weed control (or other pre-commercial silvicultural treatments; see Chapter III), many managers are reluctant to risk increased tree mortality by planting species that are susceptible to weed competition. Considerable challenges remain to ensure germination and successful establishment of diverse forests via direct seeding.

When high tree densities can be obtained, caution should be exercised as the resultant dense canopy cover within the maturing forest diminishes its suitability for many wildlife species. Thus, it is advisable to mix densely planted areas with sparse or unplanted areas. One option is to plant small areas or only part of a restoration site with fast growing tree species. These areas of rapid vertical growth potentially serve as ornithochory foci (Werner and Harbeck 1982, McClanahan and Wolfe 1993, Robinson and Handel 1993) that may result in increased diversity and density of trees, but this has not been experimentally proven in the MAV (B. Keeland personal communication). Similar areas of rapid vertical growth may be achieved by isolated trees (Guevara and Laborde 1993), small clumps of trees (Toh et al. 1999, Twedt, 2006b), or linear strips (Twedt and Portwood 2003). Even so, colonization by other woody species at these sites can be slow (Wunderle 1997) and survival poor (Toh et al. 1999), thus necessitating the need for multi-species plantings.

Few guidelines exist as to the relative planting densities of species within multi-species restorations. Historically, restoration has focused on long-lived, commercially valuable species. Even when planted at relatively low densities, intraspecific competition among these species may result in mortality of many of the planted individuals. Conversely, planting of multiple species promotes interspecific competition that results in improved stand development and enhanced wildlife habitat. This approach risks the possibility that some species may be overtopped by faster growing species but many of these species (e.g., oaks) can normally persist

and eventually out-compete the faster growing pioneer species (Clatterbuck and Hodges 1988, Johnson and Krinard 1988, Lamb 1998, Lockhart et al. 2006). Moreover, specific mixed species plantings that combine early and late successional species or shade-tolerant and shade-intolerant species have been recommended for quality timber development and wildlife habitat (Ashton et al. 2001, Lockhart et al. unpublished manuscript).

SUMMARY AND RECOMMENDATIONS

Landscape Perspective

Future conservation efforts should clearly articulate goals and objectives that directly link habitat restoration and habitat needs of priority wildlife. Following direction provided by restoration objectives, existing decision support tools can be used to focus restoration so as to promote population sustainability of priority species. These support models exist or are in development for forest birds, hydrogeomorphology, and natural flooding. We encourage development of additional science based, biologically driven, landscape oriented models for other priority wildlife, particularly the threatened Louisiana black bear. Not only will clear articulation of goals and objectives guide restoration decisions, it will facilitate improvement of restoration efforts through evaluation of both programmatic and ecological success. These results can then be used to adjust management prescriptions via adaptive management.

Site Limitations

As discussed previously, forest distribution and composition are strongly linked to both the geomorphic setting and its associated hydrology. Furthermore, much of the MAV has undergone significant, hydrologic alterations due to flood control activities (e.g., levees) and farming practices (e.g., land-leveling). In an attempt to keep our "eye on the prize", restoration activities should strive to restore local hydrology and topography via re-contouring of land-leveled fields and the promotion of natural hydrologic events.

From the onset, we made a conscience decision not to address the many facets of site preparation, handling and storage of seeds/seedlings, etc.. due to the comprehensive nature of *"A Guide to Bottomland Hardwood Restoration"* (the reader is referred to [Allen et al. 2001] for more details). However, recent research and anecdotal observations in the use of no-till sub-

soiling techniques and chemical weed control warrants further discussion. The use of sub-soiling (a.k.a. "ripping") has been shown to increase both growth and survival of planted species, as well as to facilitate planting efforts (Andy Ezell, personal communication). Additionally, the use of post-planting weed control (first-growing season) through the use chemical applications has also been shown to increase both growth and survival of planted species (Andy Ezell, personal communication) via reduced competition for resources (i.e., water). As such, we recommend that all restored sites be sub-soiled before planting and that post-planting chemical weed control during the first-growing season be considered where applicable (i.e., when weeds are presumed to be a problem).

Promotion of Vertical Stratification and Horizontal Structural Heterogeneity

Vertical stratification and increased horizontal heterogeneity within restored sites is only possible over time and with maturation of woody vegetation. As such, it seems somewhat premature to include these elements as objectives for initial restorations. However, attainment of desired stand conditions (Chapter III) is our ultimate objective regardless of the length of time it takes to be achieved. Thus, initial restoration decisions should target desired forest conditions, including increased species richness and greater structural diversity. Managers should bear in mind that increased diversity of species (including faster growing trees), higher densities of stems, and varied planting strategies (e.g., leaving patches [circa 1-2 acres] unplanted), not only represent a sound initial restoration strategy but also contributes to improved habitat conditions within maturing forests.

Recommended Planting/Survival Rates

To facilitate natural stand development processes (e.g., inter-specific competition) and to increase wildlife habitat, we recommend increasing the initial planting rate to 435 seedlings per acre (10 ft spacing), recognizing that 680 seedlings per acre (8 ft spacing) would be even better. On most sites, hard mast species, including multiple species of oak, sweet pecan, and other hickories (*Carya* spp.), should represent 30% to 60% of planted trees. These proportions are based on three assumptions: (1) that oak-hickory was part of the previous forest composition, (2) that >30% oak composition is needed to ensure an adequate abundance of oak in future stands to maintain high merchantability, thereby enhancing future management options, and (3) that

sufficient hard mast production will occur for resident wildlife species [e.g., black bear, white-tailed deer (*Odocoileus viginianus*), wild turkey (*Meleagris gallopavo*), squirrels (*Sciurus* spp.), as well as for migratory waterfowl (e.g., mallard and wood duck). The remaining 40% to 70% of the planted trees should represent a mixture of light seeded, soft mast, and fast growing species (e.g., red maple, persimmon *[Diospyros virginiana]*, elm, green ash, sweetgum, sugarberry, blackgum, American sycamore, and black willow) that would naturally occur on the site. Other trees that are native to many sites, such as honey locust (*Gleditsia triacanthos*), ironwood (*Carpinus caroliniana*), swamp dogwood (*Cornus drummondii*) and boxelder (*Acer negundo*) should not be forgotten from the mix of available species.

Although wildlife managers on public lands are not striving for commercial products, planting appropriate species mixtures (Lockhart et al. unpublished manuscript) may promote development of merchantable timber and increase management options. Achieving stocking rates of >300 trees per acre three years post-planting, including 75 – 180 hard-mast producing trees per acre, will also promote these objectives. To increase density of trees, naturally colonizing species should be encouraged. Once established, species composition within these stands can be altered using prescribed silvicultural management. Not only does natural colonization increase species diversity and stem density, these benefits are incurred at essentially no additional cost. This cost savings can be enhanced through judicious planting, wherein locations within restoration sites that are likely to have considerable colonization (e.g., near forest edges) are not planted or selectively planted at lower densities.

CHAPTER V.

FOREST EVALUATION AND MONITORING

INTRODUCTION

How "success" of restoration and management of bottomland forests is measured depends on many factors, but stated objectives are essential (Ruiz-Jaen and Aide 2005). These may be the specific objectives established within this document or entirely different objectives determined by a landowner or manager. Indeed, objectives on private lands are usually different from those on public lands. Likewise, forests established for carbon storage or sediment retention may have similar or different objectives than those established for timber production or wildlife habitat. Regardless, determination of "success" requires a well defined, coordinated monitoring program with clearly stated objectives operating at multiple spatial and temporal scales.

On lands retired from agricultural production, it could be argued that high quality wildlife habitat is being provided by natural succession, independent of survival of planted trees – thus simply removing this land from agriculture production constitutes some level of success. Although many wildlife benefits are provided by simply removing land from agriculture, other benefits such as timber production and habitat for forest-dwelling wildlife species are lacking without trees. Clearly the benefits to wildlife are dependent upon the species, as some require early successional habitat whereas others require later seral stages. Consideration of temporal and spatial scales is therefore important when defining measures of success. Logistically, some measures of success must be established at the project scale and within a relatively short time interval. This information will allow managers, on a site specific basis, to: (1) evaluate the success (or failure) of their efforts, (2) determine if additional efforts are warranted, and (3) identify modifications that will facilitate attainment of objectives. This is a practical and necessary measure of project success, even though short-term assessments may be misleading – for example low seedling densities 2-4 years after planting may not be indicative of densities in later years (Allen 1990, Twedt and Wilson 2002). Furthermore, it is difficult to "scale up" from short-term measures of project success (e.g., the number of seedlings / acre, or change in percent canopy cover) to measures of successful implementation of Desired Forest Conditions across

landscapes that support sustainable populations of priority wildlife species (e.g., biological success).

Although we can readily assess short-term changes within forests that are attributable to silvicultural treatments, long-term sustainability of desired stand conditions is not assured. As most public agencies do not have the personnel or financial resources to undertake prescribed treatments needed to attain desired forest conditions, ensuring continued merchantability of timber within sites will likely be required to attract commercial partners. Unfortunately, we still do not fully understand how to optimize planting densities (in restored stands) and silvicultural treatments to achieve the desired result (e.g., production of quality merchantable timber). However, we have learned that some activities do not consistently produce desired habitat objectives and these observations can be used to adaptively develop new recommendations for planting and treatments. Continuing research, evaluation, and monitoring are needed to test our assumptions, evaluate success, and assess progress toward conservation goals of maintaining forested landscapes capable of sustaining populations of priority wildlife through attainment of Desired Forest Conditions.

Even with the inherent uncertainty in measuring success, we propose to measure success against our overarching goal of establishing and maintaining forested landscapes capable of sustaining populations of priority wildlife in perpetuity. To achieve this goal will require: (1) strategic restoration of forest on lands retired from agricultural production to attain desired landscape conditions, (2) enhancement and maintenance of forest stand conditions to meet the habitat needs of priority wildlife, and (3) implementation of a coordinated, statistically sound monitoring program operating at multiple spatial and temporal scales such that management decisions can be made in an adaptive manner (i.e., learning from past management actions).

ADAPTIVE APPROACH TO MANAGEMENT

Our recommended forest metrics (Tables 2 and 3) may seem like an endpoint in achieving bottomland forest conservation goals and objectives within the MAV, but in the context of adaptive management they are only a beginning. Adaptive management is a systematic approach for implementing and improving resource management by learning from management outcomes

so as to reduce uncertainty (Holling 1978, Walters 1986). Management actions are a series of experiments whose outcome is predicted with some level of uncertainty but the results of which can be evaluated. In that vein, adaptive management is a blend of management, research, and monitoring that together yield valuable information – the absence of any of these components weakens the effort substantially.

Most examples of successfully applied adaptive management have been in systems where management decisions (and therefore updating) occur frequently: for example, waterfowl harvests which occur annually (Williams and Johnson 1995) or prescribed burning of prairies which also occurs relatively frequently (Gibson 1988). Forest management is characterized by relatively infrequent management decisions within stands (circa 10-15 years) and outcomes from prescribed treatments that may not be fully realized for decades. Therefore, opportunities for updating management prescriptions are limited and may span generations of researchers and managers. Lack of opportunity in time, however, can be compensated for by replication in space, such that decisions made in one stand are informed by those made in another. Maintaining written records of management actions and subsequent monitoring is a critical step in the assessment process.

We have identified general management recommendations for bottomland forests, but in each case there will likely be several treatment alternatives that managers could consider regarding the type, species, number, and spatial distribution of trees removed. Other areas that are set aside for passive management serve as experimental controls, which is actually just another type of treatment. The results of the treatments evaluated (i.e., monitoring) can used to inform models that help to identify optimal management practices in bottomland forests (i.e., management).

A similar framework should be used for assessing forest restoration. For example, survival of planted trees should be evaluated the third year after planting. Trees that have survived until that time have a good chance of continued survival. Naturally established woody species should also be counted – at least those that could affect development of vertical structure. We recommend recording: (1) separate tallies of planted and naturally established seedlings, (2) the proportion of sample plots where stocking meets the desired objective, and (3) the proportion of sample plots

that harbor target species (e.g., oaks). Spatial projection of these data may provide useful insight that can be used to identify supplemental treatments, if deemed necessary, and influence restoration approaches on subsequent sites (i.e., adaptive management).

Implementation of an adaptive approach in management of bottomland forests faces many challenges. There are many forest types and conditions in the MAV, so different site-specific models may need to be developed. Appropriate response variables must be determined as well. Even so, there are several attributes of this system that make it conducive to adaptive management: (1) many forest managers have made a commitment to manage this resource cooperatively, as evidenced by the production of this document, (2) a centralized, forest management database that allows continuous systematic updating of models is under development (see below), and (3) the large number of managed forest stands and reforested sites that are available for development and evaluation of models increases statistical power and compensates for infrequent visitation or updates within individual sites. These are significant attributes that must be taken advantage of to fully endorse an adaptive management approach to bottomland forest management in the MAV.

DEVELOPMENT OF A MONITORING PROGRAM

As previously stated, an important component of adaptive management is a comprehensive monitoring program that addresses clearly articulated goals and objectives at multiple spatial and temporal scales. That is, a comprehensive monitoring program should integrate the various ecological, temporal, spatial, and programmatic aspects of the system in addressing specific management-based objectives. If designed and implemented correctly, the sum of the parts will yield information more valuable than the individual components of the monitoring program (National Park Service, www.science.nature.nps.gov/im/monitoring.cfm).

It is important to clarify a few key terms (i.e., inventory, monitoring, and research). Although these terms are often used interchangeably, each has a strict definition that warrants discussion to clarify our use of the terms. An *inventory* is an effort to determine the location or condition of a parameter of interest (e.g., distribution, abundance) at a specific point in space and/or time, whereas *monitoring* addresses change in time – the collection and analyses of repeated

observations to evaluate change and/or progress toward meeting management objectives (Elzinga et al. 1998). However cause and effect relationships are not typically identified through inventory and/or monitoring. Instead, *research* is usually required to fully explain cause and effect relationships underlying the documented changes observed through monitoring.

Before an inventory or monitoring system can be developed, several key elements must be considered for planning, implementation, analysis, and reporting (Bart 2005, Droege undated). Specifically, an inventory and/or monitoring effort needs to clearly articulate the: (1) survey objectives, (2) sampling frame (statistical population for inference), (3) data required, (4) appropriate sample size needed to achieve desired level of statistical confidence, (5) appropriate sampling scheme and method(s) of data collection, (6) protocols for storage and management of data, and (7) protocols for the analysis and reporting of results. It is beyond the scope of this document to present a detailed, comprehensive inventory and monitoring program that addresses each of the key elements with respect to each of our stated objectives. However, we do provide general recommendations and in places offer detailed insight into the development and implementation of specific inventory and monitoring programs designed to assess forest management, restoration efforts, and wildlife response. It is our hope and expectations that LMVJV partners will develop common inventory/monitoring protocols and contribute to a common database so as to facilitate adaptive management of forests within the MAV.

GENERAL RECOMMENDATIONS

Within the MAV, forest inventories are routinely conducted on most areas under federal, state, and forest industry ownership. Many of these land mangers collect similar data (e.g., trees per acre by species and diameter class) and report in similar terms (e.g., basal area, diameter distributions). However, forest parameters deemed important to priority wildlife species are usually not recorded (e.g., canopy cover, midstory cover, understory cover). Additionally, there is no central repository or standardized method for consolidating and conducting landscape analyses. Furthermore, long-term monitoring systems are either non-existent or of dissimilar nature (e.g., different methods and parameters collected), thereby limiting our ability to conduct comprehensive landscape analyses. Similarly, there are no coordinated wildlife monitoring programs (outside the realm of site-specific research projects) designed to assess wildlife

abundance in relation to management actions (e.g., silvicultural treatments) in bottomland hardwood forests. As a first step in moving towards a coordinated, comprehensive monitoring program to assess forest management activities and progress towards achieving Desired Forest Conditions in the MAV, we offer the following recommendations.

As previously discussed, the most important element of any inventory or monitoring program is to have clearly defined objectives that facilitate achievement of the overarching goal. To that extent, our (LMVJV partnership's) overarching goal of establishing and maintaining forested landscapes capable of sustaining populations of priority wildlife in perpetuity should provide the framework for developing a comprehensive monitoring program. To measure progress (success) toward attaining this goal, we recommend the establishment of specific, realistic, and measurable objectives that address management needs. For example, the successful establishment of ≥300 stems per acre three years post-planting on restored sites, assessment of current forest conditions within management compartments (pre-treatment, post-treatment, and passively managed compartments) in relation to Desired Stand Condition parameters, assessment of Desired Forest Conditions at a landscape scale on 15 year intervals, and avian response to silvicultural treatments designed to achieve Desired Stand Conditions will facilitate measurement of success towards this stated goal.

Once objectives are clearly articulated, managers can then determine the appropriate data needed (e.g., parameters to be collected [Table 3]) and the amount of data needed (e.g., sample size). Sampling schemes are varied but the methods employed should be economical, minimizing both time and personnel required, and they must ultimately yield statistically valid information. We recommend the use of preliminary data to assess local variability which can be used to inform recommendations for sample sizes. Sampling design directly affects efficiency of data collection and should be carefully considered before implementation of data collection.
Data are often collected on paper forms, but use of electronic devices (e.g., hand-held field computers) may be more efficient and negates errors that occur during data transcription. Current forestry software can often be modified to include the additional forest parameters recommended here. To this extent, an effort is underway to customize forest inventory programs (e.g., TwoDog® and TCruise®) to accommodate these additional parameters and to facilitate

analysis and assessment of habitat conditions. Furthermore, we recommend that data be output from these programs and imported or linked to a Geographic Information System (e.g., ArcMap®) for spatial analysis and the development of decision-support tools.

Table 3. Recommended minimum forest parameters for site and landscape scale inventory and monitoring required to ascertain landscape condition (Chapter II, Table 1) and stand condition (Chapter III, Table 2). Parameter descriptions are provided in the Glossary and Appendix 4.

Forest Parameters	
Individual tree data	Trees by species Diameter at breast height (dbh) "Useable" length (dead or alive) Crown class (Dominant, Co-dominant, Intermediate, Suppressed) Tree Condition (healthy, stressed, standing dead, or down wood)
Plot level data	Overstory percent cover (10% increments) Midstory percent cover (10% increments) Understory percent cover (10% increments) Shade-intolerant regeneration Vines in overstory (None, Sparse, Moderate, Abundant) Cane (None, Sparse, Moderate, Abundant) Hydrologic-Forest Type (Table 4)

Analysis of data and reporting of results is of utmost importance. Reports should provide decision makers with adequate information to draw conclusions, or at least identify trends, regarding the status of Desired Forest Conditions. To accomplish this on a landscape scale, a central, GIS-linked data repository is required for data storage and access. Toward this end, the LMVJV office has developed a web-enabled database to track forest restoration (online at: http://www.lmvjv.org/rts_2ways.htm). Additionally, this office has begun development of a

forest management database: thus, land managers need to coordinate with database developers to ensure inclusion of appropriate information pertaining to forest treatments, inventories, and monitoring. We recognize the proprietary nature of some data, but recommend that all partners: (1) work with LMVJV staff to design and implement a central data repository, (2) contribute data from long-term, permanent plots (monitoring plots), and (3) contribute appropriate data from site scale, habitat assessments (inventory plots) such that evaluations can be conducted at multiple spatial scales.

Table 4. General hydrologically defined bottomland forest types found within the Mississippi Alluvial Valley (after NRCS Missouri, June 2004, Bottomland Forest Information Sheet, IS-MO643F, online at: http://www.mo.nrcs.usda.gov/technical/forestry/out/Bottomland_Forest_IS_FINAL. pdf.).

Hydrologic-Forest Types	
Swamp forest	baldcypress, baldcypress-water tupelo
Wet bottomland forest	overcup oak-bitter pecan, black willow, laurel oak-red maple
Moist bottomland forest	sugarberry-elm-ash, oak-elm-ash, oak-sweetgum
Dry bottomland forest	cherrybark oak-cow oak, post oak-blackgum
Levee forest	cottonwood-sycamore, sweet pecan-boxelder

SPECIFIC RECOMMENDATIONS

Although numerous methods are available for sampling and data collection, each comes with its own positives and negatives. Nevertheless, we make specific recommendations regarding data collection and sampling of forest vegetation and silvicolous birds that we believe will enhance our understanding of bottomland forest dynamics and facilitate the implementation of adaptive management schemes in the MAV.

Habitat Assessments (Inventory Plots)

Land managers routinely conduct inventory plots to assess current conditions. Unfortunately, the majority of these inventories are focused on assessing forest merchantability, with little explicit recognition of wildlife habitat. To better focus these routine inventories in terms of assessing

wildlife habitat conditions, we recommend that all stand level inventories include at a minimum, the parameters identified in Table 3. These parameters afford land managers the ability to assess current stand level habitat conditions and compare these with Desired Stand Conditions (Chapter III, Table 2). Furthermore, we recommend that habitat assessments be conducted within all management compartments and/or stands (i.e., areas subjected to similar, identifiable silvicultural actions – to include passively managed stands) within a given year, where logistically feasible. That is, the entirety of an area (e.g., National Wildlife Refuge or Wildlife Management Area) should be completely inventoried within a given year, on a circa 15 year basis. By doing so, managers will be able to make informed decisions and prioritize which stands require silvicultural treatment based on their status with regard to Desired Stand Conditions (Figure 8).

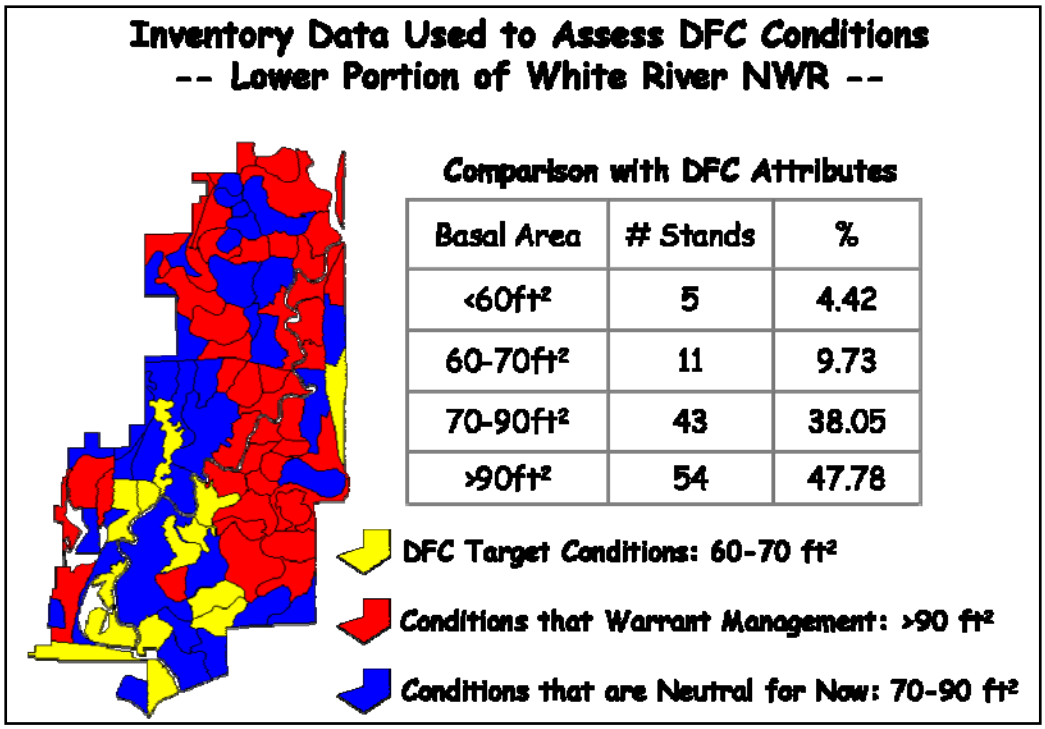


Figure 8. Spatial representation of basal area forest parameter that resulted from a 2005 inventory of 113 forested stands on White River National Wildlife Refuge, Arkansas.

After a comprehensive inventory is complete and habitat conditions are projected into the future, management decisions can be made and appropriate treatments prescribed. Management actions

can also be prioritized to target stands in most need of habitat improvement. If additional data are needed, priority stands can be re-entered to conduct more detailed inventories in preparation for silvicultural treatments. Ideally, stands will be evaluated post-treatment (e.g., 1, 3, 5, 10, 15 years post-treatment) to document and assess vegetative response such that future prescriptions can be modified or adjusted accordingly. If logistical and monetary constraints preclude post-treatment evaluation of all treated stands, we recommend that a sub-set of treated stands be periodically re-evaluated.

To quantify current habitat conditions we recommend a clustered sampling design within which several "clusters" (e.g., plots along a transect) of sample plots are inventoried within each management unit (stand) – see Appendix 4 for example. Cluster sampling is typically more economical because it reduces the amount of travel between survey locations, as well as having greater statistical benefits than simple random sampling. The number of clusters should be determined *a priori* for local landscapes (e.g., a refuge or management area) through the analysis of pilot data to examine the distributional properties and the variability of the parameter(s) of interest. For example, on White River National Wildlife Refuge a test of the coefficient of variation (CV) for density of large trees (≥24 inches dbh) was conducted on pilot data that suggested four clusters, each harboring five $1/5^{th}$ acre plots achieved acceptable precision (i.e., low CV) at a reasonable cost for time and personnel (Appendix 4). At each plot, data should be collected for each of the DFC parameters identified in Table 4, as well as any additional information needed to meet other agency or management plan objectives (e.g., see Appendix 4). Once data are collected in the field, they should be summarized, entered into a data repository, and subsequently linked to spatially delineated polygons within a GIS to facilitate visual interpretation of the data (e.g., decision support tool). Further guidance on establishing a statistically sound inventory system is provided in a prospectus that outlines the ivory-billed woodpecker habitat assessment conducted in Arkansas during 2005 and 2006 (Appendix 4).

Continuous Habitat Monitoring (Monitoring Plots)

Because stand level inventories only reflect a single point in time at a specific location they are generally not suitable for assessing long-term changes in forest composition and structure at landscape scales. Furthermore, stand level inventories (e.g., single assessments) do not permit

land managers to assess and project tree growth, decay, and mortality. Thus to provide the basis for a valid, region-wide assessment of Desired Forest Conditions, we recommend the installation, measurement, and systematic re-measurement of forest parameters on permanent Continuous Forest Inventory (CFI) plots established across all forested habitats on public lands in the MAV. We recognize many partners have already implemented some type of CFI. Therefore, we recommend the continued use of existing CFI plots, although partners may choose to re-distribute or add to these existing CFI plots to ensure representation of all forest types and ecological conditions. For partners that have not implemented a CFI, we recommend establishing new plots based on a stratified random sampling design (with forest type serving as strata).

As with stand level inventories, the number of plots needed to accurately reflect change and yield statistically valid estimates should be rooted in the variability of the system. Unfortunately, analyses to determine sample size for all forest parameters of interest have not been conducted across all landscapes. Based on anecdotal observations and preliminary analyses, we tentatively suggest that ≥1 CFI plot be established for every 300 – 500 forested acres. This would equate to approximately 20 to 30 plots per 10,000 acre landscape and should be within the realm of statistical validity as well as being logistically feasible for local land managers (i.e., 1-2 weeks worth of work). As CFI plots are designed to monitor change over time, CFI plots should be re-surveyed at 5 – 10 year intervals. Moreover, all Continuous Forest Inventory efforts should collect the minimum set of DFC parameters (Table 3; see Appendix 4 for an example data form) in addition to other agency/organization specific data needs.

Wildlife Response

Although we have emphasized the need for forest inventory and monitoring, our ultimate goal is to provide habitat for sustainable populations of wildlife. Throughout this document, we have made many assumptions regarding wildlife response to forest conditions. As such, it is imperative that we verify these assumptions by actually assessing wildlife response to Desired Forest Conditions, such that knowledge learned can be used to modify management actions accordingly (i.e., adaptive management).

Currently we know of no coordinated monitoring efforts designed to assess the impacts of forest management activities on priority wildlife species in the MAV, except for a few site-specific research projects focused on silvicolous songbirds (Twedt et al. 1999, Twedt et al. 2002, Wilson and Twedt 2005, R. J. Cooper unpublished data). As such, we recommend that the conservation community incorporate population monitoring into their day-to-day management activities. Specifically, population monitoring programs need to be designed following the general recommendations previously discussed, such that the direct impacts (both positive and negative) of forest management activities can be evaluated in a manner that facilitates the refinement of assumptions underlying conservation planning and delivery of conservation programs.

To that extent, we offer a detailed prospectus for the implementation of a coordinated monitoring program to evaluate forest breeding bird response to forest habitat conditions (Appendix 5). In brief, we propose region-wide monitoring within a temporally stratified subset of forest stands that have been subjected to silvicultural treatments (including untreated controls). In addition, the minimum vegetation parameters (Table 4) will be assessed within all stands that are monitored for birds. The National Point Count Database (http://www.pwrc.usgs.gov/point) will be used to store avian data, whereas forest vegetation parameters will be entered into the proposed forest management database maintained by the LMVJV office. This avian monitoring program should allow us to test many assumptions regarding wildlife response to Desired Forest Conditions.

Additionally, this avian monitoring program is consistent with the goals put forth by the North American Bird Conservation Initiative's monitoring subcommittee draft interim report (Opportunities for improving North American avian monitoring, http://www.nabci-us.org/aboutnabci/avianmonitoringdraft906.pdf, to improve the current state of bird monitoring in North America. Specifically, their report suggested that the conservation community should: (1) fully integrate monitoring with bird conservation and management to ensure that it is aligned with management priorities, (2) ensure monitoring programs are coordinated among institutions and integrated across spatial scales to effectively solve conservation or management problems, (3) increase the value of monitoring programs by improving their statistical design, and (4)

maintain bird population monitoring data in up-to-date data management systems.

SUMMARY

Use of the above recommendations for inventory and monitoring of key forest attributes during habitat assessments within stands (inventory) and on permanent plots (monitoring) is essential for implementation and evaluation of Desired Forest Conditions. Within each management unit (stand), analysis of current conditions may be used to determine and prioritize the need for silvicultural treatments to enhance habitat conditions towards Desired Stand Conditions. At the landscape scale, the analysis of data from permanent plots will provide an assessment of the regional status and temporal change in Desired Forest Conditions.

Although it is outside the scope of this document to provide detailed monitoring recommendations for all suites of priority wildlife, we hope that information provided on monitoring silvicolous birds will serve as a catalyst for the development of monitoring programs to assess the impact of Desired Forest Conditions on other priority wildlife species.

CHAPTER VI

RECOMMENDATIONS AND CONCLUSION

The concept of wildlife forestry in bottomland hardwood forests is relatively new. Assessment of habitat-related parameters at scales that are appropriate to influence species' populations is complex but achievable. The science of forestry is evolving towards landscape planning and is furthering our understanding of the intricate relationships between forest structure and development. We are poised to make great advances in the restoration and management of bottomland hardwood forests and the diversity of wildlife species that require these forests. Furthermore, if the conservation community is to make strides in fulfilling the habitat needs of species dependent upon extant blocks of bottomland hardwood forest, it is imperative that land managers use their habitat needs to derive management prescriptions. It was our shared goal of population sustainability that led to the development of Desired Forest Conditions for forested wetlands in the MAV. Progress towards attaining this goal can best be achieved in an adaptive manner. As such, a detailed, coordinated monitoring program is imperative. With that goal in mind, we offer the following forest restoration, management, and monitoring recommendations to enhance wildlife habitat.

Specifically, we recommend:

- use of hydrogeomorphic models to guide forest restoration, especially hydrological restoration;
- restoring micro-topography of land-leveled agricultural fields as an integral part of forest restoration;
- use of biologically-based, spatially-explicit decision support tools to determine high priority areas for restoration;
- analysis of existing farm bill programs to improving farm conservation measures on high sites (non-flood prone lands);
- a greater focus on restoring higher bottomland sites to forest cover, while linking these sites with extant and restored forests;
- that all restored sites be sub-soiled prior to planting;

- mixed-species plantings of native hardwood trees (we do not support the use of invasive and/or exotic species) on most sites, with adjustments to single-species plantations where appropriate – especially to promote rapid height development of new forest structure.
- an initial planting density of 435 seedlings per acre, with hard mast species comprising 30 to 60% of the count, especially in areas not expected to have significant natural regeneration within the first 3 years post-planting;
- survival acceptance 3 years post planting be >300 trees per acre, with modified sampling procedures used to account for high density natural regeneration in limited portions of restored site;
- mixing densely planted areas with sparse or unplanted areas. Alternatively, management actions (e.g., group cuts) should be undertaken early in the development of a stand (e.g., circa year 15 post-planting) to ensure areas of sunlight penetration to the forest floor;
- use of the LMVJV's Reforestation Tracking System (online at: http://www.lmvjv.org/RTS_2ways.htm) to document and track reforestation events;
- that 70% to 95% of the forest area within local landscapes be actively managed via sustainable silvicultural practices to attain Desired Stand Conditions (Table 2);
- that 35-50% of forest lands under active management meet the Desired Stand Conditions (Table 2) at any given point in time;
- that emphasis be placed on recognizing specific site limitations relative to the presence and abundance of specific woody (e.g., oaks) and non-woody species (e.g., cane);
- implement overstory thinning or other methods of inducing larger canopy gaps or sparse overstory cover to encourage proliferation of cane on appropriate sites;
- identify areas for cane reintroduction and advance restoration techniques;
- retention within harvested stands of snags and a portion of stressed/dying trees that contain or are likely to develop cavities, with care taken to minimize damage to cavity trees during harvests;
- targeting a small proportion (<20%) of most forest stands for regeneration of shade-intolerant tree species through small, silvicultural induced gaps;
- leaving an average of 2 to 4 trees per acre of species and individuals that will most rapidly attain dominant crown position;

- up to 5% of the actively managed forest should be in shrub-scrub habitat with no more than 10% of the landscape comprised of regenerating forests (i.e., clearcuts <1/3rd site dependant height) (Table 2). An exception being reforestation of large agricultural tracts wherein the overall goal of achieving 70 – 95% forest within a landscape overrides the 10% limitation placed on regenerating forests;
- if shrub-scrub habitat is of high importance in your local landscape, use focused, active management (i.e., periodically set back succession via mowing, burning, etc.) on a specific site to maintain early successional habitat;
- 5 – 30% of the landscape encompassing a broad representation of forest types be passively managed to serve as experimental controls for management activities;
- land managers implement forest management prescriptions to attain, retain, and maintain Desired Stand Conditions (Table 2), while still operating in a sustainable manner that produces tangible benefits to silvicolous wildlife and quality timber products;
- use inventory and monitoring programs to ascertain current conditions of forests, guide prescription development, and assess temporal changes within forest and their associated wildlife and fisheries resources;
- standardizing primary monitoring methodologies to allow effective analysis of MAV forest conditions, based upon coordinated exchange of data across political boundaries and ownerships.

From the onset, our objectives were to: (1) define desired forest conditions that reflect the collective needs of priority wildlife species; (2) provide technical recommendations for the restoration of bottomland hardwood forest; and (3) recommend protocols and procedures for implementing coordinated inventory and monitoring programs, such that management actions can be evaluated in an adaptive manner. To accomplish these objectives, we have utilized a vast array of information published in scientific journals, as well as, the cumulative knowledge and experience of on-the-ground biologists, foresters, land managers, and researchers. It is our expectation, that these recommendations will facilitate continued discussions among biologists, foresters, land managers, administrators and academia that result in improved habitat conditions for priority wildlife species. Furthermore, we hope this document provides a framework that allows restoration and management to be implemented in an adaptive manner via implementation

of forest management prescriptions that reflect DFC parameters, coordinated inventory and monitoring efforts and targeted research to address underlying assumptions and forest metrics that influence wildlife habitat suitability.

GLOSSARY

Actively Managed Forest: *Forests that are manipulated or have a history of manipulation to obtain forest products and/or provide wildlife habitat.*

Basal Area: *An area (ft^2, m^2) per unit area (acre, ha) measure of the "foot print" occupied by trees. Basal area (BA) alone is not an accurate indicator of forest structure. In most stands, BA levels >90 ft^2 / acre are generally relatively dense with trees having a closed overstory canopy. When communities exhibit large stem diameters but small, disintegrating crowns (e.g., baldcypress – water tupelo), higher ranges of BA may be appropriate. Conversely, in communities with large stem diameters and large spreading crowns (e.g., overcup oak – bitter pecan) a lower BA may be appropriate.*

Clearcut: *A treatment that results in the removal of ≥ 80% canopy cover over an area > 7 acres in size.*

Coarse Woody Debris: *Dead wood on forest floor measured in volume (ft^3) per unit area (acre) usually by diameter class. Diameters of >10 inches are preferred due to their longer retention within a stand and inhabitation by a more varied community of decomposers.*

Diameter: *Diameter at breast height (dbh); diameter of tree outside the bark measured at 4. 5 feet (1. 3 m) above ground on uphill side of tree.*

Dominant Trees: *Trees with full sunlight available to the top and portions of the sides of their crown; slightly (25% of the crown) above the general forest canopy (Dictionary of Forestry, J. A. Helms, SAF). Dominant trees are sometimes referred to as "emergent" trees by wildlife biologists, but emergent trees may not be possible in some community types without management efforts to express this attribute.*

Forest Cover: *In a landscape context, lands that are covered by forest vegetation at any seral stage. Society of American Foresters defines forest cover as having >25% tree crown coverage.*

Group Selection: *In an uneven-aged forest management system, a regeneration method that involves the clearing of forest in group cuts or corridors throughout the stand with a focus on providing sufficient light to stimulate development of understory vegetation and regeneration of*

shade–intolerant species. Although there is not an acreage or dimension specification on opening size, width of cuts generally do not exceed more than two times the height of the dominant forest.

Landscape: *An area of ≥10,000 acres (≥4,000 ha). To support priority wildlife species, landscapes should be largely forested and harbor several forest community types. Landscapes are matrices of large forested areas, smaller forested parcels, and their intervening spaces.*

Large Cavities: *Sound or unsound stems with a cavity hole ≥10 inches (25 cm) in diameter.*

Midstory Cover: *The middle layer of the forest, generally between 10-60% of canopy height. Measure of the degree of horizontal occupancy of cover (volume in space noted as midstory) within forest midstory.*

Overstory Canopy Cover: *The uppermost canopy level of a forest comprised of tree crowns. Within a stand, overstory canopy cover is a measure of the degree of structure blocking light penetration to lower levels of the forest.*

Passively Managed Forest: *Passive management occurs on lands with limited anthropogenic manipulations (e.g., forest reserves, natural areas, wilderness areas, inoperable stands, etc.). Several different forest type communities should be represented in this acreage. When embedded within actively managed forests, narrow strips of "unmanaged" habitat (e.g., streamside management zones) are generally not considered to be passively managed.*

Regenerating Forest: *A component of the managed forest landscape that has been manipulated to promote forest regeneration (particularly of shade-intolerant species) through removal of >80% of forest canopy (i.e., clearcuts) or through restoration on agricultural lands. Forests are considered regenerating until canopy trees achieve >1/3 of their anticipated, site dependent height.*

Shade-intolerant Regeneration: *Because most forest communities succeed to more shade-tolerant species without perturbations that induce increased light penetration, management should strive to ensure continued advanced regeneration of shade-intolerant species in sufficient numbers (400 stems per acre, Hart et al. [1995]) across 30 – 40% of a stand to ensure retention*

of these species in future stands. A minimum of 40% of the regeneration stocking should be hard mast species, such as oaks and pecans.

Shrub / Scrub: *Thamnic vegetation dominated by short woody plants. This structure may be ephemerally created through seral stage development within managed forests, maintained via periodic prescribed disturbance, or naturally occur as semi-permanent shrub-scrub habitats (e.g., buttonbush/swamp privet). However, hydric and mesic shrub-scrub habitats typically support different faunal communities.*

Small Cavities: *Cavities (holes) in sound or unsound stems that are ≥1 inch but <10 inches in diameter.*

Standing Dead / Stressed Trees: *Dead stems or stems that show signs of stress which suggest that they will die and "fall out" of the stand within 5-10 years.*

Tree Stocking: *A measure of the number of trees in relation to their size class. An average stocking level of 60 – 70% is appropriate but management should be implemented with stands below 50% or above 90%. Bottomland hardwood forest management experience is currently a better guide in determination of this variable than are published stocking guides*

Understory Cover: *Measure of cover (volume in space defined as understory) within forest understory between 0 – 10% of canopy height. Canopy cover is a measure of the degree of horizontal coverage through lower levels of the forest.*

Variable Retention Harvest: *Forest management that removes forest canopy through thinning and/or group selection harvests with the intensity of canopy removal differing spatially within a stand. Trees are retained to meet specific ecological objectives such as maintaining structural heterogeneity or protecting biological legacies (Mitchell and Beese 2002) and not solely to maximize their growth potential.*

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Appendix 1. Participants in the Lower Mississippi Valley Joint Venture's Forest Resource Conservation Working Group.

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Charles Baxter	U. S. Fish and Wildlife Service, Lower Mississippi Valley Joint Venture Office	LMVJV Coordinator
Martin Blaney	Arkansas Game and Fish Commission	Habitat Coordinator
Billy Burchfield	Louisiana Departmentof Wildlife and Fisheries	Biologist/ Wildlife Forester
Cody Cedotal	Louisiana Department of Wildlife and Fisheries	Biologist/ Wildlife Forester
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Bob Cooper	University of Georgia	Professor Avian Ecology
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Appendix 1. Continued.

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Leif Karnuth	U. S. Fish and Wildlife Service, West Tennessee Refuge Complex	Administrative Forester
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Appendix 1. Continued.

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Appendix 1. Continued.

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Nancy Young	Natural Resource Conservation Service, Arkansas	State Forester
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Appendix 2. Overview of cane ecology and management.

Management of Cane in Bottomland Hardwood Forests

Paul Gagnon, Louisiana State University

Canebrakes provide critical habitat for numerous bottomland hardwood forest species (Platt et al. 2001). A century ago, canebrakes were known as a last refuge for black bears, Florida panthers (*Puma concolor* subsp. *coryi*) and other game species (Roosevelt 1908). Canebrakes are still prime habitat for the threatened Louisiana black bear and several migratory birds including American Woodcock (*Scolopax minor*), Swainson's Warbler (*Limnothlypis swainsonii*) and Hooded Warbler (*Wilsonia citrina*) (Thomas et al. 1996, Moorman et al. 2002). The rare and possibly extinct Bachman's Warbler (*Vermivora bachmanii*) and at least six satyrine and skipper butterflies are also considered cane obligates (Remsen 1986, Brantley and Platt 2001).

Ecology of Canebrakes

Cane (*Arundinaria gigantea*) is the only bamboo native to the United States. Cane can be divided into two subspecies (Judziewicz et al. 1999). Switch cane (A. *gigantea tecta*) is the short-stature (typically < 2 m) subspecies found along the Atlantic and Gulf Coastal Plains. Giant cane or river cane (A. *gigantea gigantea*) is the larger subspecies, frequently producing culms 5 to 6 m tall and occasionally 8 m in fertile soils. Giant cane is found in bottomlands and along creeks and ravines throughout the southeastern United States including the Mississippi Alluvial Valley (MAV). Within the MAV, canebrakes occurred primarily on the highest ground along ridge-tops and levees (Platt and Brantley 1997). Today cane can be found growing on virtually any ground not subject to prolonged inundation (Marsh 1977). Cane attains its largest size on the most fertile soils, and common lore among early settlers was that the ground under the biggest cane grew the best crops (Platt and Brantley 1997).

Like many bamboos, cane grows clonally for years before it flowers and dies (Hughes 1951, Judziewicz et al. 1999). The time it takes for a cane seed to germinate, grow to full size, flower and die is unknown. The interval may be 20 years or more, which is typical of woody bamboos (Judziewicz et al. 1999). Cane can flower as individual culms, in small patches, or en masse.

Sparse or isolated flowering typically leads to little or no seed-set (Gagnon 2006). In contrast, large-scale flowering can produce millions of fertile grains, which sprout the same growing season they are produced, cane seedlings being inconspicuous and resembling many small understory grasses (Hughes 1951). Additionally, juvenile cane plants grow for several years before culms attain full-size (Gagnon 2006).

Like all bamboos, cane is a giant forest grass (Judziewicz et al. 1999). Stands of cane inevitably decline in the deep shade of closed forest canopy, although sparsely distributed stems can persist for years in such an environment. Cane stands need at least partial sunlight to maintain dense, canebrake-like structure; however culms of giant cane grow tallest in shade. Whereas, culms are shorter but grow more densely in full sunlight (Gagnon 2006). Hughes (1957) concluded that stands of switch cane in North Carolina gradually declined after several years of vigorous growth, and stands of giant cane in the MAV appear to follow a similar pattern. However, this decline can be avoided or reversed if cane is periodically burned (Hughes 1958, Gagnon 2006).

Ecological disturbances appear to dictate much about cane's clonal growth. Over ecological time, natural and human-caused disturbances were prevalent and diverse in the MAV. Tornadoes, hurricanes, violent thunderstorms and ice-storms all knocked down forest canopy. Flooding from the Mississippi River and its tributaries damaged forests, as did flooding from beaver dams. Fires (whether natural or anthropogenic) were also occasional disturbances. With its capacity for rapid clonal growth, ability to persist in shade, and preference for higher-light environments, cane could potentially exploit virtually any forest gap in the MAV on non-inundated land.

RESTORING CANEBRAKES

There are essentially three possible pathways for restoring canebrakes in the MAV. The first way is to restore already-present but sparsely growing cane. The second is via vegetative propagation – full-sized cane or rhizomes can be transplanted from another location. The third is to plant cane from seeds collected elsewhere.

Canebrake restoration can be straightforward when diffusely-growing cane is already present. The cane may only need a more favorable environment to form dense thickets. At least partial sunlight is critical for development of cane thickets. At best, cane growing in deep shade will persist for years as occasional, sparsely-distributed stems. In such cases, thinning the overstory can promote the growth of higher-density cane stands. Cane is somewhat shade tolerant, and on a favorable site it can grow into high-density patches in the forest gaps commonly left by uneven-aged silviculture. Expansive canebrakes, however, require large canopy gaps or a sparsely stocked overstory.

Increased light alone will not ensure the persistence of canebrakes. Hughes (1957) reported that stands of switch cane naturally senesced after a period of years, and a study of giant cane in the MAV yielded a similar result (Gagnon 2006). Hughes (1957) suggested burning stands of switch cane at intervals of 7 to 10 years to maintain them at high density. Giant cane in the MAV likewise benefits from this treatment (Gagnon 2006). Burning simultaneously stimulates vigorous sprouting of new cane culms, returns nutrients to the soil, and reduces competition from other plants. Where stand densities are too sparse for fire to spread naturally, or where natural fires are likely to be outside of management prescriptions, cane can be cut, dried in place for a week or two, and then burned. Where prescribed burning is not feasible for reasons of policy or logistics, cutting cane without burning it may offer some, though not all, of the benefits. However, this has not been tested experimentally. A combination of overstory thinning and periodic prescribed fires should maximize cane vigor and stand density.

Where cane is not already present on a site, it can be transplanted from elsewhere. This method of canebrake restoration has met with mixed results. One experienced source who has overseen both failed and successful cane transplantations suggests that rhizomes be transplanted as large root wads (30-45 cm in length) with as much intact soil as possible (Kelby Ouchley, personal communication). When transplanting root wads, Ouchley urges great care be taken to avoid introducing invasive competitors. Even well-established cane can be drought sensitive. Transplanted cane will survive and establish better if irrigated during dry periods. Reliable establishment from rhizomes may take 2 or more years. Ouchley speculates that difficulty

establishing cane on reclaimed agriculture fields may result from the absence of some critical mycorrhizal symbiont. More research on this aspect of cane biology is needed.

One cane restoration project in Missouri used cane transplanted in two-gallon root wads. After two years, the cane had established and was spreading, despite substantial competition from vines (Shively et al. 2002). Each transplanted soil wad originally had 1-4 attached culms. Some were treated by cutting off all culms prior to transplanting. These produced fewer new culms and survived less frequently than those transplanted with culms intact. Cane growth accelerated in the year after a flood temporarily inundated it under as much as 4.5 m of water. The authors speculated that cane growth accelerated because the flood reduced vine competition.

Cane can be transplanted as individual rhizomes if treated appropriately. A series of studies in southern Illinois used cane rhizomes cut into lengths of 20-30 cm, planted into greenhouse pots and treated with a regimen of frequent water misting (Zaczek et al. 2004, Hartleb and Zaczek in press). After one month in the greenhouse, more than three-fourths had sprouted at least one culm. Rhizome segments with 10 or more nodes sprouted more culms than rhizome segments with fewer nodes. Rhizomes collected in early spring outperformed those collected in either fall or late winter, but fall- and winter-collected rhizomes still sprouted frequently. Transplanted to restoration sites, culms from these sprouted rhizomes had established and spread substantially after 3-4 years. Although competition from other plants influenced cane growth after transplantation, pre-treating the restoration site with herbicide to kill competitors did not improve cane success. In the study, establishment success varied significantly by both donor sites and transplantation sites. After testing several transplantation methods, the best was to plant each rhizome distal-end up with multiple nodes and buds above ground level and exposed to light. Using this method, sprouting rates exceeded two-thirds even for rhizomes stored for one month in moist refrigeration. Results suggested that successful transplantation is possible even without first sprouting rhizomes in a greenhouse (J. Zaczek, personal communication).

Successful establishment of transplants is only the first step toward full canebrake restoration. As described above, established cane requires at least partial sunlight and periodic disturbance to attain canebrake-like stand structure. Eventually, long-term re-establishment of cane on a given

site will require successful flowering and seed production. Existing evidence suggests that out-crossing may be necessary for successful seed set. Long-term restoration success from transplanting may require that multiple genetic individuals eventually flower in-phase years later. Cane can be reintroduced from seed. Cane flowers infrequently, and procuring a large quantity of viable seeds may require some luck and good contacts where cane is abundant. With that said, cane flowers more frequently than a casual observer is likely to notice. Where cane is prevalent, widely scattered pockets of it may be flowering during any given spring or summer (Hughes 1951). Unfortunately, many of these scattered flowerings do not frequently set fertile seed (Gagnon 2006). Occasionally cane can be found flowering en masse. These events may produce millions of plump, fertile grains in the late spring. Instead of producing the usual flush of new leaves in the early spring, flowering cane will appear straw-brown as though dying. Upon closer inspection, flowering culms will be covered with inflorescences resembling heads of rice or wheat. In Louisiana, cane seeds ripen in late April or early May. This timing may be later farther north in the MAV. Cane seed-heads progress quickly from green to ripe. Once ripe, heads shatter easily and drop seeds in even a slight breeze (Hughes 1951), so frequent monitoring of flowering patches is necessary if collecting ripe seed is a goal.

Cane seeds can be planted by pressing them lightly into moist soil. Cane seeds have no dormancy, and the best germination rates result from planting soon after seeds are harvested. Even so, some seeds should remain viable for a year or more if sealed and refrigerated – in one instance 50% of seeds sprouted after18 months in refrigerated storage (M. Cirtain, unpublished data). Chances of success are maximized by planting seeds in moist, well-drained soils (Cirtain et al. 2004) under partial shade (Gagnon 2006). Seedlings can also be started in a greenhouse and then transplanted out the following growing season (Cirtain et al. 2004). Seedlings are susceptible to drought and do best in soil with an organic component. Accounts conflict whether cane seedlings benefit from fertilization (Hughes 1951, Cirtain 2004). Growth of cane seeds into adult plants is undocumented, but most bamboos require 3-7 years to reach full size (Judziewicz et al. 1999), and cane appears to follow a similar pattern (Hughes 1951, Gagnon 2006). Without careful monitoring, cane seedlings are inconspicuous, and positive results may require five or more years to manifest. Planting a large number of cane seeds may be the best way to ensure long-term canebrake restoration. The seedlings will grow up as a cohort and should be in-phase

for flowering when that time comes years later. Cane seedlings are somewhat shade tolerant, but to attain dense stand structure they will need at least partial sunlight and periodic disturbance as they mature.

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Appendix 3. Desired forest conditions for bottomland hardwood forests within the Mississippi Alluvial Valley (metric units).

Forest variables [1]	Desired stand structure	Conditions that may warrant management
Primary Management Factors		
Overstory canopy cover	60 – 70 %	>80%
Midstory cover	25 – 40 %	<20% or >50%
Basal area	13.7 – 16 m^2/ha with ≥25% in older age classes[2]	>20.6 m^2/ha **or** ≥60% in older age classes
Tree stocking	60 – 70 %	<50% or >90%
Secondary Management Factors		
Dominant trees[3]	>5/ha	<2.5/ha
Understory cover	25 – 40%	<20%
Regeneration[4]	30 – 40% of area	<20% of area
Coarse woody debris (>25cm diameter)	≥14 m^3/ha	<7 m^3/ha
Small cavities (hole <25cm diameter)	>10 visible holes/ha **or** >10 "snag" stems/ha ≥ 10cm dbh **or** ≥5 stems/ha > 51cm dbh	<5 visible holes/ha **or** <5 snags/ha ≥ 10cm dbh **or** <2.5 stems/ha ≥ 51cm dbh
Den trees/large cavities[5] (hole >25cm diameter)	One visible hole/4 ha **or** ≥5 stems/ha ≥ 66cm dbh (≥1.8 m² BA/ha ≥ 66cm dbh)	No visible holes /4 ha **or** <2.5 stems/ha ≥ 66cm dbh (<0.9 m² BA/ha ≥ 66cm dbh)
Standing dead and/or stressed trees [5]	>15 stems/ha ≥ 25cm dbh **or** ≥5 stems/ha ≥ 51cm dbh (>0.9 m² BA/ha ≥ 25cm dbh)	<10 stems ≥25cm dbh/ha or <2.5 stems/ha ≥ 51cm dbh (<0.5m² BA/ha ≥ 25cm dbh)

Appendix 3. Continued.

[1] Promotion of species and structural diversity within stands is the underlying principle of management. Management actions should promote vines, cane and Spanish moss within site limitations.

[2] We view "older age class" as those stems approaching biological maturity. We do not advocate coring for defining age but instead using species/site/size relationships as practical surrogates to discern age.

[3] Dominants (a.k.a. emergents) should have stronger consideration on more diverse sites, such as ridges and first bottoms.

[4] Advanced regeneration of shade-intolerant trees in sufficient numbers (ca. 1,000/ha) to ensure their succession to forest canopy. Areas lacking overstory canopy (i.e. group cuts) should be restricted to <20% of stand area.

[5] Utilizing BA parameters allows the forest manager to maintain this variable in size classes most suitable for the stand, versus pinpointing specific size classes as noted.

Appendix 4. Example of a forest inventory designed to assess habitat conditions.

PROSPECTUS FOR IVORY-BILLED WOODPECKER HABITAT ASSESSMENT

Randy Wilson, Kenny Ribbeck, Jeff Denman, Eric Johnson, Martin Blaney, and Chuck Hunter with statistical assistance from Ken Reinecke

BACKGROUND: In 1942 James Tanner provided the most comprehensive life history account of the Ivory-billed Woodpecker (IBWO) throughout its historic range and the only in-depth, ecological investigation conducted on a population of IBWO. Tanner's observations of the Singer Tract population of IBWO led him to hypothesize that foraging habitat was the limiting factor of habitat occupancy and possibly of population growth. Tanner went on to describe foraging habitat as recently dead trees (<4 years) with 84% of the foraging observations occurring on trees 12-36 inches in diameter. Unfortunately, this is the only published work detailing habitat characteristics associated with the occupancy of IBWO.

Since Tanner's publication, there have been numerous reports of IBWO sightings across the southeast, but none have had the benefit of being confirmed by a series of "re-sightings" or by locating a "base-activity" site (i.e., roost or nest site). The confirmed rediscovery of the IBWO in the Cache/Lower White River basin of Arkansas has set in motion a series of conservation actions. Key among these activities is the continued search effort led by Cornell Lab of Ornithology. As the Cornell staff and their partners continue to search and document evidence (e.g., sightings and sound recordings), it is imperative that a concurrent habitat inventory and assessment be conducted to facilitate the search efforts and to document existing habitat conditions.

OBJECTIVE: The purpose of this inventory is to quantify current habitat conditions on public lands within proximity to recent Ivory-billed Woodpecker (IBWO) sightings and audio recordings and areas perceived to likely harbor IBWO based on local land manager knowledge. These data will then be used to: (1) develop a spatially-explicit decision support model to

facilitate search efforts, (2) provide ground-truth data to enhance accuracy of remotely-sensed data, and (3) provide land managers with a basis for making management decisions.

STUDY AREAS: The areas to inventory include public lands in proximity to previous sightings and audio recordings in the Big Woods area of eastern Arkansas; which includes the Bayou DeView area of Cache River National Wildlife Refuge, Jacks Bay and Prairie Lake area of White River National Wildlife Refuge and the entirety of Dagmar Wildlife Management Area. Additionally, time and manpower permitting we propose to inventory additional areas perceived to be providing "suitable" IBWO habitat based on local land manager knowledge. These additional areas potentially include: other areas on White River National Wildlife Refuge and Cache River National Wildlife Refuge, Bayou Meto Wildlife Management Area, Wattensaw Wildlife Management Area, Rex Hancock/Black Swamp Wildlife Management Area, and Henry Gray/Hurricane Wildlife Management Area.

SAMPLING FRAMEWORK: This habitat inventory will cover bottomland hardwood forest (excluding reforestation and bodies of water [e.g., oxbow lakes]) within the boundaries of the individual Wildlife Management Areas and National Wildlife Refuges previously identified. Within these public lands, the inventory will focus primarily on areas with evidence of IBWO existence (e.g., sightings and or auditory recordings): Bayou DeView area (ca. 10,000ac) of Cache River NWR, Jack's Bay and Prairie Lakes region (ca. 60,000ac) of White River NWR, and the entirety of Dagmar WMA (ca. 10,000ac). However, additional areas (ca. 10-20,000ac) may also be assessed in a preemptive manner to facilitate search efforts to locate the bird(s).

Due to the large acreage of interest, the inventory will be sample-based. That is, sampling effort will be allocated and conducted in such a manner to reduce the amount of time, manpower cost, and potential disturbance, all the while maintaining a level of statistical precision in the data. To accomplish this, individual management compartments within the area of interest will be broken down into homogenous stands approximately 500 acres in size (Fig. 1). Each management compartment and stand will be digitized to create a GIS shapefile for use in the allocation process, as well as, in analysis of the data.

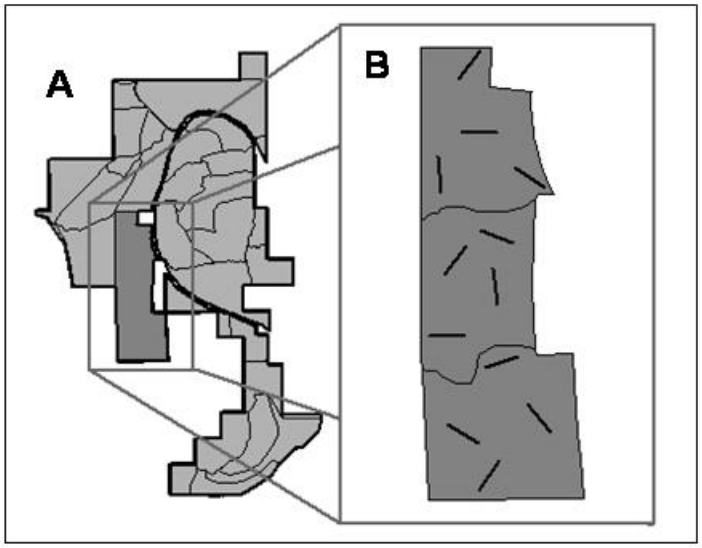

Figure 1. Schematic demonstrating: (A) the delineation of management compartments within a management area; and (B) the delineation and allocation of sampling units within stands across a management compartment.

SAMPLE SIZE DETERMINATION: As with any sampling effort, there are trade-offs in terms of cost (e.g., number of samples and manpower) and the reliability of the data. That is, collect too few samples and the data lack statistical power to provide precise parameter estimates. Whereas, on the other extreme, there is a point where no additional precision can be obtained regardless of the number of samples taken. One means of assessing these trade-offs is to examine pilot data collected from the area of interest to generate summary statistics that provide insight into distributional properties of the data. In particular, the coefficient of variation (CV) is the population quantity on which sample size depends when one desires to control the relative precision of the data (Thompson 1992; Sampling. John Wiley and Sons Inc. 343pp).
To facilitate the determination of sample size requirements for conducting habitat inventories for Ivory-billed Woodpeckers (e.g., the density of large diameter trees [≥24inches]; density of dead/dying trees), pilot data from White River NWR was subjected to sensitivity analyses to assess precision (i.e., stability of coefficient of variation values) under different sample sizes. To accomplish this, we subjected the pilot data (n=15 clusters of 5, 1/5th acre plots) to simulation models that randomly selected clusters of points at varying sample sizes and generated summary statistics for the parameter of interest (e.g., density of trees ≥24 inches in diameter at breast height [dbh]). In these simulations, CV values were calculated for sample sizes of 2, 3, 4, 5, 6, 8,

and 10 clusters by randomly selecting clusters and then replicating the procedure 10 times. Simulations resulted in the calculation of 10 CV values for each sample size (Fig. 2). The simulations revealed great variation in precision estimates (e.g., CV values) for sample sizes ≤3; whereas sample sizes ≥6 demonstrated little variation in the precision estimates (Fig. 2). Precision estimates calculated for sample sizes of 4 and 5 clusters were similar in the amount of variation expressed in the replicates and also produced acceptable levels of precision (i.e., none exceeded 15%).

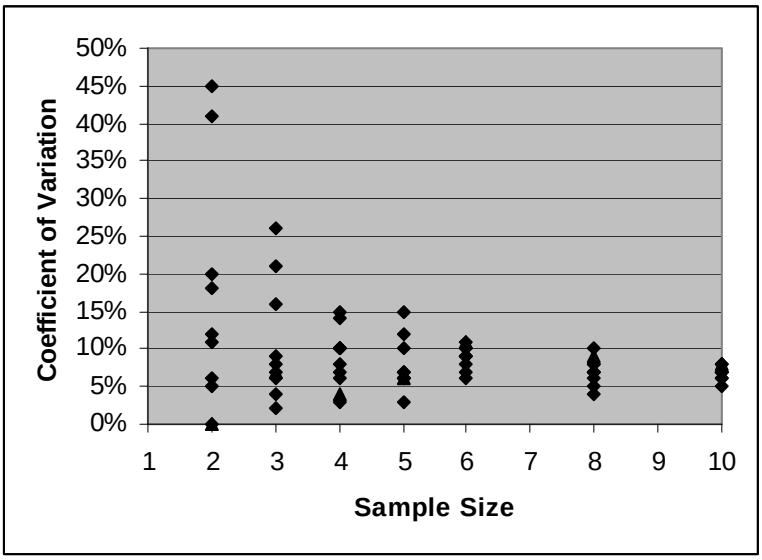

Figure 2. Sensitivity analysis to assess implications of sample size (e.g., number of clusters) on the coefficient of variation for density of large trees (≥24inches dbh) based on pilot data from White River NWR.

Given the current funding constraints, availability of manpower, the large area of interest in the Big Woods of Arkansas (Cache River NWR, White River NWR, and Dagmar WMA) and the desire to maintain an acceptable level of precision (i.e., low CV values) in parameter estimates, a sample size of 4 clusters per sampling unit (e.g., stand) appears to be the best option. That is, sample sizes of ≤3 clusters were not sufficient to consistently produce a high level of precision. Where as, sample sizes ≥4 clusters produced precise parameter estimates with sample sizes ≥6 clusters being very precise in the parameter estimates. Due to the constraints described above, it seems reasonable to opt for a sample size of 4 or 5 clusters given that both continuously produced acceptable levels of precision (e.g., CV ≤15%). A closer examination of CV values for

these two sample sizes reveals nearly identical CV values produced during simulation analyses, suggesting that a sample size of four clusters is sufficient to maintain the desired level of precision in parameter estimates.

MARGIN OF ERROR: Although the final precision estimates will be determined by the larger, more comprehensive data set, sensitivity analyses of the pilot data set suggest that a sample size of 4 clusters could reasonably be expected to produce parameter estimates within 15% of the true mean 95% of the time when the sample CV=10% (Table 1). Alternatively, if the probability level was lowered to 90% (P=0.10), parameter estimates would approach a 10% margin of error with a CV of 10% (Table 1).

Table 1. Sample size in relation to margin of error and coefficient of variation (n=4; P=0.95).

Estimated Number of Clusters (Transects)*				
		P=0.05; CV=10%		
Strata	Area	Margin of Error ± 10%	Margin of Error ± 15%	Margin of Error ± 20%
x	~500 acres	8	4	2
		P=0.05; CV=15%		
Strata	Area	Margin of Error ± 10%	Margin of Error ± 15%	Margin of Error ± 20%
x	~500 acres	17	8	5
		P=0.10; CV=10%		
Strata	Area	Margin of Error ± 10%	Margin of Error ± 15%	Margin of Error ± 20%
x	~500 acres	5	2	1
		P=0.10; CV=15%		
Strata	Area	Margin of Error ± 10%	Margin of Error ± 15%	Margin of Error ± 20%
x	~500 acres	10	5	3

* Sample size calculated using the following formula: $((cv*t)/e)^2$ where cv=coefficient of variation; t=t-statistic based on 3 degrees of freedom; and e=the margin of error.

ALLOCATION OF SAMPLES: From the sensitivity analyses of pilot data, it was determined that cluster sampling yielded equivalent or higher levels of precision in parameter estimates than

a simple random sampling scheme. Thus, we propose to allocate samples within a stand using cluster-sampling procedures. For example, plots will be allocated using point-transects where each transect contains five, 1/5th acre plots (52.7 ft radius) spaced four chains (264 ft) apart (Fig. 3) and each stand contains four randomly allocated point-transects (Fig. 1B). Additionally, the use of cluster sampling reduces the amount of travel time required to move from point to point, thus increasing the overall cost efficiency of the inventory. It is also important to note that these transects are flexible. That is, if at some point along the route a barrier is encountered (e.g., oxbow lake) the observer has the flexibility to randomly alter the route such that all plots are conducted.

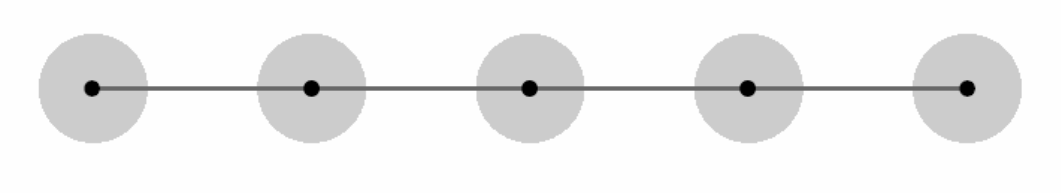

Figure 3. Schematic of a point-transect depicting a cluster of five, 1/5th acre plots spaced four chains (264 ft) apart upon which habitat metrics will be sampled.

PARAMETERS TO BE COLLECTED: Based on data provided in Tanner (1942) and discussions with Martjan Lammertink, (Cornell Lab of Ornithology Post-Doctorate Student), it is assumed that site-scale IBWO habitat occupancy is influenced by the density of large trees (≥24 inches dbh) and the amount of dead/dying wood often associated with high densities of larger diameter trees (e.g., crown dieback, over topped stressed trees). To inventory and assess habitat in the areas of interest (e.g., sightings and/or sound recordings) and other areas perceived to meet these criteria (as noted by local land managers) we propose to collect data on forest metrics listed in Table 2. It is believed that these metrics will provide both a quantitative estimate of parameters of interest, as well as, additional qualitative estimates that will facilitate the characterization of IBWO habitat, based on our limited knowledge. Furthermore, these data are also expected to provide additional benefits in terms of assessing habitat quality for other priority wildlife species (e.g., Swainson's Warbler).

DATA RECORDING AND PROCESSING: All data is to be collected on tally sheets (Table 3) in the field and subsequently entered into Microsoft Excel spreadsheets. Data must be

correctly entered into Microsoft Excel spreadsheets following the desired formats. Upon completion of data entry and quality assurance checks, all data is to be promptly forwarded to the Lower Mississippi Valley Joint Venture Office for analysis. If data cannot be entered into Microsoft Excel spreadsheets for some reason, field observers should contact Randy Wilson (randy_wilson@fws.gov; 601.965.4903 ext 15) for assistance with data entry.

DATA ANALYSIS AND REPORTING: Data will be analyzed using SAS statistical software to generate summary statistics for all parameters. Parameter estimates will be generated for each stand, management compartment, and for the area of interest (e.g., entirety of Dagmar WMA, Bayou DeView area of Cache River NWR, Jacks Bay / Prairie Lakes region of White River NWR). After summary statistics are calculated, parameter estimates will be appended to GIS shapefiles depicting management compartments and stands to develop spatially explicit decision support models to facilitate search efforts. Summary reports will be provided to Arkansas Game and Fish Commission, Cache River NWR, White River NWR, Cornell Lab of Ornithology, U.S. Fish and Wildlife Service, Southeastern Regional Office and other entities as deemed appropriate.

Table 2. Parameters and definitions of metrics to be collected during the habitat inventory and assessment project in the Big Woods of Arkansas.

Parameter	Sample Area	Value	Comments
Tree Species	1/5th Acre	Alpha Code for Tree Species; Appendix 4	All trees ≥ 10" dbh
DBH	1/5th Acre	2" classes (9.0" – 10.9" = 10")	
Length in feet or # of logs	1/5th Acre	Dead or down wood: 5' increment. Cruiser option: 1 – 4.5 in half-log increments if sawlog, 5' increment for pulpwood.	Required for dead wood. *Cruiser option on # of logs*.
Crown Class	1/5th Acre	D = Dominant C = Co-dominant I = Intermediate S = Suppressed X = Dead	
Tree Condition	1/5th Acre	1 = No dieback (not very common) 2 = Lower crown dieback, natural pruning 3 = < 1/3 top crown dieback 4 = > 1/3 top crown dieback 5 = Recently dead, retains many twigs 6 = Dead, retains only large limbs 7 = Dead, only bole remains, ≥ 5' tall 8 = Down wood ≥ 8" @ 3' from base	
Stress Factor: Epicormic Branching	1/5th Acre	1 = Little to None (<20% of bole) 2 = Moderate (20% - 50% of bole) 3 = Heavy (≥ 50% of bole)	Bole is portion of tree beneath the crown.
Stress Factor: Bark Disfiguration: Ex: bleeds, tannin stains; bug holes; frass, conks	1/5th Acre	1 = Little to None (<20% of bole) 2 = Moderate (20% - 50% of bole) 3 = Heavy (≥ 50% of bole)	Ex: Red Oak w/ blocky bark; Ash w/ smooth bark; Rot; Bare wood from beaver, skinning, etc.
Overstory Canopy Cover	Visible Range	1 = < 50% 2 = 50% - 80% 3 = > 80%	Vertical sunlight blockage
Midstory Cover	Visible Range	1 = < 25% 2 = 25% - 60% 3 = > 60%	Horizontal vision blockage, 10' – 30' height
Understory Cover	Visible Range	1 = < 25% 2 = 25% - 60% 3 = > 60%	Horizontal vision blockage, < 10' height
Vines	Visible Range	1 = Sparse (<25% [1 of 4 overstory trees]) 2 = Moderate (25-50% [2 of 4 trees]) 3 = Heavy (>50% [3 of 4 overstory trees])	# of dominant or co-dominant trees with vines on the bole and/or canopy

Table 2. Continued…

Cane	Visible Range	1 = None 2 = Sparse (1% - 25% area coverage) 3 = Heavy (> 25% area coverage	
Station Option Shade-intolerant regeneration	Visible Range	Alpha Code for Tree Species; Appendix 4	Sufficient presence to occur if released
Potential IBWO cavity	Incidentally on Unlimited Area	A = very large irregular oval or rectangle, 4.5" x 5.5". Record tree species, DBH, height to cavity, face (north, west, etc.) and GPS coordinates (UTM, NAD 83).	Cavity size follows Cornell Lab of Ornithology.
Potential IBWO Bark Scaling	Incidentally on Unlimited Area	Extreme horizontal gouges of tight bark. Record tree species, DBH, height to cavity, face (north, west, etc.) and GPS coordinates (UTM, NAD 83).	
IBWO sighting or hearing of kent calls or double knocks	Incidentally on Unlimited Area	Record GPS coordinates UTM, NAD 83. Also direction and estimated distance to sighting or sound. ASAP contact inventory coordinator	

Table 3. Data sheet for collection of Desired Forest Condition parameters.

Location Data:

Date:_____ Crew:_____
Location:_____ Unit:_____ Stand:_____ Line#:_____ Plot#:_____
GPS Coordinates for the Plot:_____Hydro-Forest type: _____

Plot-level Data:

Overstory	Midstory	Understory	Vines	Cane	Shade-intolerant regeneration
10% increments	10% increments	10% increments	0= None 1=Sparse <25% 2= Mod. 25-50% 3=Heavy >50%	0=None 1= Sparse <10% 2= Mod + >10%	

Tree Data: (≥9.5" dbh): 1/5th acre plot (r=52.7') (down wood diameter @ midpoint)

Species	DBH	Length / Height*	Crown Class	Tree Condition	Epicormic Branching	Bark Disfiguration	Codes.
							*Length / height (only recorded for down dead wood and/or standing dead wood; merchantable height taken at discretion). **Crown Class** D=Dominant C=Co-dominant I=Intermediate S= Suppressed X= Dead …… **Tree Condition** 1 = No dieback 2 = Lower crown dieback 3 = <1/3 crown damage/top dieback 4 = >1/3 crown damage/top dieback 5 = Recently Dead, retains twigs 6 = Dead, retains large limbs 7 = Dead, only bole remains 8 = Down wood >8" diameter …… **Epicormic Branching** 1 = Little to None (<20%) 2 = Moderate (20-50%) 3 = Heavy (≥50%) …… **Bark Disfiguration** 1 = Little to None (<20%) 2 = Moderate (20-50%) 3 = Heavy (≥50%) ……

Comments: _____

Appendix 5. Prospectus for implementing a forest breeding bird monitoring program to assess forest management activities.

ASSESSING FOREST BREEDING BIRD RESPONSE TO FOREST MANAGEMENT

Randy Wilson and Dan Twedt

Background: Many priority forest interior avian species in the Mississippi Alluvial Valley (MAV; Table 1) are disturbance dependent species (e.g., Swainson's Warbler, Kentucky Warbler). That is, these species require complex vegetative structure that typically results from disturbance to the forest canopy (e.g., increased light penetration resulting from tornadic events, tree mortality, or timber harvest). With only 24% of the once vast 24 million acre MAV remaining in bottomland forest, the expectation that habitat needs of these priority species can be met via successional events stemming from storm damage is questionable. Thus, silvicultural intervention will likely be integral to meeting their habitat needs. Conservation partners within the MAV have identified "Desired Forest Conditions" to guide forest management activities based on our current understanding of the habitat needs of priority species. As land managers implement forest management strategies to achieve "Desired Forest Conditions," it is imperative that we monitor the avian response so that forest management prescriptions can be modified following the principals of adaptive management.

Table 1. Priority Forest Breeding Birds in the Mississippi Alluvial Valley (Partners in Flight, 2005).

Species	Score	Action
Prothonotary Warbler	20	*Immediate Management*
Swainson's Warbler	20	*Immediate Management*
Cerulean Warbler	19	*Immediate Management*
Swallow-tailed Kite	18	*Immediate Management*
Mississippi Kite	18	*Management Attention*
Orchard Oriole	18	*Management Attention*
Northern Parula	16	*Management Attention*
Wood Thrush	16	*Management Attention*
Yellow-billed Cuckoo	15	*Management Attention*
White-eyed Vireo	15	*Management Attention*
Yellow-breasted Chat	15	*Management Attention*
Kentucky Warbler	15	*Management Attention*
Eastern Wood-Pewee	14	*Management Attention*
Acadian Flycatcher	14	*Management Attention*
Yellow-throated Warbler	14	*Management Attention*
Hooded Warbler	13	*Management Attention*

Goal: Obtain statistically valid estimates of the species-specific densities, along a temporal gradient (e.g., 1-20 years post-harvest), with respect to forest management strategies that target Desired Forest Conditions (see example in Fig. 1). Estimates for common species should be obtained within 2 years and estimates for all priority species (Table 1) should be obtained within 5 years.

Objective(s): Information is sparse regarding when priority species respond to forest management activities (e.g., 1-year, 2-years, 5-years post harvest, etc.) and the duration of optimal forest conditions. For example, when do Swainson's Warbler populations increase (if at all) and decrease following timber harvest? As such, the objective of this monitoring program is to generate species-specific density curves that reflect changes in abundance along a chronological gradient (e.g., years post-harvest). Furthermore, density estimates will be evaluated against "quasi-control stands" (e.g., stands >20 years post harvest), as well as, with "old-growth" stands (>100 years post harvest).

Quantitative Objective: From a statistical viewpoint, our objective is to generate density estimates corrected for detectability with coefficient of variation (CV) values of ≤20% within fixed time-treatment periods (e.g., 2 year or 3 year intervals post harvest). If this objective proves to be unattainable, time-treatment periods will be lumped into 2-3 year time-treatment periods (e.g., 5-7 years post harvest, etc.) to facilitate analyses. Over all time periods we are striving for a 10% margin of error at a 90% confidence level. Derivation of density estimates is based, in part, on the number of detections and good estimates require a minimum of 50 detections per species. Because species specific detections are likely to vary greatly among forest stands, we anticipate that 15-20 stands (90-120 counts) will be needed within each time-treatment interval to assess densities of common species. However, we anticipate that >600 point counts (100 stands) may be needed within each time-treatment interval to assess densities of priority species. As such, densities and their associated coefficients of variation (CV) will be assessed annually, with sample sizes (number of stands within time-treatment intervals) adjusted to achieve the desired levels of precision. Once a suitable CV level has been achieved (i.e., sufficient data acquired to answer the question) sampling within that time-treatment interval will be suspended.

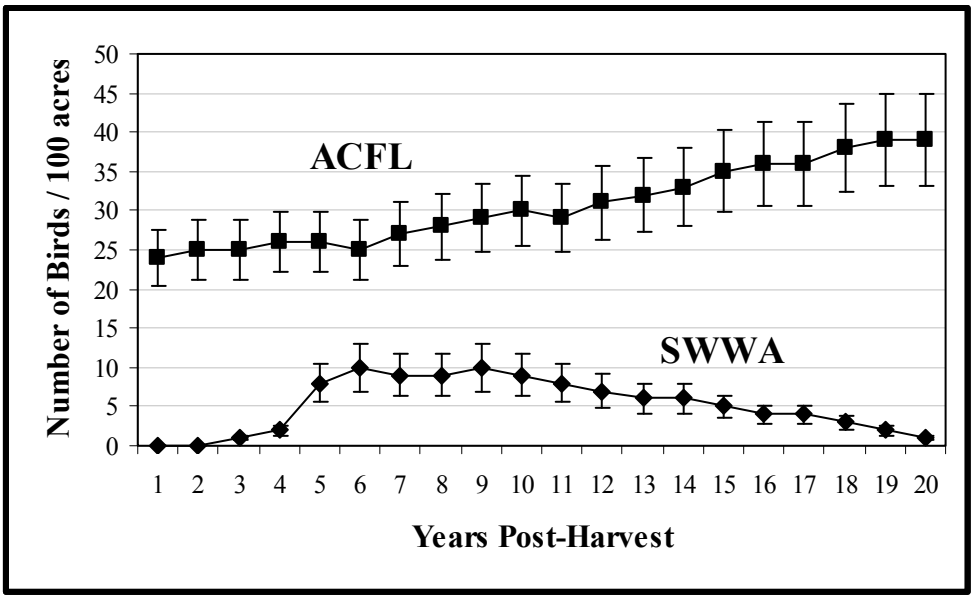

Figure 1. Schematic of hypothetical data demonstrating the expected product generated from this monitoring program.

Sampling Framework: Because our objective is to evaluate avian response to forest management that targets Desired Forest Conditions (or some wildlife-friendly derivation thereof) in bottomland forests of the MAV, the area sampled will focus on conservation lands (e.g., National Wildlife Refuges, State Wildlife Management Areas, and National Forests).. Data from all locations will be pooled to generate estimates applicable to the entirety of conservation lands within the MAV.

Avian surveys will be conducted within hardwood forest communities on conservation lands within the MAV and its associated bottomlands. Within these communities, forest management has historically been undertaken following uneven-aged management, although some even-aged management treatments have been applied. As discussed above, the "Desired Forest Conditions" being promoted in the MAV revolves around the achievement of stand-level characteristics resulting from thinnings and small group selection timber harvest. As such, this monitoring program will target stands subjected to treatments perceived to yield stand-level, target conditions prescribed for wildlife habitat improvement.

Ideally, stands monitored will be stratified among forest communities (e.g., cypress/tupelo, overcup oak/bitter pecan, Nuttall oak/sweetgum, etc.) and/or hydrologic gradients (e.g., wet vs. dry). However, anecdotal observations suggest that insufficient treatments exist to satisfy all these sample design requirements. As such, forest community types and hydrologic gradients will be used as covariates to help explain patterns of bird abundance.

Furthermore, most (if not all) bottomland forests in the MAV have been subjected to timber harvest at some point in the past. As such, we will treat all forest stands as if it they had been treated, with stands treated >20 years ago representing "quasi-controls". Additionally, we will locate and sample as many "old-growth" stands (e.g., areas with no known harvest for >100 years) as possible to "true-controls."

Sample Allocation: Within each forest stand (i.e., a defined area subjected to similar silvicultural treatment), we will allocate six point count locations. Points may be randomly or systematically located within each stand but should be at a minimum of 250 meters apart. Additionally, plots should be >100 meters from roads or agricultural edges. As a general "rule of thumb", a single point count with a 150 meter outer band represents approximately 7 hectares (ca. 18 acres). Thus, treated areas ≤ 40 hectares (ca. 100 acres) will be not be included in the survey.

Field Methods: Since the publication of "A Land Managers Guide to Point Counts of Birds in the Southeast (Hamel et al. 1996), several papers have been published suggesting that "unadjusted" point counts do not provide accurate estimates of bird abundance or estimates of density (see overview by Thompson [2002]). That is, some birds are not detected due to: (1) variables that affect the observers ability to detect and correctly identify birds (e.g., experience, hearing acuity); (2) environmental factors (e.g., wind, vegetation); and/or (3) physical and behavioral attributes of birds themselves (e.g., plumage coloration, singing rate). As a result, several methods, both methodological and analytical have been proposed for estimating detection probabilities that can be used to adjust abundances and thereby obtain density estimates from point count data. For example, Bart and Earnst (2002) suggested double sampling and Nichols et al. (2000) suggested double observer sampling. Both of these methods are modifications to field sampling and as their name suggest, they essentially double the amount of time personnel spend

in the field. Other methods described by Farnsworth et al. (2002) and Rosenstock et al. (2002) utilize computer programs to analyze data that are recorded in temporal intervals and distance bands, respectively, to achieve estimates of detection probability.

Although we do not discount the need for or the importance of double sampling and the use of double observers, these methods are labor intensive and reduce the number of points that can be counted during a give year, thus reducing sample size. As such, we believe the most applicable method for estimating detection probabilities, while maintaining an adequate sample size, is through a temporal and spatial approach. That is, use of methods described by Farnsworth et al (2002) and/or Rosenstock et al. (2002) should permit the calculation of detection probabilities and not detract from sample size. Use of these methods requires only slight modifications to current point count protocols (Hamel et al. 1996). For example, point count duration must be 10 minutes with birds recorded separately for three distinct time intervals (0-3 min, 4-5 min, and 6-10 min). Also, the distance bands in which birds are recorded are set at (0-25 m, 25-50 m, 50-100 m, and 100-150 m). (Detections beyond 150 m and flyovers are recorded separately and not use to estimate detection probabilities). These modifications are compatible with past data collections and require only that data are collected in discrete time and distance intervals.

Below are step-by-step instructions for conducting the recommended 10 minute point counts, with birds recorded separately in three time periods (0-3 min, 4-5 min, and 6-10 min), as well as birds recorded in four distance intervals (0-25 m, 25-50 m, 50-100 m, and 100-150 m). Readers are referred to Hamel et al. (1996), "A Land Managers Guide to Point Counts of Birds in the Southeast" for details.

Standard Operating Procedure for Counting Birds:

1. Prior to the day of the counts, determine which points will be sampled and the order they are to be counted. Also, determine and upload the x,y coordinates for each point into a GPS.

2. Sampling will occur in the morning, beginning as soon as it is light enough to see a distance of 200 m and ending no later than 10 am. The observer should arrive at the first point while it is still dark so that the count can begin as soon as it is light enough to see. This is important

because singing rates for most species are highest near sunrise and then slowly decline over the morning.

3. Do not conduct the count during high winds or heavy rains. Counts should not be conducted if it is raining hard (rain code 4; Table 2) or if wind strength on the Beaufort Scale is a sustained 4 or greater (see Table 3). If these conditions are encountered, either wait until the weather improves or cancel the sampling for the day and reschedule.

4. Approach the location, noting any birds within 100 m of the counting station that are flushed, fly away, or retreat. Mark these birds in the appropriate distance band on a bull's-eye data sheet. Concentric circles on the data sheet indicate distances of 0-25 m, 25-50 m, and 50-100 m, record birds detected in the 100-150 m band in the margins outside the 100 m band.

5. Orient the bull's-eye data sheet to a fixed direction, record the wind and sky conditions (Tables 2 and 3), temperature, date, time, and observer.

6. Position a GPS unit and start it recording, if exact location is not already known.

7. As soon as possible, start the count. Use a pocket timer or watch to keep track of time.

8. Record each bird seen or heard with the appropriate species codes (Appendix C in Hamel et al. (1996). Count family groups of juveniles with a single adult as a single bird.

9. Mark birds on the data sheet in the appropriate distance band and approximate spatial location. Use standard coding symbols included on the data sheet to aid in separating individuals (4 letter species alpha codes can be found in Appendix C of Hamel et al. 1996).

10. Record data for different time intervals (0-3 min, 4-5 min, and 6-10 min) of the count in different ways. Some people like to use different color pens; alternatively, detections can be underlined or double underlined to indicate the different time periods. Be sure to record a legend of the chosen coding scheme on the data sheet for future reference.

11. Holding the sheet in a fixed position, spend part of the time facing in each of the cardinal directions in order to better detect birds.

12. Mark each bird once, using the mapped locations to judge whether subsequent songs are from new or already recorded individuals. All birds greater than 100 m from point center are recorded outside of the 100 m band; likewise, flyovers are recorded at the bottom of the page. The recorded distance should be the horizontal distance between the location a bird was first detected and the plot center. For species that occur in flocks, record the flock (e.g., species) and flock size in the appropriate distance band. There is no need to record each bird in a flock individually.

13. Do not record any birds believed to have been counted at previous stations.

14. At the end of 10 minutes, stop recording bird observations. Do not record any new birds seen or heard after the 10 minutes have passed.

15. Record the latitude and longitude coordinates from the GPS unit and mark the location.

16. Field notations from the bull's-eye data sheet can be transcribed to a point count summary form before they are entered into the National Point Count Database (www.pwrc.nbs.gov). The transcription process will facilitate data entry.

Procedures for Conducting Habitat Assessment:

At each point count location, complete the habitat data sheet (see below) at two spatial locations (one at the center of the point count and one at 100m from point center in the direction of travel to the next point count location). For example, there should be two habitat plots per point count location (point center and 100m). See Table 1 for variable descriptions.

1. For plot level data (i.e., the visible area around the point) record (circle) the appropriate categorical estimate listed on the datasheet for Vines, Cane, Overstory, Midstory, and

Understory. For clarification – overstory (i.e., canopy cover) is vertical cover of the upper canopy (>30ft), whereas midstory (10-30ft) and understory (<10ft) are measured on the horizontal plane.

2. For tree level data (i.e., individual trees) use a 10-factor prism* and record tree species and the number of trees by size category (4 – 9.5 dbh; 10 – 20 dbh; 20 – 30 dbh; and >30 dbh) that are considered to be "in" the plot.

*Procedural Note: When using a prism, the prism must stay over plot center with the user rotating around the prism.

All habitat parameters are based on forest metrics listed in Table 2 of the "Restoration, Management, and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat" document produced by the LMVJV Forest Resource Conservation Working Group, 2007.

Training: Bird identification workshops will be conducted annually by U.S. Fish and Wildlife Service's Migratory Bird Program and/or partners (e.g., Arkansas Game and Fish Commission). Workshops will expose participants to: (1) bird identification tips, techniques, and available resources; (2) bird/habitat relationships; and (3) key elements of bird monitoring programs.

Data Management: All data should be entered into the National Point Count Database as noted in step #16 of the standard operating procedure.

Data Analysis and Reporting: Data will be analyzed annually by Lower Mississippi Valley Joint Venture (LMVJV) Office staff and/or in conjunction with partners (e.g., U.S. Geological Survey scientists). Summary reports will be generated to assess progress and to facilitate revisions of sampling strategy. All reports will be circulated to partners and posted on the LMVJV web site.

Literature Cited

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Rosenstock, S. S., D. R. Anderson, K. M. Giesen, T. Leukering, and M. F. Carter. 2002. Landbird counting techniques: current practices and an alternative. Auk 119: 46-53.

Thompson, W. L. 2002. Towards reliable bird surveys: accounting for individuals present but not detected. Auk 119:18-25.

Variable Circular Plot Point Count Summary Sheet

Date:	Observer:	Start:	End:

State:	Location:	Unit:	Compartment:	Stand:	Point:

Temp (F):	Wind:	Sky:	Cover Type:	Treatment:	Year of Treatment:

Species Alpha Code	0 – 25 m			25 –50 m			50 – 100 m			100 - 150 m		
	0-3 min	4-5 min	6-10 min	0-3 min	4-5 min	6-10 min	0-3 min	4-5 min	6-10 min	0-3 min	4-5 min	6-10 min

Flyovers:_____

Data Compiler:_____

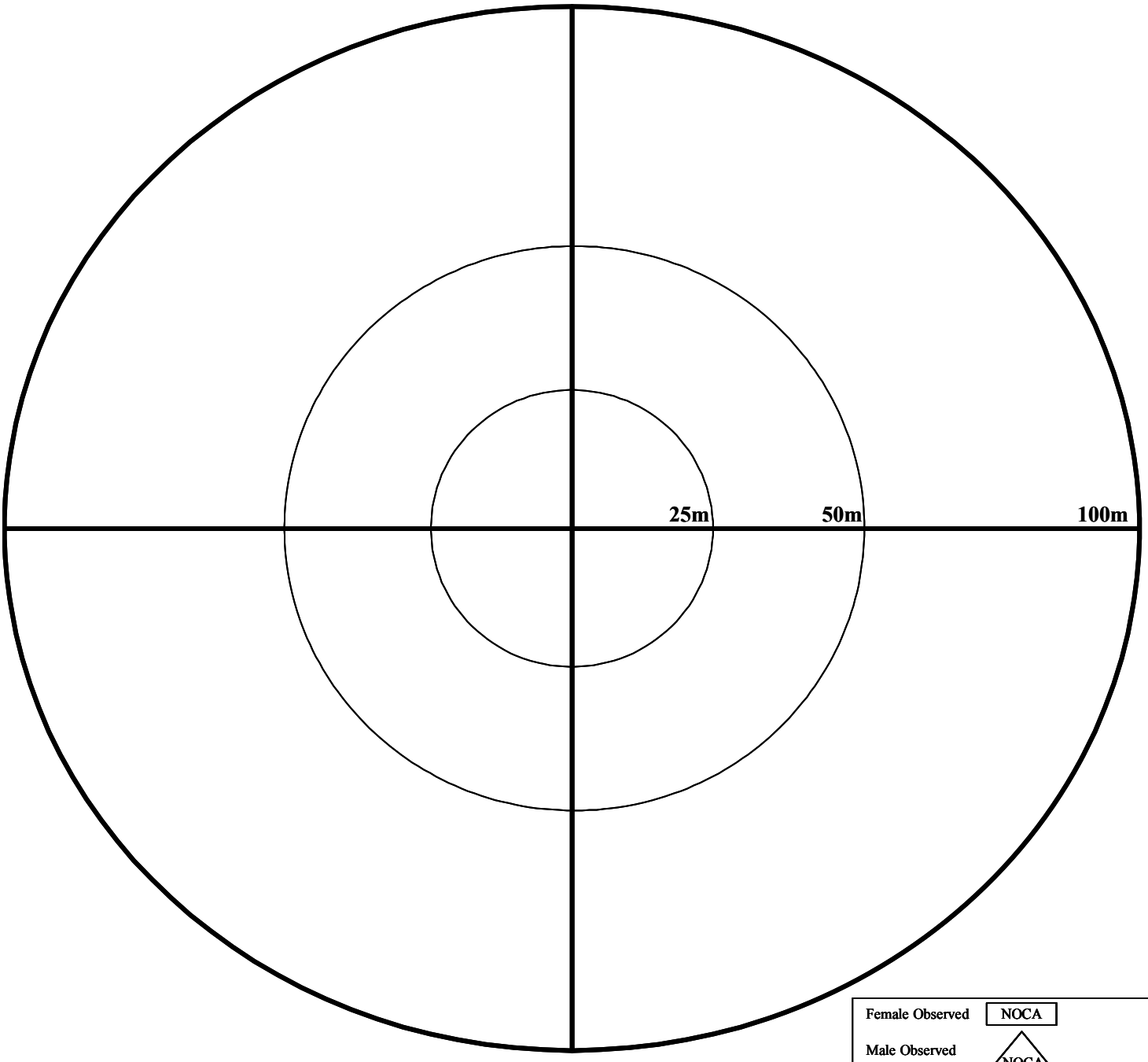
Comments:_____

Variable Circular Plot Point Count Field Sheet

Date:	Observer:	Start:	End:

State:	Location:	Unit:	Compartment:	Stand:	Point:

Temp (F):	Wind:	Sky:	Cover Type:	Treatment:	Year of Treatment:



N-S Coordinate:_____ **E-W Coordinate:**_____ **Zone*:**_____

(N-S=Latitude; E-W=Longitude) *Zone = 0 for lat-long (geographic); else enter a UTM Zone.

Flyovers:_____.

Female Observed	NOCA	
Male Observed	NOCA	
Pair Together, assumed mated	NOCA	
Observed, sex unknown	NOCA	0-3 minutes
	NOCA	4-5 minutes
	NOCA	6-10 minutes

Habitat Data Associated with Forest Breeding Bird Point Counts

Date:	**Observer:**			
State:	**Location:**	**Unit:**	**Compartment:**	**Stand:**
Treatment:		**Year Treatment Implemented:**		
GPS Coordinates (*NAD83-UTM 15*):	**N-S:**	**E-W:**	**UTM Zone:**	

Point Count#_____ Habitat Plot#_____

Plot-level Data: *visible area around plot*				
Vines	**Cane**	**Overstory (>30ft)**	**Mid-Story (10-30ft)**	**Understory (<10ft)**
1 = None *2 = Sparse (<25%)* *3 = Moderate (25-50%)* *4 = Heavy (>50%)*	*1 = None* *2= Sparse (<25%)* *3 = Moderate (25-50%)* *4 = Heavy (>50%)*	*1 = None* *2 = Sparse (<50%)* *3 = Moderate (50-80%)* *4 = Heavy (>80%)*	*1 = None* *2 = Sparse (<25%)* *3 = Moderate (25-60%)* *4 = Heavy (>60%)*	*1 = None* *2 = Sparse (<25%)* *3 = Moderate (25-60%)* *4 = Heavy (>60%)*

Tree Data: *plotless area using 10-factor prism*				
Tree Species	**Number Stems (dbh 4 - 9.5")**	**Number Stems (dbh 10 - 20")**	**Number Stems (dbh 20 - 30")**	**Number Stems (dbh > 30")**

****

Point Count#_____ Habitat Plot#_____

Plot-level Data: *visible area around plot*				
Vines	**Cane**	**Overstory (>30ft)**	**Mid-Story (10-30ft)**	**Understory (<10ft)**
1 = None *2 = Sparse (<25%)* *3 = Moderate (25-50%)* *4 = Heavy (>50%)*	*1 = None* *2= Sparse (<25%)* *3 = Moderate (25-50%)* *4 = Heavy (>50%)*	*1 = None* *2 = Sparse (<50%)* *3 = Moderate (50-80%)* *4 = Heavy (>80%)*	*1 = None* *2 = Sparse (<25%)* *3 = Moderate (25-60%)* *4 = Heavy (>60%)*	*1 = None* *2 = Sparse (<25%)* *3 = Moderate (25-60%)* *4 = Heavy (>60%)*

Tree Data: *plotless area using 10-factor prism*				
Tree Species	**Number Stems (dbh 4 - 9.5")**	**Number Stems (dbh 10 - 20")**	**Number Stems (dbh 20 - 30")**	**Number Stems (dbh > 30")**

Tree Species Codes

QUNU = Nuttall Oak
QUNI = Water Oak
QUPH = Willow Oak
QULY = Overcup Oak
QUPA = Cherrybark Oak
QUSH = Shumard Oak

CAIL = Sweet Pecan
CAAQ = Bitter Pecan

TADI = Cypress
NYAQ = Tupelo

ULAM = American Elm
ULCR = Cedar Elm

DIVI = Persimmon

PLOC = Sycamore
PODE = Cottonwood
LIST = Sweetgum

ACNE = Boxelder
ACRU = Red Maple

CELA = Sugarberry

FRPE = Green Ash

GLAQ = Water Locust
GLTR = Honey Locust

SNAG = Dead Trees

Table 1. Description of variables recorded at point count locations.

Variable	Description
Date	MM/DD/YYYY
Observer	Observer identification (e.g., initials).
Start Time	Time survey started.
End Time	Time survey ended.
State	State
Location	Name of forest, management area, refuge, etc...
Unit	Name of management unit within the location.
Compartment	Name of management compartment within the unit and/or location.
Stand	Name of management stand within the management compartment.
Point #	Number of the point within the compartment, unit, and/or station.
Temp (F)	Temperature in degrees Fahrenheit.
Wind	Wind speed from Beaufort scale (see Table 3).
Sky	Sky condition, combining cloud cover and precipitation (see Table 2).
Cover Type	Forest types follow Table 4 in the DFC Document, LMVJV Forest Resource Conservation Working Group 2007). *Swamp Forest – baldcypress, baldcypress-water tupelo* *Wet Bottomland Forest – overcup oak-bitter pecan, black willow* *Moist Bottomland Forest – sugarberry-elm-ash, oak-elm-ash* *Dry Bottomland Forest – cherrybark oak-cow oak* *Levee Forest – cottonwood-sycamore, sweet pecan-boxelder*
Treatment	Type of treatment (e.g., thinning, group selection, etc..)
Year of Treatment	Year treatment was implemented.
Flyovers	Birds observed flying over the plot.
N - S Coordinate	UTM (Northing - 7 digits) or latitude (DDMMSS) = (30°42'33").
E - W Coordinate	UTM (Easting - 6 digits) or longitude (DDMMSS) = (089°14'59").
Zone	UTM Zone or 0 if latitude / longitude recorded.
Comments	Notes and specific remarks about the count.

Table 2. Codes and descriptions for sky conditions (Weather Bureau Codes)[1].

Sky Conditions:		
Code #		**Description**
0		Clear or a few clouds
1		Partly cloudy (scattered)
2		Cloudy (broken) or overcast
4		Fog or Smoke
5		Drizzle
7		Snow
8		Showers

[1] These codes are the same codes used in the Breeding Bird Survey. Acceptable conditions for counting birds include a sky condition of 0,1, or 2 and wind speeds less than 20 km / h (12 mi/h), preferably less than 13 km / h (8 mi / h).

Table 3. Codes and descriptions for wind speeds (Beaufort Scale)[1].

Wind Speed Codes:						
Code #		**km / h**		**mi / h**		**Description**
0		< 2		< 1		Smoke rises vertically
1		2 to 5		1 to 3		Wind direction shown by smoke drift
2		6 to 11		4 to 7		Wind felt on face; leaves rustle
3		12 to 20		8 to 12		Leaves, small twigs in constant motion; light flag extended
4		21 to 32		13 to 18		Small branches are moved
5		33 to 30		19 to 24		Small trees begin to sway

[1] These codes are the same codes used in the Breeding Bird Survey. Acceptable conditions for counting birds include a sky condition of 0, 1, or 2 and wind speeds less than 20 km / h (12 mi/h), preferably less than 13 km / h (8 mi / h).

Appendix 6. Frequently asked questions and answers pertaining to *"Restoration, Management, and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat".*

FREQUENTLY ASKED QUESTIONS

What is the purpose of this report? -- *The Lower Mississippi Valley Joint Venture Management Board chartered the forest resource conservation working group to serve as a technical forum for coordination among Joint Venture partners. Specifically, the working group was charged with the task of ensuring that conservation programs of Joint Venture partners reflect reforestation and forest management prescriptions and practices that sustain populations of priority birds and other forest-dependant wildlife in concert with sustainable forestry. To that extent, this report provides Joint Venture partners with contemporary recommendations based on the collective experience of on-the-ground managers, researchers, and published literature.*

What are desired forest conditions? -- *Desired forest conditions are intended to reflect some of the structural characteristics found in forests after long periods of natural perturbations. More specifically, desired forest conditions can be presented at multiple spatial scales (Table 1 and 2). For example, 70-100% of the area within local landscapes should be forested, with 70-95% of the forest under active management (i.e., 5-30% should be not be actively manipulated). At the stand scale, a series of primary management factors (e.g., canopy cover, mid-story, basal area) and secondary management factors (e.g., regeneration, cavities, coarse woody debris, etc.) represent the metrics for forest stand assessment and provide guidance for development of management prescriptions. Additionally, we note that desired forest conditions are <u>not</u> intended to be met on every acre within a stand or within a landscape. Instead, these forest metrics when measured within a stand should on average be within desired stand conditions. Moreover, desired stand conditions are only expected to be achieved on 30-50% of the stands within a landscape at any single point in time.*

Do desired forest conditions pertain to all bottomland hardwood forests? -- *Yes. Even though some tracts of bottomland hardwood forest are small and all priority species do not occur within all forest tracts of the Mississippi Alluvial Valley, we believe the implementation of desired forest condition recommendations has benefits to other wildlife (e.g., deer, turkey) as well as to overall forest conditions. Furthermore, we acknowledge that many of the conditions*

(e.g., increased understory) we are striving for will not be obtainable on all sites (e.g., bald cypress / water tupelo situations). However, we believe the recommended structural characteristics do not impose any negative constraints on these systems.

Does the report put forth specific management prescriptions? -- *No. This report does not specify management prescriptions, although some past and current management practices have been identified as promoting development of desired stand conditions. Instead, recommendations are couched within specific habitat metrics (Table 2), such that local managers can evaluate site-dependant conditions and limitations to determine the most appropriate management prescriptions for achieving desired forest conditions.*

Do desired forest conditions promote regeneration of shade-intolerant species? --*Yes. Regeneration is encouraged through silvicultural treatments so as to establish advanced regeneration of shade-intolerant species on 30-40% of treated stands (Secondary Management Factor; Table 2). Although silvicultural practices that retain forest structure are necessary to achieve desired stand conditions, all silvicultural management tools are available to managers to manipulate forest structure as needed to regenerate and release established regeneration of shade-intolerant species. However, large (>7 acre) clearcuts should not represent more than 10% of any local landscape and group selection cuts (i.e., clearcuts <7 acres) should be limited to <20% of the area of treated stands.*

What is the justification for increasing reforestation stocking rates given its greater cost?
Much as the old commercial stated "pay me now or pay me later", we are recommending payment up front to insure a more species diverse and structurally complex forest is restored. Increasing diversity and potential upfront structural competition in the newly developing forests will promote more quality growth attributes of the trees leading to greater management options down the road. Additionally, if early treatments are not feasible, natural competition will allow greater natural mortality in the forests, providing an important secondary management factor (deadwood/coarse woody debris) normally absent in lesser stocked stands during the early stages of forest development.

How do reforested stands fit into desired forest conditions?
By our definition, reforested areas are considered regeneration areas. However, reforested stands are <u>not</u> limited to 10% of the landscape as are regeneration harvests (e.g., >7 acre

clearcuts). That is, achieving increased forest cover (i.e., reforestation) within the landscape overrides the 10% limitation placed on regeneration. Additionally, as restored stands develop, stand-level factors (i.e., midstory, overstory, vines, coarse woody debris, etc…) evolve, leading to development of structurally diverse forest systems that contribute to desired stand-level conditions (Table 2).

How will progress towards obtainment of desired forest conditions be measured?

This document puts forth recommendations for implementing both a forest monitoring program as well as a prospectus for monitoring the response of forest interior songbirds to management actions. Working collectively across agencies and organizations (through the LMVJV partnership) the conservation community should be able to implement monitoring programs, in a coordinated fashion, such that we can address management/conservation questions at multiple spatial scales following the principles of adaptive management. That is, these recommendations are intended to be dynamic and change as we learn more about forest developmental processes and within stand dynamics as it pertains to the structural characteristics of "Desired Forest Conditions" and the response of wildlife species. Furthermore, to achieve these monitoring recommendations will likely require a re-engineering of existing infrastructure in the form of roving teams and/or new job responsibilities for existing staff, as well as, new staff positions (e.g., biometrician, monitoring coordinator).

Great Trinity Forest Management Plan

Wildlife Management

Controlling Wildlife Damage in the Great Trinity Forest

Controlling Wildlife Damage in the Great Trinity Forest

Introduction

Wildlife is an asset to any forest, both for species diversity and viewing by visitors. However, any species can be detrimental to an area due to unusually large numbers, destructive behavior or conflicts with people or other wildlife species. In fact, some species may make it almost impossible to improve the Great Trinity Forest because they may destroy the planted mast-producing hardwood seedlings. Controlling these species will protect the habitat, native species and visitors from disease and injury.

Creating a Wildlife Damage Plan

When creating a plan it is important to first correctly identify the species causing the problem and to learn about its ecology. Then, all control methods and programs should be researched to find the most effective yet humane control method for that species. Information about control methods and programs can be collected from other parks and forest managers in the area, nongovernment agencies and government agencies such as the USDA Animal and Plant Health Inspection Service and Texas Parks and Wildlife.

Species of Concern

Any species, whether native or introduced, can damage a habitat. One excellent example of an extremely destructive, introduced species is the feral pig. This animal will predate a variety of animals and will consume vegetation and mast, which takes resources away from native species. However, the biggest problem is rooting which will destroy the planted hardwood seedlings. In fact, if pig numbers are high enough it will be almost impossible to replant in the Great Trinity Forest. Browsing species such as white-tailed deer and rabbits can also damage areas by overgrazing. Though these species are native and do not need to be eradicated, without control they can cause significant damage to the planted hardwood seedlings and any natural tree regeneration.

Control Methods

Exclusion- erecting fences to keep animals out of an area. For small areas this method may be the most effective and practical, even if it is not the most cost efficient. However, this method is not practical for large areas due to cost and maintenance needed and it does not address the issue of population control.

Frightening- using materials such as firecrackers can provide temporary relief from some wildlife species. However, this method will be difficult to implement over large areas and may disturb visitors and desirable wildlife species.

Repellents- this can be an effective control method. But it may be unusable over large areas and it is costly.

Toxicants- this method can be effective but some toxicants need special licenses to use and they can kill nontarget wildlife species.

Habitat Modification- some species can be controlled by removing cover, den sites or by encouraging natural predators. If over-browsing is a problem, then plants that are resistant to browsing damage can be planted.

Trapping with cages or snares- this can be effective for some species but the species must be disposed of by translocation, shooting or euthanization. Unfortunately, destroying the animal may be the only option since many nuisance species are introduced and are very destructive to many habitat types.

Shooting- hunting in the forest may not be a viable option due to the large number of visitors that have access to the forest. However, it may be a practical option for disposing of nuisance wildlife in traps since it is fast, humane and more feasible than euthanization.

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Great Trinity Forest Management Plan

Wildlife Management

Integrated Pest Management and Wildlife

NRCS Natural Resources Conservation Service
Wildlife Habitat Management Institute

WILDLIFE HABITAT COUNCIL

Integrated Pest Management (IPM) and Wildlife

October 2002 *Fish and Wildlife Habitat Management Leaflet* *Number 24*

C. Rewa

Conservation buffer practices such as field borders provide valuable habitat for wildlife as well as beneficial insects.

General Information

Integrated Pest Management (IPM) ideally combines biological and cultural controls with limited pesticide use to keep pest populations below economically damaging levels, prevent future pest problems, and minimize the harmful effects of pesticides on humans and natural resources, including wildlife. Practitioners of IPM can reduce pest damage and economic loss by recognizing and using natural controls such as weather conditions, pest diseases and predators, pest life cycles, and modified agricultural practices.

Pest elimination is typically not a goal of IPM, however, prevention of crop damage is an integral component. If and when pesticides are used, they are used at lower application rates and lower toxicities in combination with other control methods. IPM can increase profits in the long run by reducing chemical pest control costs, reducing environmental and human health risks associated with pesticide use, improving soil health and productivity, and increasing revenues from land leased for recreational use. Although generally associated with cropland, IPM is implemented by a variety of private landowners and managers including farmers, ranchers, foresters, homeowners, and groundskeepers.

This leaflet provides an introduction to the use of IPM on agricultural lands and general guidance on integrating fish and wildlife considerations into IPM plans. The role of wildlife as an agent of integrated pest management is also introduced. Landowners and mangers should be familiar with proper use of and restrictions on pesticides and requirements for pesticide applicators. Landowners and managers should also be familiar with state and federally listed rare, threatened, and endangered plant and animal species in their area to ensure their consideration and protection.

IPM and wildlife

Beneficial insects, birds, and mammals are natural enemies of many crop pests and can play an important role in IPM. Landowners and managers spend a considerable amount of time and money to control pest populations where natural pest inhibitors are lacking. Modified farming techniques, increased crop diversity, and use of cover crops and conservation buffers can increase food and cover on croplands for many species, including those beneficial in controlling pest populations.

S. Bauer, USDA ARS

Lady beetle adults and larvae prey on aphids, mites, and other pest insects.

Terms and Definitions Associated with IPM

Pest

- An organism, plant or animal, which is undesirable or is detrimental to the interests of humans and capable of causing injury or damage.
- Major pest types include insects and other arthropods, nematodes, pathogens, vertebrates, and weeds.

Pesticides

- Chemical compounds used to control individuals or populations of pests.
- *Herbicides* are pesticides used to control undesirable vegetation, such as weeds or invasive woody plants.
- *Insecticides* are used to control undesirable insects on plants or on/in the soil.
- *Fungicides* are used to control fungus growth and spore dispersal.
- Individuals applying pesticides must comply with federal and state laws and regulations.

Resistance

- Genetically inherited ability of organisms to evolve strains that can survive exposure to pesticides formerly lethal to earlier generations.

Resurgence

- Occurs when insecticide application initially reduces an infestation, but soon afterwards the pest rebounds (resurges) to higher levels than those before treatment.

Economic Injury Level (EIL)

- This is the economic break even point where the cost of pest damage equals the cost of control.

Economic/action Threshold Level

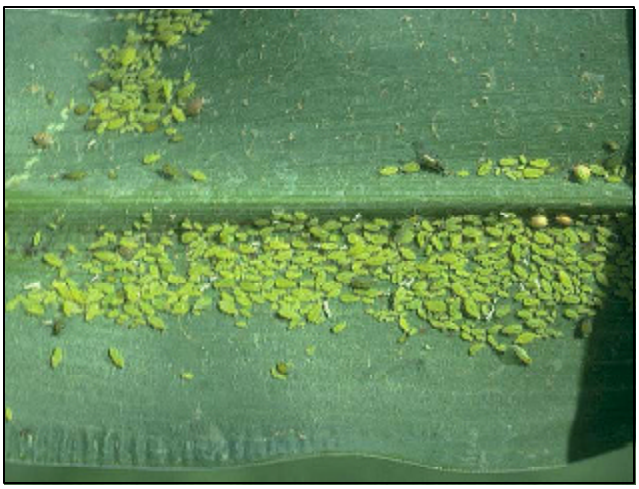
- Population level at which control measures are needed to prevent pest populations from reaching economic injury levels; action threshold is lower than EIL to allow for control measures to take affect before the pest population reaches the EIL levels.

IPM incorporates the flowering patterns of native plants and crops and the life history and movements of beneficial insects and wildlife.

IPM limits pesticide use, which affects non-target species such as beneficial insects and wildlife. Estimates of wild birds killed in the United States every year by exposure to legally-applied pesticides range in the tens of millions. Aquatic invertebrates, fish, amphibians, mammals, and others are also at risk. Insects are a major vehicle for pollination in orchards and vineyards, but their populations decrease after pesticide misuse. Herbicides can reduce or eliminate potential wildlife food and cover plants. Use of insecticides can reduce beneficial invertebrate populations that help control pests and are important food sources to many wildlife species. By using insecticides to address pest problems only where other measures fail to achieve the desired level of control, IPM seeks to minimize the negative effects of pesticide use on wildlife and other natural resources.

IPM Strategies

IPM follows a sequence: pest identification, scouting, management treatments, and post-treatment monitoring. Together, these actions form the key to IPM, which is long-term pest *prevention*. Preventing pest problems is the most effective and efficient pest control method. Prevention contributes to the long-term protection and productivity of crops, as well as wildlife habitat and other natural resources. Local extension agents can help landowners and managers develop a scouting schedule, correctly identify pests and symptoms, and determine economic thresholds and management actions. Cooperative relationships and information sharing between adjacent crop growers can further reduce pest problems.



Texas A&M Department of Entomology

Greenbugs are aphids that feed on sorghum. Lady beetles are natural predators of greenbugs and can help keep their populations from reaching economically damaging levels.

Pest Identification

Pest identification is an important component of IPM. Whether pests are insects, vertebrates, diseases or weeds, landowners and managers should be familiar with pests associated with their crops. Landowners and managers should be able to recognize seasonal conditions that favor pests, potential hosts, and signs of pest damage. Local extension agents may be able to assist in pest identification.

Scouting

Scouting is used to monitor pest densities. Landowners can use scouting data to determine the pest population size and correct method for controlling pests before the economic threshold is reached. Scouting tools include: 10x hand lens for viewing insects, larvae, or eggs; notebook and pen for recording notes; sweep net or other device for catching insects on the wing; and a vial or other closed container for insect samples. Regular, systematic sampling is crucial to estimate pest populations and prevent future outbreaks. Notes should be taken during each scouting run, and permanent records kept to track trends. During weekly scouting trips, each crop should be sampled for pests. Landowners and managers should take samples from the field interior, not just around the field border. Record the crop stage and condition, the date and time of day, moisture conditions, the number and type of pests, and other insects or wildlife observed. Also note nearby buildings, vegetation, buffers, water sources, or other features that might serve as overwintering or migrating grounds for pests, beneficial insects, and wildlife. Collect samples of pests and other insects that cannot be positively identified, as well as samples of plant materials.

Management Treatments and Their Effects on Habitat

Whenever possible, landowners and managers should avoid disturbing high-use wildlife areas, especially during the breeding and nesting season (March-July). Many ground-nesting birds, small mammals, and reptiles and amphibians may use croplands and ground cover crops for breeding and raising young. When possible, avoid treating frequently used foraging areas. Woody draws, riparian vegetation, wetlands, native grasslands, and other sensitive habitats should be preserved.

Ring-necked pheasants can benefit from a variety of cultural pest control practices. However, mechanical treatments should be avoided from March-July to protect these and other ground-nesting birds and their eggs and young.

Cultural control

Cultural controls can help create, maintain, and enhance habitats that harbor beneficial insects and wildlife. Cultural controls generally target some weak point in the pest's life cycle through physical or genetic treatments. Physical controls modify the growing environment to help control pest populations. Some physical controls are actual barriers, such as buffers, hedgerows, or windbreaks, that help prevent pests from entering cropfields and serve as habitat for beneficial insects and wildlife.

Crop rotation is a physical control mechanism that can significantly reduce pest populations, especially those

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Conservation tillage practices leave at least 30% residue cover, which helps reduce erosion and provide winter cover for wildlife inhabiting cropfields and surrounding areas.

that are crop-specific or overwinter on site. In order for crop rotation to be effective, the alternate host crop must be unacceptable to the pest. For example, corn rootworm populations are reduced or eliminated by rotating from corn to just about any other crop. Rotating crops to native grasses or legumes, small grain cover crops, and winter cover crops can provide food and cover for some wildlife species while disrupting the corn rootworm life cycle and reducing their numbers. Landowners and managers should avoid continuous crop monocultures, which can increase reliance on pesticides and reduce soil fertility. In some cases, adjusting planting or harvesting dates is an effective control method. For example, early alfalfa harvest dates can help reduce alfalfa weevil populations by eliminating their overwintering source (alfalfa stalks).

USDA

Crop residue can provide winter cover for birds and small mammals. Snow trapped in the stubble creates pockets of space used by small mammals in winter. Trapped snow also adds ground moisture in the spring for new plant growth.

Table 1. Cultural controls and their application in Integrated Pest Management*.

Cultural control	Application in IPM	Advantages/disadvantages
Crop rotation	Cultivated area that alternates between different kinds of crops to reduce crop-specific pest populations and improve soil health, tilth, and increase crop vigor.	Planting the same crops year after year can lead to a buildup of crop pests and reduced soil fertility. Crop rotation breaks the life cycles of some pests, especially if pests are crop-specific or over-winter on-site. Rotation can significantly reduce pesticide use. Not all crops in a rotation are equally profitable.
Tillage	Practice of cultivating soil to prepare a seedbed or control weeds.	Can significantly reduce herbicide use. Moving soil increases erosion; exposes weed seeds on soil surface, which encourages new weed growth.
Conservation tillage	All-encompassing term for minimum tillage, no-tillage, and other farming practices that reduce or eliminate plowing; newly planted crops protected by at least 30% residue cover.	Enhances soil and water conditions by reducing erosion. Can improve wildlife habitat, especially cover for many wildlife species. After many years, no-till can result in soil compaction unless cut below soil surface. Relies heavily on herbicides.
Sanitation	Cleaning or sterilizing equipment or materials used in pest-infested fields to help reduce the spread of pests to other crops.	Spraying or cleaning contaminated equipment can help reduce the spread of fungi, diseases, and weed seeds to noninfested crops. Sanitation also includes removing trash from waterways and removing heavy vegetation from around buildings and structures.
Exclusion	Actual barriers used to prevent pests from entering fields.	Fences, both aboveground and underground are used to prevent vertebrate pests from entering fields. Other types of barriers include certified disease-free and weed-free seeds.
Prescribed burning	Fire set deliberately by management to achieve a particular management objective. A fire plan must be approved and/or meet legal requirements.	Clears residual materials that may harbor over-wintering pests and helps control woody or undesirable vegetation. Smoke may be a problem in more urban areas.

**The cultural controls listed are most effective when used in combination and with biological controls to reduce pesticide use and improve long-term crop and soil health.*

Tillage is the primary cultural control method, and is particularly effective when used in combination with spot herbicide treatments. However, tillage can increase soil erosion and if conducted during the breeding season, can destroy eggs, young, and adult ground-nesting birds and other wildlife.

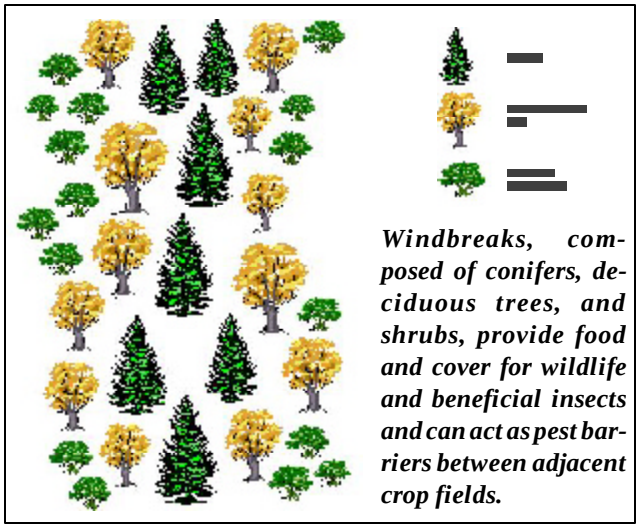
Conservation tillage practices reduce or eliminate plowing, and newly planted croplands are protected by at least 30 percent residue cover. Crop stubble can provide winter cover for wildlife by creating space in snow trapped against the stubble. These snowdrifts also increase soil moisture for spring planting. Over time, conservation tillage can also improve soil and water quality by increasing organic matter, reducing soil erosion and pesticide runoff, and increasing soil clumping, which promotes root establishment.

Other cultural controls like mowing, disking, sanitation, and increased row spacing (to increase airflow and reduce dampness) can be used in various combinations to control pest populations. Genetic controls use resistant plant strains to help prevent pest outbreaks. Weed- or disease-free certified seeds can be planted to help reduce herbicide and fungicide use. Table 1 describes some commonly used cultural controls that when combined and integrated with biological controls and limited pesticide use, typically improve wildlife habitat and long-term crop and soil health on agricultural lands.

Biological control

Predators, parasitoids, and pathogens are the three main agents of biological control. Common predators include insects, birds, and bats and other mammals. Parasitoids are typically tiny wasps that lay eggs on insect hosts. The wasp larvae then feed on and kill the hosts. Parasitoids are not dangerous to humans, livestock, or poultry. Pathogens are selective organisms that cause disease and include viruses, bacteria, fungi, and nematodes.

Biological control agents, particularly predators, need suitable habitat near or adjacent to crops. There are several habitat management practices that landowners and managers can implement that create, maintain, or enhance habitat for beneficial species. Agroforestry, a combination of agriculture and forestry, is a land use system that retains or introduces a mix of trees and other woody perennials in crop and animal production systems to take advantage of economic and ecological interactions, providing habitat for beneficial animals and other wildlife. Some agroforestry practices include:



Windbreaks, composed of conifers, deciduous trees, and shrubs, provide food and cover for wildlife and beneficial insects and can act as pest barriers between adjacent crop fields.

- ***Windbreaks***—multiple rows of trees and shrubs planted and managed to protect farmsteads or incorporated as part of crop or livestock operations to enhance production.
- ***Alley cropping***—growing food, forage, or other crops between rows of planted trees or shrubs.
- ***Riparian forest buffers***—Natural or re-established forests along waterways comprised of trees, shrubs, and grasses designed to filter non-point source pollution from adjacent croplands.

Agroforestry and other habitat enhancing practices often benefit wildlife that use edge habitats. Establishment of non-native or woody plants in areas

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Big-eyed bugs (top) are important predators in many crop systems in North America, particularly in cotton. They feed on eggs and larvae of bollworm (bottom), pink bollworm, tobacco budworm, and other pests. Big-eyed bugs also prey on whiteflies, mites, and aphids.

of native prairie grassland is generally not recommended. Many grassland wildlife populations, especially birds, are rapidly declining; introduction of woody vegetation to native grasslands may accelerate this decline.

When maintaining or enhancing habitat for beneficial species, there are treatments that improve habitat quality. As a general rule, the wider the windbreak or buffer, the more beneficial it is for wildlife. Choose native trees, shrubs, grasses, and legumes for planting conservation buffers and ground cover crops that best support beneficial species without harming crop growth. Fruit- and seed-producing vegetation provides a rich food source for many wildlife species. Diverse, vertical vegetation structure provides for various nesting, roosting, and foraging needs. Snags should be preserved when possible for cavity-nesting birds and small mammals. Leaving a vegetated buffer strip between crops and high-use wildlife areas can be beneficial to insects and animals during tillage operations and chemical treatments. Windbreaks and other conservation buffers should connect habitat patches on the landscape where possible.

J. Dykinga, USDA ARS

Green lacewing larvae prey on aphids, spider mites, small caterpillars, and the eggs of leafhoppers, leafminers, moths, and other pests.

Beneficial insects—predators and parasitoids

Introducing beneficial insects can be expensive, and there is no guarantee that beneficial species will stay in a particular field, especially if suitable habitat is not available. Perhaps the best way to integrate beneficial insects into an IPM plan is to ensure that habitat attractive to these animals is available near crop fields in need of protection. Field borders and other conservation buffer practices containing a diversity of native vegetation is one way to provide this habitat near and between crop fields. Beneficial insects and other arthropods include predators and parasitoids.

Predators feed on the eggs, larvae and adults of insect pests. Beetles, mites, and spiders are common predators. Lady beetle larvae feed on aphids and the eggs of other pest insects. Green lacewings consume aphids, mites, and other pests. Predatory mites consume spider mites. Damsel bugs, big-eyed bugs, mantids, minute pirate bugs, assassin bugs and others are important pest predators in various seasons.

B. Blossey Cornell University

B. Blossey Cornell University

Galerucella calmeriensis (top) and G. pusilla are European beetles introduced in 1992 to North America to control purple loosestrife (bottom), an exotic weed that chokes our native vegetation in North American wetlands, greatly decreasing wildlife habitat value.

S. Long Cornell University

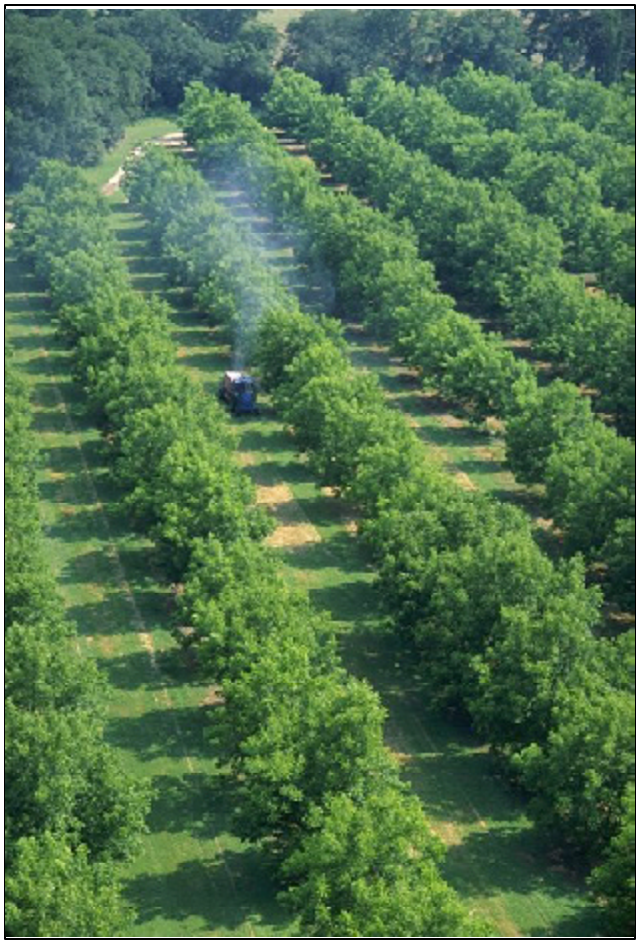
Muscidifurax raptor is an important parasitoid of house flies, stable flies, and other fly species.

Parasitoids are insects that attack and lay eggs inside the pupa case of another species. After hatching, the parasitoid larva consumes the host pupa before emerging as an adult. *Encarsia* spp., *Muscidifurax raptor*, *Nasonia vitripennis*, and *Spalangia cameroni* are a few important parasitoid species. Parasitic nematodes also consume grubs, beetles, grasshoppers, and other pests.

Pathogens

Pathogens are micro-organisms, including bacteria, fungi, protozoa, and viruses, that cause disease and live on and in the bodies of insects. Pathogens occur naturally and can substantially reduce pest populations. They are highly selective, so they have limited negative effects on humans and non-target organisms.

The most commonly used pathogen is Bt (*Bacillus thuringiensis*), which is a bacterium that controls a variety of plant pests from caterpillars (Lepidoptera) to mosquito and small fly larvae (Diptera) to beetles (Coleoptera). As a biological pesticide, Bt also controls simuliid blackflies, which are vectors for river blindness in Africa. Landowners and managers can use variations of Bt that are used to control particular families or species of insects without harming non-target insect species. Varieties of some crops, such as Bt corn and Bt cotton, have been genetically altered to contain the Bt bacterium toxin to kill susceptible insect pests. However, there is controversy regarding the ability of pests to develop resistance to Bt crops.



Ken Hammond USDA

Bats can help control insect pests in orchards and reduce the need for pesticide application.

Bat Conservation International

Big brown bat preying on insect.

Different kinds of pathogens control different types of pests. For example, Japanese beetle grubs can be controlled using milky spore disease (*Bacillus popilliae*), which occurs naturally in some grubs. Milky spore disease bacteria are cultured in living hosts and used for long-term control of chafer beetles, particularly Japanese beetles. Fungi can also act as important pest controls. Pine root rot (*Heterobasidion annosum*), one of the most damaging root pathogens of coniferous trees, spreads quickly from infected roots to healthy roots and also colonizes freshly cut stumps. Another fungus, *Phlebiopsis gigantea*, helps prevent invasion of pine root rot when applied to freshly cut stumps.

Bats and IPM

Bats are a recently recognized form of biological control useful in IPM. Bats play key ecological roles in many plant communities, eating insects, pollinating flowers, and dispersing seeds. Bats are useful in controlling pest populations in agricultural fields and orchards, and are the only major predator of night-flying insects. The food items consumed by bats depend on the bat species, season, and available prey. Listed below are some little-known bat facts.

- ✓ An average-sized maternity colony of 150 big brown bats can consume 38,000 cucumber

Bat Conservation International

Monitoring bat boxes during daylight hours minimizes disturbance to roosting bats.

beetles, 16,000 June bugs, 19,000 stink bugs, and 50,000 leafhoppers in one summer.

- ✓ One endangered gray bat can eat 3,000 insects per night, including moths, flies, and midges.

- ✓ One little brown bat can catch 600 mosquitoes per hour.

- ✓ In a Georgia pecan orchard, Mexican free-tailed bats took up residence in bat houses installed by the landowners. The colony contained about 600 individual bats and virtually eliminated problems and pesticide use associated with tent caterpillars, hickory shuckworms, and other pests.

- ✓ A Willamette Valley, Oregon organic farmer nearly eliminated pesticide use for corn earworm moths by attracting local bat colonies to the orchards. The Oregon farmer reduced pesticide use from 13 to two applications per year, and did not need to spray until after birds and bats had migrated south for the season.

Attracting bats to croplands and orchards requires proper bat house construction and placement in proximity to reliable food sources. If there is a local colony of bats nearby, bats will likely take notice of bat houses more readily. For more information on bat habitat and building and installing houses for bats in North America, see Fish and Wildlife Habitat Management Leaflet No. 5, *Bats.*

Birds and IPM

Birds are another recently recognized addition to the list of biological pest control agents. When used in combination with other pest control treatments, birds may help reduce populations of insects and small mammals. Erecting perches and artificial nesting structures for raptors and songbirds is an easy way to complement IPM efforts. Perches and nesting structures can be placed around the perimeter of crop fields or in nearby suitable habitat. Designs for nest boxes and other wildlife nesting structures are provided in Fish and Wildlife Habitat Management Leaflet No. 20, *Artificial Nesting Structures.*

A study in the Pacific Northwest found that hawks, kestrels, and shrikes were attracted to sites where artificial nesting structures were installed. Voles were a major diet component, but the results of the study concerning the effect of raptor predation on small mammal populations were inconclusive. In a separate study, barn owls consumed large numbers of gophers, mice, and other rodents that are potential pests to crops, tree plantations, orchards, and vineyards. These and

WHC

Eastern bluebirds, which prefer the open field habitat associated with agricultural lands, may benefit from reduced pesticide use on crop fields.

other studies indicate that raptors can be effective biological pest control agents on agricultural lands, especially when used in combination with other control methods.

Chemical control

Chemical control agents include pesticides, biopesticides, pheremones, and other chemicals used to suppress pest outbreaks. Under IPM, some level of pest activity is tolerated, and most crops survive some damage before economic loss occurs. IPM chemical controls, specifically pesticides, are used when routine scouting trips show that pest populations reach levels that reduce yields and breach economic thresholds. Chemical controls are applied as a last resort, and are still used in combination with other management treatments. Individuals applying chemical pesticides must do so in compliance with applicable federal and state laws and regulations. For more information contact your state pesticide regulatory agency, state department of agriculture, or state department of environmental quality.

Pesticides can negatively affect non-target organisms and natural resources, including beneficial insects, natural pest enemies, fish, wildlife, humans, and soil, air, and water quality. Pesticides such as herbicides also reduce food and cover that is important to beneficial insects and fish and wildlife. The list below includes some of the important concepts of chemical use under IPM.

- Choose the least toxic chemical to reduce the chance of harming beneficial organisms, fish, wildlife, and humans. Choose a less persistent chemical to increase the rate of chemical breakdown in the soil. Remember to consider the whole landscape when choosing pesticides. Some chemicals do not affect certain species, but can be detrimental to others, both on-site and elsewhere in the watershed.

- Minimize spray drift during application by using the appropriate nozzle, pressure, and volume to regulate droplet size. Also Consider: (1) adding a drift control agent, (2) using groundbooms, fitted with a skirt, instead of airplanes, (3) applying at a lower temperature and higher humidity, (4) not spraying during a temperature inversion, (5) using a soil incorporation method instead of spraying.

- Avoid spraying if wind speeds are greater than 10 mph.

- Avoid spraying over, or washing equipment near, lakes, ponds, streams, or other bodies of water. Immediately report any chemical spills to the proper authorities.

- Conduct chemical controls through spot treatments if pest outbreak is limited to particular areas. Spot treatments reduce costs and save time by treating only the affected area, and conserve beneficial species and surrounding habitat in untreated areas.

- Use less volatile pesticides to minimize volatilization, which occurs when a solid pesticide converts to a gas and is carried away from the target area by wind.

Post-treatment Monitoring

Post-treatment monitoring determines the short- and long-term effectiveness of management treatments. If management actions do not produce the desired results, then re-evaluate and adjust the treatments.

Organic Farming

Organic farming is an alternative to conventional farming that incorporates many principles of IPM. This type of farming does not use chemical control methods, but relies on techniques such as crop rotation, natural manures, composting, organic fertilizer, and biological pest controls. Some farmers are concerned with lower yields associated with organic farming, but low production costs usually compensate for lower yields. When properly conducted, organic farming techniques increase soil organic matter and soil tilth, minimize runoff and erosion, and provide quality fish wildlife habitat. Overall, organic farming is an environmentally friendly, sustainable agricultural practice that can benefit producers and wildlife.

Landowner Assistance

There are many agencies and organizations experienced with IPM treatments and effects on fish and wildlife habitats. The USDA NRCS produced the Core4 Conservation Practices Training Guide (see References), which contains information about integrated pest management, conservation tillage,

nutrient management, and conservation buffers. Extension agents and NRCS technicians can supply landowners with information about IPM. The National IPM Network lists contacts by region and state, gives technical information about specific pests and management treatments, and contains a directory of state IPM coordinators on-line at www.reeusda.gov/nipmn. The EPA Office of Pesticide Programs also has information and links to IPM information on-line at www.epa.gov/pesticides. The Consortium for International Crop Protection (CICP) and IPMnet website contains IPM technical information and links at www.ipmnet.org. Many universities also develop IPM handbooks through agriculture, forestry, or entomology departments.

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In cooperation with partners, the mission of the Wildlife Habitat Management Institute is to develop and disseminate scientifically based technical materials that will assist NRCS field staffs and others to promote conservation stewardship of fish and wildlife, and deliver sound habitat management principles and practices to America's land users.

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Acknowledgments

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Damage Identification

DAMAGE IDENTIFICATION

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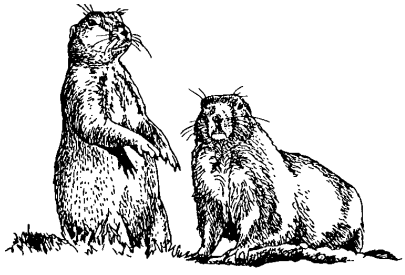
IDENTIFICATION AND ASSESSMENT OF WILDLIFE DAMAGE: AN OVERVIEW

Introduction

Wildlife management is often thought of in terms of protecting, enhancing, and nurturing wildlife populations and the habitat needed for their well-being. However, many species at one time or another require management actions to reduce conflicts with people or with other wildlife species. Examples include an airport manager modifying habitats to reduce gull activity near runways, a forester poisoning pocket gophers to increase tree seedling survival in a reforestation project, or a biologist trapping an abundant predator or competing species to enhance survival of an endangered species.

Wildlife damage control is an increasingly important part of the wildlife management profession because of expanding human populations and intensified land-use practices. Concurrent with this growing need to reduce wildlife-people conflicts, public attitudes and environmental regulations are restricting use of some of the traditional tools of control such as toxicants and traps. Agencies and individuals carrying out control programs are being more carefully scrutinized to ensure that their actions are justified, environmentally safe, and in the public interest. Thus, wildlife damage control activities must be based on sound economic, ecological, and sociological principles and carried out as positive, necessary components of overall wildlife management programs.

Wildlife damage control programs can be thought of as having four parts: (1) problem definition; (2) ecology of the problem species; (3) control methods application; and (4) evaluation of control. Problem definition refers to determining the species and numbers of animals causing the problem, the amount of loss or nature of the conflict, and other biological and social factors related to the problem. Ecology of the problem species refers to understanding the life history of the species, especially in relation to the conflict. Control methods application refers to taking the information gained from parts 1 and 2 to develop an appropriate management program to alleviate or reduce the conflict. Evaluation of control allows an assessment of the reduction in damage in relation to costs and impact of the control on target and nontarget populations and the environment. Increasingly, emphasis is being placed on integrated pest management whereby several control methods are combined and coordinated with other management practices in use at that time.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

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United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

Birds

Damage Assessment

Birds annually destroy many millions of dollars worth of agricultural crops in North America. The greatest loss appears to be from blackbirds feeding on ripening corn; a survey in 1981 indicated a loss in the United States of 330,000 tons (300,000 metric tons) worth $31 million (Besser and Brady 1986). Blackbird damage to sunflower crops in the upper Great Plains states was estimated at $5 million in 1979 and $8 million in 1980 (Hothem et al. 1988). Damage by various bird species to fruit crops, peanuts, truck crops, and small grains also can be severe in localized areas (Besser 1986). Fish-eating birds can cause major losses at fish rearing facilities. Economic losses from bird strikes to aircraft are perhaps more substantial than those in agriculture, at least $20 million annually each for US commercial air carriers (Steenblik 1983) and military aircraft (Merritt 1990).

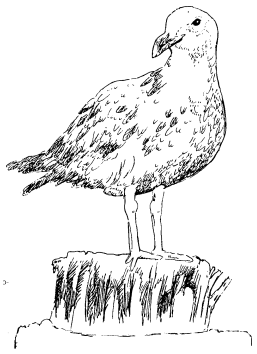
Unlike most mammals, which are secretive when causing damage, birds are often highly visible and their damage conspicuous. For this reason, subjective estimates often overestimate losses as much as tenfold (Weatherhead et al. 1982). Thus, objective estimates of bird damage to agricultural crops are important in order to accurately define the magnitude of the problem and to plan appropriate, cost-effective control actions (Dolbeer 1981).

To estimate losses due to birds in agricultural crops, one must devise a sampling scheme to select the fields that are to be examined and then determine the plants or areas to be measured in the selected fields (Stickley et al. 1979). For example, to objectively estimate the amount of blackbird damage in a ripening corn or sunflower field, the estimator should examine at least 10 locations widely spaced in the field. If a field has 100 rows and is 327 yards (300 m) long, the estimator might walk staggered distances of 33 yards (30 m) along 10 randomly selected rows (for example, 0 to 33 yards [0 to 30 m] in row 9, 34 to 65 yards [31 to 60 m] in row 20; and so on). In each 33-yard (30-m) length, the estimator should randomly select 10 plants and estimate the damage on each plant's ear or head. Bird damage to corn can be estimated by measuring the length of damage on the ear (DeGrazio et al. 1969) or by visually estimating the percent loss of kernels (Woronecki et al. 1980) and converting to yield loss per acre (ha). Fruit loss can be estimated by counting the numbers of undamaged, pecked, and removed fruits per sampled branch (Tobin and Dolbeer 1987). Sprouting rice removed by birds can be estimated by comparing plant density in exposed plots with that in adjacent plots with wire bird exclosures (Otis et al. 1983). The seeded surface area of sunflower heads destroyed by birds can be estimated with the aid of a clear plastic template (Dolbeer 1975).

Losses of agricultural crops to birds can be estimated indirectly through avian bioenergetics. By estimating the number of birds of the depredating species feeding in an area, the percent of the crop in the birds' diet, the caloric value of the crop, and the daily caloric requirements of the birds, one can project the total biomass of crop removed by birds on a daily or seasonal basis (White et al. 1985, Weatherhead et al. 1982).

Damage Identification

Most bird damage occurs during daylight hours. Thus, observation is the best way to identify the species causing damage. Presence of a bird species in a crop that is receiving damage does not automatically prove the species guilty, however. For example, large, conspicuous flocks of common grackles in sprouting winter wheat fields were found, after careful observation and examination of stomach contents, to be eating corn residue from the previous crop. Smaller numbers of starlings were removing the germinating wheat seeds (Dolbeer et al. 1979). Below, the characteristics of damage for various groups of birds are described.



Gulls

Several gull species have adapted to existing in proximity to people, taking advantage of landfills for food. For example, the ring-billed gull population in the Great Lakes region has been increasing at about 10% per year since the early 1970s (Blokpoel and Tessier 1984). Gulls are the most serious bird threat to flight safety at airports (Solman 1981). They are increasingly causing nuisance problems in urban areas by begging for food, defacing property, contaminating municipal water supplies, and nesting on rooftops. In rural areas, gulls sometimes feed on fruit crops, consume fish at aquaculture facilities, eat duck eggs and kill ducklings, and compete with threatened bird species for nest sites.

Blackbirds and Starlings

The term *blackbird* loosely refers to a group of about 10 species of North American birds, the most common of which are the red-winged blackbird, common grackle, and brown-headed cowbird. The starling, a European species introduced to North America in the late 1800s, superficially resembles native blackbirds and often associates with them. Together, blackbirds and starlings constitute the most abundant group of birds in North America, comprising a combined population of more than 1 billion (Dolbeer and Stehn 1983).

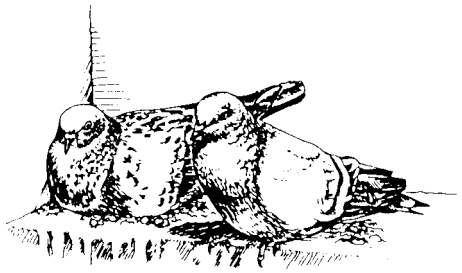
Blackbird damage to ripening corn, sunflower, and rice can be serious (Dolbeer 1994). Much of this damage is done in late summer during the milk or dough stage of seed development. The seed contents of corn are removed, leaving the pericarp or outer coat on the cob. Blackbird damage to sprouting rice in the spring can be important in localized areas.

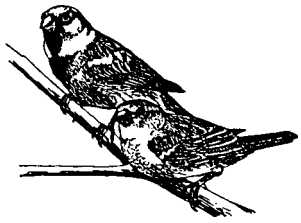
Starling depredations at feedlots in winter can cause substantial losses (Glahn et al. 1983, Besser et al. 1968). Although contamination of livestock feed by starling feces is often a concern of farmers, a study indicated this contamination did not interfere with food consumption or weight gain of cattle and pigs (Glahn and Stone 1984). Starlings can be serious depredators in fruit crops such as cherries and grapes.

Perhaps the greatest problem caused by blackbirds and starlings is their propensity to gather together in large, nocturnal roosting congregations, especially in winter. The noise, fecal accumulation, and general nuisance caused by millions of birds roosting together near human habitations can be significant (White et al. 1985). Roosting birds near airports can create a safety hazard for aircraft. Roost sites, if used for several years, can become focal points for the fungus that causes histoplasmosis.

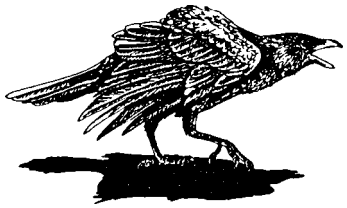
Pigeons and House Sparrows

Pigeons and house sparrows are urban and farmyard birds whose droppings deface and deteriorate buildings. Around storage facilities they consume and contaminate grain. Pigeons and sparrows may carry and spread various diseases to people, primarily through their droppings (Weber 1979). Droppings allowed to accumulate over several years are of particular concern





because they may harbor spores of the fungus that causes histoplasmosis. House sparrows can damage small grain crops but this is normally of economic concern only around agricultural experiment stations with small but valuable research plots (Royall 1969). Sparrows build bulky grass nests in buildings, drain spouts, and other sites where they can cause fire hazards or other problems.



Crows, Ravens, and Magpies

Crows, ravens, and magpies are well-known predators of eggs and nestlings in other birds' nests. In certain situations, these species kill newborn lambs or other livestock by pecking their eyes (Larsen and Dietrich 1970). Magpies sometimes peck scabs on freshly branded cattle.

Crows occasionally damage agricultural crops such as sprouting and ripening corn, apples, and pecans. Most of this loss is localized and minor. Crow damage to apples can be distinguished from damage by smaller birds by the deep (up to 2 inches [5 cm]), triangular peck holes (Tobin et al. 1989). Roosting congregations of crows in trees in parks and cemeteries sometimes cause nuisance problems because of noise and feces.

Herons, Bitterns, and Cormorants

These species sometimes concentrate at fish-rearing facilities and cause substantial losses (Salmon and Conte 1981). Salmon smolts released in rivers in the northeastern United States have suffered heavy depredation by cormorants. In recent years, double-crested cormorants have caused serious losses at commercial fish ponds in the southern United States (Stickley and Andrews 1989). Nighttime observations are sometimes necessary to determine the depredating species because herons and bitterns will feed at night.

Hawks and Owls

The raptors most often implicated in predation problems with livestock (primarily poultry and game farm fowl) are goshawks, red-tailed hawks, and great-horned owls (Hygnstrom and Craven 1994). Unlike mammalian predators, raptors usually kill only one bird per day. Raptor kills usually have bloody puncture wounds in the back and breast. Owls often remove the head. Raptors generally pluck birds, leaving piles of feathers. Plucked feathers with small amounts of tissue clinging to their bases were pulled from a cold bird that had probably died from other causes and was simply scavenged by the raptor. If the base of a plucked feather is smooth and clean, the bird was plucked soon after dying. Because raptors have large territories and are not numerous in any one area, the removal of one or two individuals will generally solve a problem.

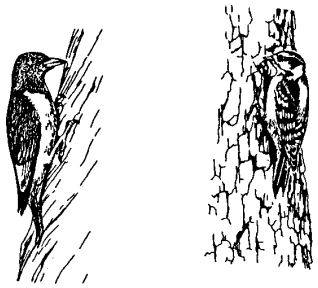
Golden Eagles

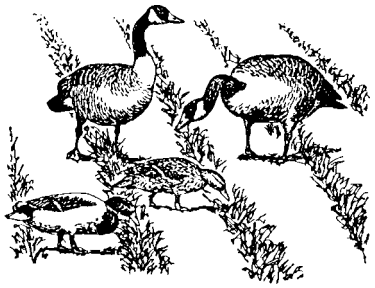
Golden eagles occasionally kill livestock, primarily lambs and kids on range. This predation can be locally severe in the sheep-producing areas from New Mexico to Montana (Phillips and Blom 1988).

Close examination is needed to identify an eagle kill. Eagles have three front toes opposing the hind toe, or hallux, on each foot. The front talons normally leave punctures about 1 to 2 inches (2.5 to 5.0 cm) apart in a straight line or small "V" and the wound from the hallux will be 4 to 6 inches (10 to 15 cm) from the middle toe. In contrast, mammalian predators almost always leave four punctures or bruises from the canine teeth. Talon punctures are usually deeper than tooth punctures and there is seldom any crushing of tissue between the talon punctures. If a puncture cannot be seen from the outside, skin the carcass to determine the pattern of talon or tooth marks. Often a young lamb is killed with a single puncture from the hallux in the top of the skull and the three opposing talons puncturing the base of the skull or top of the neck (O'Gara 1978, O'Gara 1994).

Woodpeckers

Woodpeckers at times cause damage to buildings with wood siding, especially cedar and redwood (Evans et al. 1983). The birds peck holes to locate insects, store acorns, or establish nest sites. They also damage utility poles. Sapsuckers attack trees to feed on the sap, bark tissues, and insects attracted to the sap. This feeding can sometimes kill the tree or degrade the quality of wood for commercial purposes (Ostry and Nicholls 1976). Woodpeckers occasionally annoy homeowners by knocking on metal rain gutters and stove pipes to proclaim their territories.





Ducks, Geese, and Sandhill Cranes

Damage by ducks and cranes to swathed or maturing small grain crops during the fall harvest is a serious localized problem in the northern Great Plains region (Knittle and Porter 1988). Damage occurs from direct consumption of grain and from trampling, which dislodges kernels from heads. Losses from trampling may be at least double the losses from consumption (Sugden and Goerzen 1979).

Canada and snow geese that graze on winter wheat and rye crops can reduce subsequent grain and vegetative yields (Kahl and Samson 1984, Conover 1988). Canada geese can also cause serious damage to sprouting soybeans in spring and to standing corn fields in the autumn. Canada geese have adapted to suburban environments in the past 20 years, creating nuisance problems around parks and golf courses through grazing and defecation (Conover and Chasko 1985).

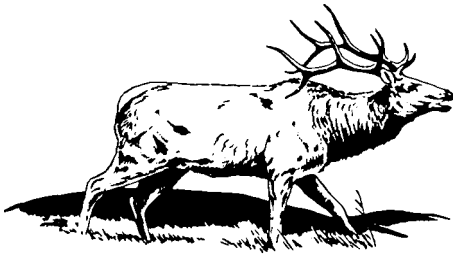
Ungulates (Deer, Elk, Moose)

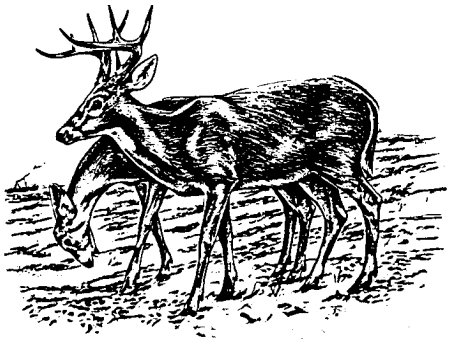
Damage Assessment

Ungulate damage to various agricultural, forestry, and ornamental crops caused by feeding, trampling, and antler rubbing is an increasing problem. Deer browsing in winter on buds of apple and other fruit trees can reduce yields the following year (Austin and Urness 1989) or adversely alter the growth pattern of tree limbs (Harder 1970). Similar browsing on nursery plants and in Christmas tree plantations can reduce or eliminate their market value (Scott and Townsend 1985). Browsing of hardwood saplings and young fir trees in regenerating forests can reduce growth rates, misshape trees, and even cause plantation failures (Crouch 1976, Tilghman 1989).

Damage to trees caused by antler rubbing can be severe (Scott and Townsend 1985). Small trees (1/2 to 1 inch [1.6 to 2.5 cm] in diameter at 6 inches [15 cm] above ground) with smooth bark, such as green ash, plum, and cherry, were preferred for antler rubbing by white-tailed deer in an Ohio nursery (Nielsen et al. 1982).

Objective estimates of economic loss from ungulate browsing and rubbing in orchards, nurseries, and reforestation projects are difficult to obtain. Losses in yield or tree value may accumulate for many years after damage occurs and vary with other stresses, including rodent damage, inflicted on the plants. In Ohio, growers reported average losses to deer in 1983 of $82 per acre ($204/ha) for orchards, $89 per acre ($219/ha) for Christmas tree plantings, and $108 per acre ($268/ha) in nursery plantings (Scott and Townsend 1985). Losses apparently





are in the millions of dollars annually in some US states (Black et al. 1979, Craven 1983*b*, Connelly et al. 1987).

Deer also feed on various agricultural crops, especially young soybean plants and ripening ears of corn. Hygnstrom and Craven (1988) estimated a mean loss of 2,397 pounds of corn per acre (2,680 kg/ha) for 51 unprotected corn fields in Wisconsin. Yield reductions in soybean fields are most severe when feeding occurs during the first week of sprouting (DeCalesta and Schwendeman 1978). Elk in some areas raid haystacks and cattle feedlots (Eadie 1954).

Damage Identification

Ungulates do not have an upper set of incisors. Thus, twigs or plants nipped by these hoofed species do not show the neat, sharp-cut edge left by most rodents and lagomorphs, but instead show a rough, shredded edge, and usually a square or ragged break. Pearce (1947) observed that deer in the Northeast seldom browse higher than 6 feet (1.8 m) from a standing position, but are able to reach up to 8 feet (2.5 m) by rearing up on their hind legs. Elk and moose browse to a height of about 10 feet (3 m). Deer seldom browse on branches more than 1 inch (2.5 cm) in diameter. Moose and elk will gnaw the bark of aspen trees. When male ungulates rub the velvet from their antlers, the scarring is generally confined to the trunk area up to 3 feet (1 m) high (Pearce 1947).

Rodents and other Small Mammals

Damage Assessment

Rodents and other small mammals are seldom observed in the act of causing damage, and their damage is frequently difficult to measure. Nonetheless, assessments of damage that have been made indicate rodents and nonpredatory small mammals cause tremendous annual losses of food and fiber in the United States. Forest animal damage in Washington and Oregon was estimated to total $60 million annually to Douglas fir and ponderosa pine and the potential reduction in the total value of forest resources was estimated to be $1.83 billion (Black et al. 1979, Brodie et al. 1979). Although these figures include losses attributable to ungulates, rodents and hares are responsible for much of the damage.

Miller (1987) surveyed forest managers and natural resource agencies in 16 southeastern states and estimated annual wildlife-caused losses, primarily by beavers, to be $11.2 million on 70 million acres (28.4 million ha). An additional $1.6 million was spent to control wildlife damage on this land. Arner and Dubose (1982) estimated that economic loss to beavers exceeded $4 billion over a 40-year period on 988,000 acres (400,000 ha) in the southeastern United States. Annual loss in Mississippi to nonimpounded timber was estimated to be $215 million over a period of at least 10 years (Bullock and Arner 1985).

Rats cause substantial losses to sugarcane. Lefebvre et al. (1978) estimated annual losses to be about $6 million ($95 per acre, [$235/ha]) in one-third of the area producing sugarcane in Florida. Hawaiian losses were reported to be in excess of $20 million per year (Seubert 1984). Ferguson (1980) estimated that in 1978, voles caused losses that approached $50 million to apple growers in the eastern United States. Losses of forage on rangelands to rodents, rabbits, and hares are also known to be extensive; however, accurate estimates of the monetary losses are difficult to obtain because of the nature of the damage and the wide area over which it occurs (Marsh 1985).

Pearson and Forshey (1978) compared yields of apple trees visibly damaged by voles to those not showing damage to determine the dollar losses in gross return per tree. Richmond et al. (1987) determined reductions in growth, yield, and fruit size of apple trees damaged by pine vole populations of known size maintained in enclosures around the trees.

An index of rodent damage to sugarcane was developed through sampling at harvest to determine the percent of stalks damaged (Lefebvre et al. 1978). Clark and Young (1986) established transects in corn fields and noted rodent damage to individual seedlings over a 10-day period. Forage losses have been estimated by comparing production on areas with and without rodents (Turner 1969, Foster and Stubbendieck 1980, Luce et al. 1981). Sauer (1977) used exclusion cylinders to determine losses of forage to ground squirrels. Alsager (1977) described a method to determine forage production reductions from pocket gopher damage. These methods are useful in evaluating efficacy of control techniques. However, loss estimates must be converted to accurate assessments of dollar loss to enable benefit-cost evaluation of control programs. This conversion is difficult given the vast acreages involved and the variability in rodent populations.

In some situations (for example, timber flooded by beaver, gopher damage to conifer seedlings, vole damage to apple trees), failure to initiate control may mean loss of the entire resource. Thus, potential loss in these situations is equal to the cost of replacement of the resource. In other situations, control may be necessitated irrespective of cost (for example, rats or mice in homes).

These examples illustrate the complexity of damage situations and the need for better damage assessment methods, an area of high priority for future research. Lack of methods for determining damage levels has been a serious impediment to the development of cost-effective control strategies.

Damage Identification

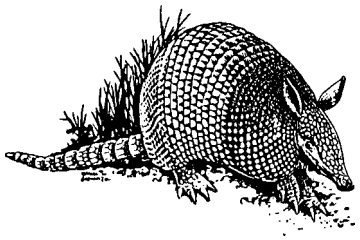
Most wild mammals are secretive and not easily observed; many are nocturnal. Often the investigator must rely on various signs, such as tracks, trails, tooth marks, scats, or burrows to determine the species doing the damage. Trapping may be necessary to make a positive identification of small rodents; frequently, more than one species is involved.

Characteristics of the damage may also provide clues to the species involved. In orchards, for example, major stripping of roots is usually caused by pine voles, whereas damage at the root collar or on the trunk up to the extent of snow depth is most often caused by meadow voles. In sugarcane, various species of rats gnaw stalks so that they are hollowed out between the internodes but usually not completely severed. Rabbits, in contrast, usually gnaw through the stalks, leaving only the ring-shaped internodes.

Damage to plants can generally be grouped as follows: root damage — pocket gophers and pine voles; trunk debarking—meadow voles, squirrels, porcupines, wood rats, rabbits, and mountain beavers; stem and branch cutting—beavers, rabbits, meadow voles, mountain beavers, pocket gophers, wood rats, squirrels, and porcupines; needle clipping—mice, squirrels, mountain beavers, porcupines, and rabbits; debudding—red squirrels and chipmunks. These characteristics can aid in identification of the species responsible, but positive identification should be made either by species-specific signs (tracks, hair, droppings) or by capture of individuals.

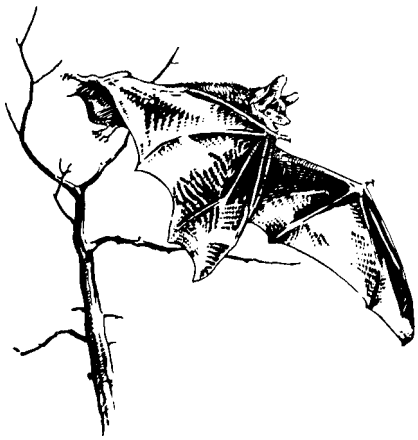
Armadillos

The armadillo has extended its range eastward and northward from Texas and is now found in all Gulf Coast states and parts of New Mexico, Oklahoma, Kansas, Arkansas, and Missouri (Humphrey 1974). Armadillos feed primarily on invertebrates obtained by rooting in ground cover. When rooting



takes place in lawns, golf courses, or gardens, economic damage results. There is also concern about the impact of armadillos on forest floor communities within their expanded range (Carr 1982).

Armadillo burrows under orchard trees can cause root damage or excessive aeration (Marsh and Howard 1990). Nuisance problems result when armadillos burrow under structures. Armadillos carry the bacterium that causes leprosy in humans, but their importance in transmission of the disease to humans has not been determined (Davidson and Nettles 1988).



Bats

Bats, the only mammals capable of true flight, eat vast quantities of insects. Only a few of the 40 species of bats found in the United States and Canada cause problems, primarily when they form roosts or maternity colonies in human dwellings or structures. Those most commonly encountered in pest situations are the little brown bat, big brown bat, Mexican free-tailed bat, pallid bat in the Southwest, and *Yuma myotis* in the West (Greenhall 1982, Frantz 1986). Species identification may be difficult but is important because several bat species are endangered and protected by state and federal law. Control operators unfamiliar with bat identification are urged to seek professional help from wildlife agencies or universities (Frantz 1986).

The presence of bats in a building is usually evidenced by noise (squeaking, scratching) and by the presence and distinctive pungent odor of the accumulated fecal droppings and urine. Bat feces are readily distinguished from those of rodents by odor, insect content, and the ease with which they are crushed (Greenhall 1982).

Many people are fearful of bats and panic in their presence. Bats occasionally contract rabies, and although few human deaths have resulted from bat-transmitted rabies (Greenhall 1982), contact with a rabid bat or a bite by a bat that escapes requires postexposure treatment of people and pets without current vaccinations (Frantz 1986). The fungal causative organism of histoplasmosis, a respiratory disease of humans, can develop where bat colonies are allowed to persist and guano deposits accumulate. Bats roosting near airports may be hazardous to aircraft (Kincaid 1975).

Beavers

Beaver damage is easily identified by the distinctive cone-shaped tree stumps resulting from their gnawing, and often by the presence of their dams and lodges. The latter might not be present, however, in ponds or reservoirs, or along swift mountain streams, where they burrow into banks. Usually, when beavers are active in an area, green sticks with the bark freshly peeled off may be found.

Damage caused by beavers results from feeding behavior (tree cutting) and their efforts to control water levels (dam building). Tree cutting in certain situations results in selective elimination of preferred tree species, such as aspen and cottonwood, from the vicinity (Beier and Barrett 1987). Loss of timber and crops from flooding is of much greater importance, however, especially in the southeastern United States where beaver populations have increased dramatically as a result of a

decline in trapping due to low pelt prices (Woodward 1985). Beavers often use sticks to plug road culverts or water-control structures in ponds and reservoirs. Additionally, beavers can cause extensive damage to levees and human-made dams by their burrowing.

Beavers are susceptible to infection by protozoan parasites (*Giardia* spp.) that can cause gastroenteritis and diarrhea in humans. Transmission to humans can be prevented by use of proper water treatment measures (Davidson and Nettles 1988).

Chipmunks

Occasionally, chipmunks damage grain fields, garden seeds, flower bulbs, and plants through burrowing and feeding. They infrequently destroy eggs and nestling birds (Eadie 1954). They can establish residence in or under human dwellings. Chipmunks cause reforestation problems by consuming seeds, seedlings, and the terminal buds of older plants, and by caching seeds, often in large quantities (Marsh and Howard 1990). In parts of the western United States, chipmunks are a potential reservoir for plague and are controlled in campgrounds (Marsh and Howard 1990). Chipmunks are easily observed due to their diurnal activity; their presence can also be determined by trapping.

Cotton Rats

The hispid cotton rat, a common species in the southern United States and in Mexico, is the species of cotton rat most often causing damage. Two other species have localized occurrences in Arizona and New Mexico. Cotton rats are primarily herbivorous, but they also prey on eggs and young of ground nesting birds (Hawthorne 1994). They undergo major population fluctuations. Most damage is a result of feeding in agricultural crops, especially melons and sugarcane.

Cotton rats are active day and night and, when abundant, are often observed. Their presence is also indicated by well developed runways through dense vegetation and the presence of grass cuttings 2 to 3 inches (5 to 8 cm) in length placed in piles. Pale greenish-yellow droppings, about 1/2 inch (0.9 cm) long and 1/4 inch (0.5 cm) wide, are sometimes present in the runway. Cotton rat sign is similar to that of voles but droppings, runways, and clippings of the cotton rat are usually larger (Hawthorne 1994). Cotton rats are often one of several rodent species causing damage in crops.

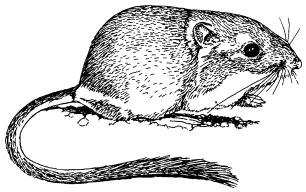
***Peromyscus* (Deer Mice, White-footed Mice)**

The genus *Peromyscus* is large, and one or more species is found in all parts of North America. These mice are nocturnal and active all year. *Peromyscus* populations may show large fluctuations. These mice are the most important seed predators in the Pacific Northwest, causing extensive damage in reforestation efforts (Sullivan 1978). Effects on reforestation have caused a shift to the use of hand-planted seedlings in many areas. *Peromyscus* also can cause significant losses to corn seedlings in conservation tillage systems but this damage may be offset by their consumption of harmful insects and weed seeds (Johnson 1986, Clark and Young 1986). *Peromyscus* may invade homes where they eat stored food and damage upholstered furniture or other materials shredded for use in nest building. They recently have been implicated in the transmission of an often fatal hantavirus to humans. Infections may occur through contact with mouse urine, feces, or saliva. Trapping with snap or live traps is the best method to determine the species present.

Ground Squirrels

Ground squirrels (genus *Spermophilus*), are important pest species in north central and western North America, causing serious losses of tree seeds and emergent seedlings. A careful search of an area showing damage will reveal opened seed hulls and caches. Ground squirrels can inflict serious damage to pastures, rangelands, grain fields, vegetable gardens, and fruit or nut crops. Their burrows can cause collapse of irrigation levees, increase erosion, and result in damage to farm machinery. They are also an important predator of waterfowl eggs in the prairie pothole region (Sargeant and Arnold 1984). They carry several diseases transmissible to humans, including plague; in plague endemic areas, ground squirrel control should be combined with ectoparasite control (Marsh and Howard 1990).

Ground squirrels are diurnal and easily observed (Marsh 1985). They hibernate and estivate, and have major dietary shifts during the year (Marsh 1985, 1986). Effective control strategies must consider these factors.



Kangaroo Rats

Kangaroo rats are competitors of livestock on arid western rangelands (Marsh 1985) when present in high populations, especially during drought. They can also retard recovery of overgrazed rangelands when cattle are removed (Howard 1994) and spread undesirable shrub species by caching of seeds (Reynolds and Glendening 1949, Marsh 1985). Kangaroo rats cause significant damage to alfalfa and corn on irrigated sandy soils by consuming newly planted seeds and clipping off seedlings (Howard 1994). Sorghum, other grains, and garden crops can also be damaged in local areas.

Several species of kangaroo rats are endangered. Kangaroo rats are nocturnal, but their burrow systems, with aboveground mounds and interconnecting runways, are readily observed. Snap trap surveys can identify the species present, provided the damage area is not within the range of one of the species listed as endangered.

Marmots

Marmots (woodchucks), like ground squirrels, can cause damage to many crops; forage production may be markedly reduced by marmot feeding and trampling (Marsh 1985). They damage fruit trees and ornamental shrubs by gnawing or scratching woody vegetation (Bollengier 1994). Their burrows, often located along field edges, can cause damage to farm machinery and injure livestock; when located along irrigation ditches they can cause loss of water. In suburban areas, burrows located under buildings or in landscaped areas cause problems (Marsh and Howard 1990). The presence of woodchucks is easily determined by direct observation of animals and burrows. During periods of forage growth, vegetation around burrows is noticeably shorter than in surrounding areas. Occupied burrows can be identified in spring by the presence of dirt pellets ranging from marble to fist size.

Voles

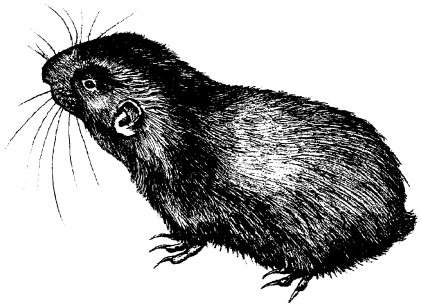
Voles (genus *Microtus*), also called meadow mice, field mice, and pine mice, cause extensive damage to forests, orchards, and ornamentals by gnawing bark and roots (Pearson and Forshey 1978, Byers 1984, Pauls 1986, Sullivan et al. 1987, O'Brien 1994). Tree or shrub damage usually occurs under snow or dense vegetation; the bark is gnawed from small trees near the root collar and up the trunk as far as the snow extends. Voles gnaw through small trees or shoots up to about 1/4 inch (0.6 cm) in diameter. Some species (for example, pine vole) also cause extensive damage to root systems; this damage may not be detected until spring when it is reflected in the condition of new foliage. Voles can also damage field and garden crops; when vole populations are high, these losses can be catastrophic (Clark 1984, Marsh 1985). Voles are carriers of plague and tularemia.

Vole populations are subject to large, rapid fluctuations. The presence of voles is most easily determined by searching for their runways and burrow systems. In orchards these can be found by pulling the grass and other debris from the bases of trees to expose the runways. Burrows of pine voles are usually subterranean. Gnawing on the trunks and roots of trees is usually less uniform than that of other rodents. Tooth marks can be at all angles, even on small branches, and may vary from light scratches to channels 1/10 inch (0.3 cm) wide, 1/12 inch (0.2 cm) deep, and 1/2 inch (1.3 cm) long. In hay crops, runways with numerous burrow openings, clipped vegetation, and feces, can be located in dense vegetation.

Moles

Moles feed primarily on soil invertebrates, especially earthworms and grubs (beetle larvae). About 20% of their food is plant material, which may include garden vegetables and small grains (Silver and Moore 1941). Voles and mice use the burrows of moles and can be responsible for some damage attributed to moles (Henderson 1994). Burrowing by moles may reduce production of forage crops by undermining and smothering vegetation, and by exposing root systems to drying. Their surface burrows can also plug harvesting machinery and contaminate hay and silage (Wick and Landforce 1962). Moles can damage lawns and golf greens extensively through burrowing.

The presence of moles can usually be detected by the mounds of soil thrown up from extensive tunnels dug in search of food and by the raised soil of surface burrows. Mole hills can be distinguished from pocket gopher mounds by their more rounded contour and the lack of a burrow entrance or soil plug (Eadie 1954).



Mountain Beavers

Mountain beavers cause serious economic loss by burrowing through and feeding on garden vegetables, berry plants, and young trees. They use drainage ditches for burrow sites, and their burrows may undermine roadways.

Mountain beavers are a major factor limiting reforestation in the Pacific northwest (Borrecco and Anderson 1980, Evans 1987*a*). Plantations are most susceptible to damage for 4 years after planting and when precommercially thinned at about 12 to 15 years (Evans 1987*a*). Mountain beavers clip

seedlings and gnaw saplings and the stems and bark of larger trees.

Mountain beavers normally clip seedlings through at a 45° angle. On small seedlings this clipping may be difficult to distinguish from rabbit damage; however, rabbits seldom clip stems larger than 1/4 inch (0.6 cm) in diameter or 20 inches (50 cm) above ground level, whereas mountain beavers often cut stems larger than 1/2 inch (1.3 cm) in diameter and up to 9 feet (3 m) above ground (Lawrence et al. 1961). Mountain beavers leave branch stubs, cut at a 45° angle, protruding from the main stem. The bark of the main stem shows horizontal tooth marks and vertical claw marks (Packham 1970). Runways and burrows are present in or near the damaged area.

Muskrats

Muskrats most often cause problems where people have created or manipulated wetlands or where wetlands border agricultural crops. The most serious damage results from burrows in pond dams, levees, and irrigation canals. The burrow entrance is below water level and penetrates the embankment at an upward angle to allow for a room above the water level. Damage is increased when the water level rises and the burrow is extended higher to provide a dry chamber, thereby increasing chances of washouts and cave-ins. At times, muskrats cause severe damage to grain, such as rice, and to garden crops growing near water. Muskrats are primarily vegetarians, but they will feed on aquatic animals where vegetation is limited (Miller 1994).

Muskrats commonly construct cone-shaped houses projecting 6 inches to 3 feet (15 to 90 cm) above the water surface. Muskrat presence is indicated by houses and burrow entrances. Underwater runs can be observed when the water is clear or after a winter draw down of ponds or reservoirs (Miller 1994).

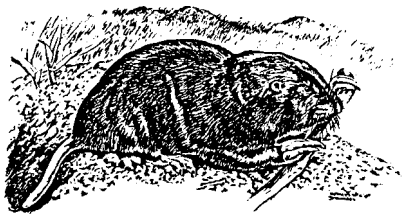
Nutria

Nutria are semiaquatic, herbivorous mammals that feed on aquatic plants, roots, seeds, and crops grown close to waterways. The greatest losses from this introduced rodent are to sugarcane and rice, especially in fields adjacent to Gulf Coast marshes (LeBlanc 1994). Nutria may severely impede cypress regeneration (Conner and Toliver 1987). They also damage wooden structures and floating marinas.

Nutria presence is evidenced by tracks, droppings, and trails to and from the damage area. Nutria also may be observed in the damage area.

Pocket Gophers

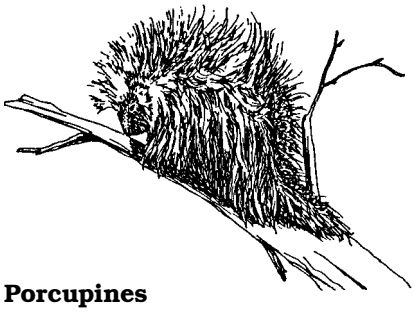
Pocket gophers cause substantial damage to agricultural crops, lawns, rangeland, and tree plantings. Gophers feed primarily on the underground portions of plants and trees. Damage often is undetected until a tree shows aboveground signs of stress; by then damage is frequently lethal (Cummings and Marsh 1978). Pocket gophers may also damage plastic irrigation lines on agricultural lands as well as underground pipes, cables, and electric wires.



On rangeland, soil disturbance and mound building by pocket gophers result in increased plant diversity and a replacement of perennial by annual grasses (McDonough 1974, Foster and Stubbendieck 1980, Marsh 1985). They can greatly reduce the carrying capacity of rangeland for livestock. They can be a serious pest in alfalfa by feeding on the leaves, stems, and roots (Marsh 1985). Gopher mounds can cause equipment breakage and increased wear on haying machinery. Gopher tunnels result in water loss in irrigated areas (Case and Jasch 1994).

Pocket gophers are a major impediment to reforestation in the western United States (Crouch 1986). During winter pocket gophers often forage above ground by tunneling in the snow. Coniferous trees have been found debarked to a height of 12 feet (3.5 m) by pocket gophers working under the snow (Capp 1976). Gophers also fill some of the snow tunnels with soil, thus forming long tubular "casts" that remain after the snow melts.

Pocket gopher presence is easily determined by fan-shaped soil mounds in contrast to the conical mounds of moles. Burrow entrances are usually plugged. Aboveground debarking injuries caused by pocket gophers show small tooth marks, differing from the distinct broader grooves left by porcupines, and the finely gnawed surface caused by meadow voles. Gophers will at times pull saplings and vegetation into the burrow.

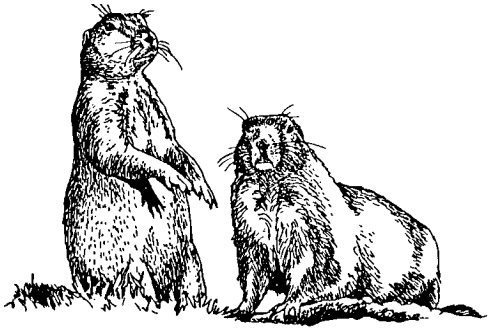


Porcupines

Porcupines are usually nocturnal and are active all year. During summer, porcupines often feed on succulent plants, including garden and truck crops in open meadows, fields, and along the banks of streams and lakes. Greatest damage is caused in winter

when porcupines feed on the inner bark of trees (Marsh and Howard 1990). Girdling in the upper trunk of trees often results in dead tops (Evans 1987*b*). Basal girdling may occur on seedlings. Porcupines are attracted to anything containing perspiration salt: saddles, harnesses, belts, and tool handles.

Porcupine damage can be identified by broad incisor marks on the exposed sapwood. Abundant oblong droppings about 1 inch (2.5 cm) long can be found under freshly damaged trees. Clipped twigs and tracks may also be found on snow. Top girdling in pine results in trees with a characteristic brushy crown.



Prairie Dogs

Prairie dogs were widespread on the Great Plains throughout the 1800s and reached peak numbers around 1900 after reduction of natural predators and establishment of cattle grazing. By 1921 the area occupied by prairie dogs was estimated to be 99 million acres (40 million ha). By 1971, following intensive control efforts, only 1.5 million acres (0.6 million ha) were occupied. Populations have been expanding in recent years, commensurate with reduced control efforts (Fagerstone 1981).

Prairie dogs damage rangelands and pastures by clipping vegetation for food and nesting material and by clearing cover from the vicinity of burrows (Hygnstrom and Virchow 1994). This activity not only reduces available forage, but can alter species composition of the vegetation in favor of forbs. Competition with cattle does not always exist, however, and in some situations beneficial effects of prairie dogs offset competition. Therefore, each conflict situation should be evaluated individually (Fagerstone 1981).

Crops planted near prairie dog colonies can receive serious damage from feeding and trampling. Also, damage to irrigation systems is common, and badgers digging for these rodents cause even greater damage. The burrows and mounds created by prairie dogs can increase soil erosion, cause drainage of irrigation water, and result in damage to farm implements. Prairie dogs also serve as a reservoir for plague (Hygnstrom and Virchow 1994).

Prairie dog colonies provide habitat for other species, such as the endangered black-footed ferret. All lethal control should be preceded by a careful survey to ensure that ferrets are not present. The Utah prairie dog is a threatened species and should not be controlled.

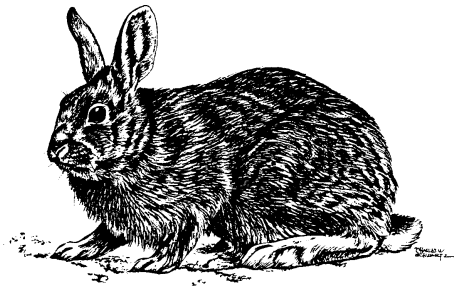
Prairie dog colonies are easily identified by the conical mounds around burrow entrances and by the presence of the easily observed animals.

Rabbits and Hares

Rabbits and hares can damage or completely destroy tree plantings, gardens, ornamentals, agricultural crops, and rehabilitated rangeland. In winter, they strip bark from and debud fruit trees, conifers, and other trees and shrubs (Craven 1994).

Rabbits are known vectors of tularemia, which is transmissible to humans, and they may carry larvated eggs of several ascarid roundworms that can produce disease if accidentally ingested (uncooked) by humans (Davidson and Nettles 1988).

Jackrabbits also damage orchards, gardens, ornamentals, and some agricultural crops, especially in areas adjacent to rangeland, and most frequently when natural vegetation is dry (Knight 1993). Jackrabbit populations show



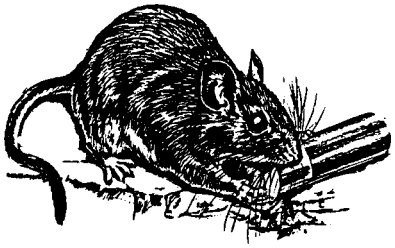
large fluctuations, and, at times of high density, damage to rangeland vegetation and competition with livestock can be severe.

Trees clipped by rabbits and hares have a clean oblique knifelike cut on the stem. Rabbits and hares usually clip stems 1/4 inch (0.6 cm) in diameter or less at a height not more than 20 inches (50 cm) above the ground (Lawrence et al. 1961). Repeated clipping will deform seedlings. Rabbits and hares can often be observed at damage sites along with their tracks, trails, and droppings.

Tree Squirrels

Tree squirrels may be divided into three groups: large tree squirrels (gray, fox, and tassel-eared), pine squirrels (red and Douglas), and flying squirrels (northern and southern) (Jackson 1994). Squirrels eat plants and fruit, dig up newly planted bulbs and seeds, strip bark and leaves from trees and shrubs, invade homes, and consume bird eggs (Jackson 1994, Hadidian et al. 1987). They cause problems by shorting out transformers and gnawing on power and telephone lines (Marsh and Howard 1990, Hamilton et al. 1987).

Squirrels can often be observed at the damage site. Damage to conifer seed is indicated by green, unopened cones scattered on the ground under mature trees and by the accumulated cone scales and "cores" at feeding stations. Bark stripping can be observed in trees and bark fragments are often found on the ground, as are the tips of twigs and small branches.



Wood Rats

Wood rats, also called pack rats, brush rats, or trade rats, are attracted to food supplies left in buildings and will remove small objects such as spoons, forks, knives, and other items, sometimes leaving sticks or other objects "in trade." They often construct conspicuous stick houses in cabins, abandoned vehicles, or in the upper branches of trees (Marsh and Howard 1990, Salmon and Gorenzel 1994). They will shred mattresses and upholstery.

Wood rats are agile climbers and consume fruits, seeds, and green foliage of herbaceous and woody plants (Lawrence et al. 1961). They strip and finely shred patches of bark from conifers and fruit trees to line nest chambers (Hooven 1959). They will also clip small branches. Their damage may be confused with that of tree squirrels and porcupines; however, wood rats leave a relatively smooth surface with a few scattered tooth marks, and tend to litter the ground beneath the tree less than tree squirrels.

Several subspecies of wood rats are endangered. Local regulations should be checked before control efforts are undertaken.

Commensal Rodents

The three species of commensal rodents (those that live primarily around human habitation) are Norway rats, roof (black) rats, and house mice. These omnivorous rodents consume millions of bushels of grain each year in the field, on the farm, in the elevator, mill, store, and home, and in transit. They also waste many more millions of bushels by contamination. These rodents typically drop 25 to 150 pellets and void 1/3 to 2/3 ounce (10 to 20 ml) of urine every 24 hours, and constantly shed fine hairs.

Rats cause extensive damage to sugarcane in Hawaii and Florida, and roof rats are serious pests in Hawaiian macadamia nut plantations. These rodents will feed on poultry chicks and occasionally even attack adult poultry, wild birds, newborn pigs, lambs, and calves. Health departments annually report hundreds of human babies bitten by rats. Many viral and bacterial diseases are transmitted to humans by rodent feces and urine that contaminate food and water (Weber 1982).

Gnawing by rodents causes considerable property damage. Fires are sometimes started when rats and mice gnaw the insulation of electric wiring. They will also use materials such as oily rags and matches for building nests, which can result in fires by spontaneous combustion. Extensive damage to foundations and concrete slabs is sometimes done when Norway rats burrow under buildings. Burrows into dikes and outdoor embankments cause erosion.

Signs of commensal rodents are gnawing, droppings, tracks, burrows, and darkened or smeared areas along walls where they travel. Reviews of problems caused by these species and methods of control are provided by Meehan (1984), Jackson (1987), Baker et al. (1993), Marsh (1994), and Timm (1994).

Carnivores and other Mammalian Predators

Damage Assessment

Mammalian predators have always been a concern to livestock producers. Wade (1982) estimated that the direct loss of sheep and goats to coyotes in the United States ranged from $75 million to $150 million annually. Pearson (1986), using a summary of other studies and surveys, estimated the loss of sheep, lambs, and goats to predators (primarily coyotes) to be $68,160,000 in the 17 western states in 1984. Terrill (1988), using data from all 50 states, reported that annual losses of sheep and lambs to coyotes and other predators ranged from $69 million to $83 million in 1985 to 1987. In 1990, 490,000 sheep and lambs valued at $21.7 million and 129,400 goats valued at $5.6 million were lost to predators in the United States (NASS 1991). In 1991, the National Agricultural Statistics Service estimated that predators killed 106,000 cattle and calves in the United States, valued at $41.5 million (NASS 1992). Losses of poultry to predators, although not well documented, are also thought to be substantial.

Mammalian predators, especially red foxes, striped skunks, raccoons, and mink, seriously impact waterfowl nesting success in small wetland areas surrounded by agricultural lands. A study in North Dakota indicated nesting success of only 8% for mallards on such wetlands, half of what was needed to sustain the population (Cowardin et al. 1985). The red fox is apparently the most serious waterfowl predator because it is adept at catching nesting hens as well as destroying eggs (Sargeant et al. 1984).

Damage Identification

Predation is rarely observed; therefore, the accurate assessment of losses to specific predators often requires careful investigative work. The first action in determining the cause of death of an animal is to check for signs on the animal and around the kill site. Size and location of tooth marks will

often indicate the species causing predation. Extensive bleeding usually is characteristic of predation. Where external bleeding is not apparent, the hide can be removed from the carcass, particularly around the neck, throat, and head, and the area checked for tooth holes, subcutaneous hemorrhage, and tissue damage. Hemorrhage occurs only if skin and tissue damage occurs while the animal is alive. Animals that die from causes other than predation normally do not show external or subcutaneous bleeding, although bloody fluids may be lost from body openings (Bowns 1976). Animal losses are easiest to evaluate if examination is conducted when the carcass is still fresh (Wade and Bowns 1982).

Animals may not always be killed by a throat attack, but may be pulled down from the side or rear. Blood is often on the sides, hind legs, and tail areas. Calves can have their tails chewed off and the nose may have tooth marks or be completely chewed by the predator when the tongue is eaten (Bowns 1976).

Tracks and droppings alone are not proof of depredation or of the species responsible. They are evidence that a particular predator is in the area and, when combined with other characteristics of depredation, can help determine what species is causing the problem.

Badgers

Badgers eat primarily rodents such as mice, prairie dogs, pocket gophers, and ground squirrels. They will also prey on rabbits, especially the young. Badgers destroy nests of ground-nesting birds and occasionally kill small lambs and poultry, parts of which they sometimes bury in holes resembling their dens. Dens in crop fields may slow harvesting or cause damage to machinery, and the digging can damage earthen dams or dikes (Lindzey 1994).

Badgers usually eat all of a prairie dog except the head and fur along the back. This characteristic probably holds true for most of the larger rodents they eat; however, signs of digging near prey remains are the best evidence of badgers. Badger tracks often appear similar to coyote tracks but on close examination they are distinctively "pigeon-toed" with impressions from the long toenails apparent in most situations.

Bears

Black and grizzly bears prey on livestock. Black bears usually kill by biting the neck or by slapping the victim. Torn, mauled, and mutilated carcasses are characteristic of bear attacks. Often, the bear will eat the udders of female prey, possibly to obtain milk. The victim usually is opened ventrally and the heart and liver are consumed (Bowns and Wade 1980). The intestines are often spread out around the kill site, and the animal may be partially skinned while the carcass is fed upon. Smaller livestock such as sheep and goats may be consumed almost entirely, and only the rumen, skin, and large bones left. Feces are generally found within the kill area, and a bedding site is often found nearby. Bears use their feet while feeding so they do not slide the prey around as do coyotes. If the kill is made in the open, it may be moved to a more secluded spot.

The grizzly has a feeding and killing pattern similar to that of the black bear. Murie (1948) found that most cattle are killed by a bite through the back of the neck. Large prey often have claw marks on the flanks or hams. The prey's back is sometimes broken in front of the hips where the bear simply crushed it down. Young calves are occasionally bitten through the forehead.

The presence of bears has stampeded range sheep, resulting in death from suffocation or from falls over cliffs. A marauding bear searching for food may also play havoc with garbage cans, cabins, camp sites, and apiaries (Maehr 1983).

Black bear damage to trees can be recognized by the large vertical incisor and claw marks on the sapwood and ragged strips of hanging bark. Pole-size trees to small saw timber are preferred. Most bark damage occurs during May, June, and July (Packham 1970). After the bark is pulled away, bears will scrape off the cambium layer of the tree with their incisor teeth, leaving vertical tooth marks (Murie 1954).

The bear track resembles that of a human, but has distinctive claw marks. The little inside toes often leave no marks in dust or shallow mud so the print appears to be four-toed (Murie 1954).

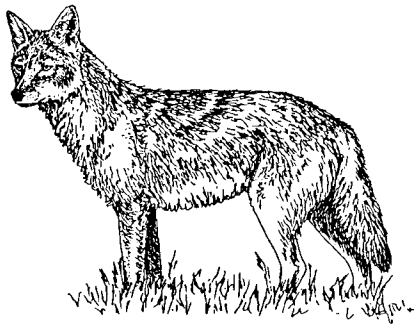
Bobcats and Lynx

These related species occasionally prey on sheep, goats, deer, and pronghorns; however, they more commonly kill smaller animals such as porcupines, poultry, rabbits, rodents, birds, and house cats. Bobcats characteristically kill adult deer by leaping on their back or shoulders, usually when the victim is lying down, and biting them on the trachea. The jugular vein may be punctured, but the victims usually die of suffocation and shock. Bowns (1976)

reported that a lamb killed by a bobcat had hemorrhages produced by claws on both sides of the carcass, indicating that the bobcat had held the lamb with its claws while biting the neck. Small fawns, lambs, and other small prey are often killed by a bite through the top of the neck or head (Young 1958). The hindquarters of deer or sheep are usually preferred by bobcats, although the shoulder and neck region or the flank are sometimes eaten first. The rumen is often untouched. Poultry are usually killed by biting the head and neck (Young 1958); the heads are usually eaten. Also, both species reportedly prey on bird eggs.

Bobcat and lynx droppings are similar; in areas inhabited by both species, the tracks will help determine the responsible animal. The lynx has larger feet with much more hair and the toes tend to spread more than they do on the more compact bobcat tracks.

Feline predators usually attempt to cover their kills with litter (Cook et al. 1971). Bobcats reach out 12 to 14 inches (30 to 35 cm) in scratching litter, compared to a 35-inch (90-cm) reach of a mountain lion (Young 1958). The distance between the canine teeth marks will also help distinguish a lion kill from that of a bobcat—1 1/2 inches (3.8 cm) for a lion versus 3/4 to 1 inch (1.9 to 2.5 cm) for a bobcat (Wade and Bowns 1982).



Coyotes, Wolves, and Dogs

These predators prey on animals ranging from big game and livestock to rodents, wild birds, and poultry. Coyotes are the most common and most serious predator of livestock in the western United States (Wade and Bowns 1982) and are rapidly becoming a problem throughout the east.

Coyotes normally kill livestock with a bite in the throat, but they infrequently pull the animal down by attacking the side, hindquarters, and udder. The rumen and intestines may be removed and dragged away from the carcass. On small lambs, the upper canine teeth may penetrate the top of the neck or the skull. Calf predation by coyotes is most common when calves are young. Calves that are attacked, but not killed, exhibit wounds in the flank, hindquarters, or front shoulders; often their tails are chewed off near the top. Deer carcasses are frequently completely dismembered and eaten (Bowns 1976).

Complaints of pets being killed by coyotes have increased with urbanization (Howell 1982). Also, the increase in the number of reported human attacks has created additional concern for urban dwellers. Avocado producers using drip irrigation systems report that coyotes chew holes in plastic pipe and disrupt irrigation (Cummings 1973). Coyotes damage watermelons by biting holes through the melons and eating the centers out; raccoons, on the other hand, make small holes in the melons and scoop the pulp out with their front paws. Coyotes will also damage other fruit crops.

Wolves prey on larger ungulates such as caribou, moose, elk, and cattle. Wolves usually bring down these animals by cutting or damaging the muscles and ligaments in the back legs or by seizing the victim in the flanks. Slash marks made by the canine teeth may be found on the rear legs and flanks. The downed animals usually are disembowelled.

Domestic dogs can be a serious problem to livestock, especially to sheep pastured near cities and suburbs. Dogs often attack the hindquarters, flanks, and head of livestock. They rarely kill as effectively as coyotes (Green et al. 1994). Normally, little flesh is consumed. Dogs are likely to wound the animal in the neck and front shoulders; the ears often are badly torn. Attacking dogs often severely mutilate the victim (Bowns and Wade 1980).

Coyote and dog tracks are similar but distinguishable. Dog tracks are round with the toes spread apart. Toenail marks are usually visible on all toes (Dorsett 1987). Coyote tracks are more rectangular and the toes are closer together. If any toenail marks show, they are usually of the middle toes. Also, coyote tracks appear in a straight line whereas those of a dog are staggered.

Foxes

Gray and red foxes feed primarily on rabbits, hares, small rodents, poultry, birds, and insects. They also consume fruits. The gray fox eats fish, a prey seldom eaten by the red fox. Gray and especially red foxes kill young livestock, although poultry is their more common domestic prey. Foxes usually attack the throat of lambs and birds, but kill some by multiple bites to the neck and back (Wade and Bowns 1982). Normally, foxes taking fowl leave behind only a few drops of blood and feathers and carry the prey away from the kill location, often to a den. Eggs are usually opened enough to be licked out. The shells are left beside the nest and are rarely removed to the den, even though fox dens are noted for containing the remains of their prey, particularly the wings of birds.

Einarsen (1956) noted that the breast and legs of birds killed by foxes are eaten first and the other appendages are scattered about. The toes of the victims are usually drawn up in a curled position because of tendons pulled when the fox strips meat from the leg bone. Smaller bones are likely to be sheared off. The remains are often partially buried.

Like other wild canids, foxes will return to established denning areas year after year. They dig dens in wooded areas or open plains. Hollow logs are also used. Dens may be identified by the small doglike tracks or by fox hairs clinging to the entrance. The gray fox is the only fox that readily climbs trees, sometimes denning in a hollow cavity.

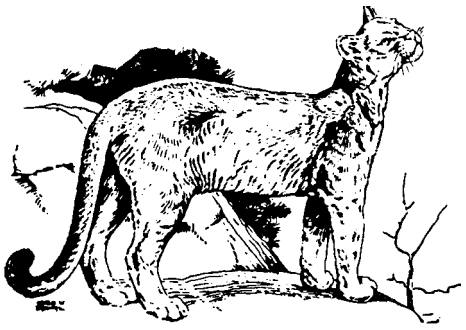
Hogs

Problems associated with feral or wild hogs have increased across the southern United States. Rooting and wallowing by wild hogs can damage agricultural crops and timber and also damage farm ponds and irrigation dikes (Barrett 1994). Wild hogs also feed on young sheep and goats in certain parts of the United States. The losses are difficult to determine at times because almost the entire carcass is either eaten or carried off and the only evidence may be tracks and blood where feeding occurred (Wade and Bowns 1982).

Tracks of adult hogs resemble those made by a 200-pound (90-kg) calf. In soft ground dewclaws will show on adult hog tracks (Barrett 1994).

Mountain Lions

Often called cougar or puma, this large feline preys on deer, elk, and domestic stock, particularly horses, sheep, goats, and cattle. It also eats rodents and other small mammals, when available. In one situation, according to Young (1933), a lone lion attacked a herd of ewes and killed 192 in one night. However, 5 to 10 sheep killed in a single night is more typical (Shaw 1983).



Mountain lions, having relatively short, powerful jaws, kill with bites inflicted from above, often severing the vertebral column and breaking the neck. They also kill by biting through the skull (Bowns 1976). Lions usually feed first on the front quarters and neck region of their prey. The stomach is generally untouched. The large leg bones may be crushed and the ribs broken. Many times, after a lion has made a kill, the prey is dragged or carried into bushy areas and covered with litter. A lion might return to feed on a kill for three or four nights. They normally uncover the kill at each feeding and move it from 11 to 27 yards (10 to 25 m) to recover it. After the last feeding the remains may be left uncovered, and a search of the area might reveal previous burial sites (Shaw 1983).

Adult lion tracks are approximately 4 inches (10 cm) in length and 4 1/4 inches (11 cm) in width; they have four well-defined impressions of the toes at the front, roughly in a semicircle. Lions have retractable claws; therefore, no claw prints will be evident. The untrained observer sometimes confuses large dog tracks with those of the lion; however, dog tracks normally show distinctive claw marks, are less round than lion tracks, and have distinctly different rear pad marks.

Opossums

Opossums are omnivorous and occasionally eat fish, crustaceans, insects, mushrooms, fruits, vegetables, eggs, and carrion. They will also raid poultry houses. The opossum usually kills one chicken at a time, often mauling the victim (Burkholder 1955). Eggs will be mashed and messy, the shells often chewed into small pieces and left in the nest. Opossums usually begin feeding on poultry at the cloacal opening. Young poultry or game birds are consumed entirely and only a few wet feathers left.

Raccoons

Raccoons eat mice, small birds, snakes, frogs, insects, crawfish, grass, berries, acorns, corn, melons — the list is almost endless. Garbage cans and dumps can be a major source of food in urban areas. Field crops or gardens near wooded areas may suffer severe damage from raccoons. Ripening corn is frequently eaten and much is wasted (Conover 1987). They raid nesting cavities of birds (Lacki et al. 1987). They will on occasion kill small lambs, usually by chewing the nose.

Occasionally, raccoons enter poultry houses and take several birds in one night. The breast and crop can be torn and chewed, and the entrails sometimes are eaten. There may be bits of flesh near water. Eggs may be removed from poultry or game bird nests and eaten away from the nest. Rearden (1951) found that eggshells were located within 28 feet (9 m) of the nest.

The raccoon leaves a distinctive five-toed track that resembles a small human hand print. Tracks are usually paired, the left hind foot beside the right forefoot (Murie 1954). Raccoon and opossum tracks can be difficult to distinguish in soft sand where toes do not show.

Skunks

Insects, particularly grasshoppers, beetles, and crickets, make up a large portion of the skunk's diet. Skunks usually dig small cone-shaped holes in lawns, golf courses, and meadows in search of beetle larvae. A common complaint of objectionable odor occurs

when skunks take up residence under buildings. Skunks may depredate beehives.

Skunks kill few adult birds, but are serious nest robbers (Einarsen 1956). Eggs are usually opened at one end; the edges are crushed as the skunk punches its nose into the hole to lick out the contents (Einarsen 1956, Davis 1959). The eggs may appear to have been hatched, except for the edges. When in a more advanced stage of incubation, eggs are likely to be chewed in small pieces. Eggs may be removed from the nest, but rarely more than 3 feet (1 m) away.

Most rabbit, chicken, and pheasant carcasses found at skunk dens are carrion that have been dragged to the den sites (Crabb 1948). When skunks kill poultry, they generally kill only one or two birds and maul them considerably. Crabb (1941) observed that spotted skunks help control rats and mice in grain storage buildings. They kill these rodents by biting and chewing the head and foreparts; the carcasses are not eaten.

Inhabited dens can be recognized by fresh droppings containing undigested insect parts near the mound or hole. Hair and rub marks also may be present. Dens usually have a characteristic skunk odor, although the odor may not be strong.

Weasels and Mink

Weasels and mink have similar feeding behaviors, killing prey by biting through the skull, upper neck, or jugular vein (Cahalane 1961). When they raid poultry houses at night, they often kill many birds, eating only the heads of the victims. Predation by rats usually differs in that portions of the body are eaten and carcasses are dragged into holes or concealed places.

Errington (1943) noted that mink, while eating large muskrats, make an opening at the back or side of the neck. As the mink eats away flesh and pieces of the adjacent hide, the ribs, head, and hindquarters are pulled out through the same hole and the animal is skinned. McCracken and Van Cleve (1947) noted similar feeding behavior by weasels eating small rodents.

Teer (1964) observed that blue-winged teal eggs destroyed by weasels were broken at the ends and had openings 1/2 to 3/4 inch (1.5 to 2.0 cm) in diameter. Close inspection of shell remains frequently will disclose finely chewed edges and tiny tooth marks (Rearden 1951).

Weasels den in the ground (for example, in a mole or pocket gopher burrow), under a barn, in a pile of stored hay, or under rocks. Mink dig dens approximately 4 inches (10 cm) in diameter into banks. Mink also use muskrat burrows, holes in logs and stumps, and other natural shelters.

Domestic Cats

Domestic cats rarely prey on anything larger than ducks, pheasants, rabbits, or quail. Einarsen (1956) noted the messy feeding behavior of these animals. Portions of their prey are often strewn over several square yards (m) in open areas. The meaty portions of large birds are consumed entirely, leaving loose skin with feathers attached. Small birds are generally consumed and only the wings and scattered feathers remain. Cats usually leave tooth marks on every exposed bone of their prey. Nesting birds are particularly vulnerable to cat predation. In areas managed for game birds or waterfowl production, vagrant cat control is almost a necessity. Unlike their native cousins, domestic cats are observed readily in the daytime, although feral cats are often extremely wary.

Acknowledgments

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OBTAINING ASSISTANCE TO CONTROL WILDLIFE DAMAGE

Introduction

The Wildlife Society (TWS) policy statement for wildlife damage control (1992) states: "Prevention or control of wildlife damage . . . is an essential and responsible part of wildlife management." The role of wildlife damage control in our society is changing and so is public perception of it. This change is recognized among wildlife managers and researchers.

Efforts are under way to make the wildlife damage control profession more responsive to concerns of society. Formal petition for the establishment of a Wildlife Damage Working Group within TWS was made to the Wildlife Society Council on March 21, 1993 and the following day the council approved interim status for the working group.

Wildlife damage control professionals should be prepared to promptly supply the best information available to solve conflicts between people and wildlife. Often, the most urgently needed information is where to go for assistance when a problem arises.

This chapter provides options for obtaining assistance. It tells who does what to minimize conflicts between people and wild animals, and it gives suggestions for obtaining self-help information and/or reaching people who can provide onsite help.

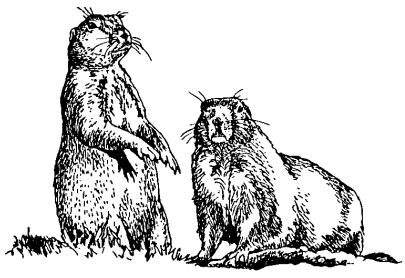
Background

Wildlife managers and agricultural specialists are often familiar with damage caused by wild animals to livestock, crops, and other types of private and public property. Conover and Decker (1991) surveyed wildlife managers and agricultural specialists throughout the United States and concluded that damage caused by wild animals was a major agricultural problem. Twenty-seven species were cited as causing the greatest problems. From a national perspective, deer reportedly caused the most damage, followed by elk, raccoons, beavers, blackbirds, and coyotes.

Damage by wild animals to ornamental plants, buildings, roads, and other structures can be serious. Some of the most costly problems are caused by house mice, Norway and roof rats, beavers, and deer (see chapters on these species in this handbook). Wild animals also cause nuisance problems, particularly in urban areas. Problems range from feces left on golf course greens by ducks and geese and garbage containers overturned by raccoons, to disturbing sounds made as small mammals move in attics and walls. Chapters in this handbook provide information about nuisance problems caused by bats, tree squirrels, raccoons, woodpeckers, ducks and geese, and other problem species.

Under some conditions wild animals are reservoirs of diseases, presenting a threat to other wildlife populations, to domestic animals, and to human health (See **Wildlife Diseases and Humans,** Friend 1987, Davidson and Nettles 1988). Also, public safety is at risk from automobile and aircraft collisions with wild animals (Dolbeer et al. 1989, Hansen 1983).

People usually enjoy having wild animals near their homes and most are willing to tolerate moderate damage from wildlife. Some people are able to control wildlife damage on their own. Others, before acting on their own, need information about the life histories of the animals causing problems, the legal status of the animals, and suggestions about controlling damage. Still others need professional, onsite help to solve wildlife damage problems. There are programs available to meet the needs of do-it-yourself wildlife managers and onsite assistance for people who need more help.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

Obtaining Assistance

Table 1 shows whom to contact for information, permits, and hands-on assistance. Mailing addresses and telephone numbers of coordinating offices for federal and state agencies are listed in the National Wildlife Federation Conservation Directory, which is published annually. Some key national groups and telephone numbers are listed below in the section on "Groups That Help Prevent and Control Wildlife Damage." Private pest control operators and local offices of government agencies that help control wildlife damage may be found in public telephone directories.

Keep in mind that permits may be required **before** control activities are initiated. When there is a possibility that endangered species or migratory birds will be affected, contact the US Fish and Wildlife Service. When game animals are involved, contact your state wildlife management agency. When aquatic habitats such as wetlands or streams may be affected, contact the US Army Corps of Engineers and your state environmental regulatory agency.

Special materials may be required to prevent and control wildlife damage. Chapters on individual species list information about such materials. Most items will be available from hardware and gardening supply stores. When pesticides are used, read labels carefully. You may need to contact USDA-APHIS-Animal Damage Control (ADC) or the Extension Service for explanation of some applications. The Pocatello Supply Depot operated by USDA-APHIS-ADC provides some chemical control agents for wildlife (see section below on the ADC Program). The **Pesticides** section in this handbook provides more details.

Effective techniques for controlling damage from wild animals do not exist for all situations. Information about research to solve special problems or international issues related to wildlife damage control may be obtained from the Denver Wildlife Research Center or the Jack H. Berryman Institute of Wildlife Damage Management at Utah State University. A section on wildlife damage research is presented below.

Attracting wildlife through feeding and habitat enhancement has gained popularity in recent years. This has resulted in greater appreciation of wildlife among urban residents and provides educational opportunities. Conflicts may develop, however, when wild animals concentrate near feeders and protected sites.

The key to enhancing urban wildlife is careful planning to develop compatible situations where the needs of wild animals are met without creating intolerable situations for people. Keep in mind that wild animals enjoyed by some people may cause problems for neighbors. The fox that one family likes to see in the backyard may be a serious problem for neighbors raising chickens, and the deer that people enjoy viewing from a distance may be a safety hazard on roads or may cause serious damage to ornamental plants and gardens in the community.

Groups that Help Prevent and Control Wildlife Damage

Cooperative Extension Service

The Cooperative Extension Service is a good place to start when you have a problem with wild animals and do not know where to obtain help. The extension service provides a wide range of information on prevention and control of wildlife damage through local agents in most counties and specialists at many state universities. Extension wildlife activities are coordinated nationally through the Natural Resources and Rural Development Program (202-720-5468). Local extension service offices are listed in government sections of telephone directories.

Animal Damage Control Program

USDA-APHIS provides operational and technical assistance to reduce conflicts between people and wildlife through the nationwide ADC, program. Help is available to states, individuals, and public and private organizations when wild animals damage livestock, poultry, beneficial wildlife, or crops including forests and rangelands. Help is also available when wild animals threaten human health and safety.

The ADC program includes a deputy administrator (202-720-2054), headquarters support staff, the Denver Wildlife Research Center, and the Pocatello Supply Depot. Operational activities are managed within most states through the eastern and western regional offices, and individual state offices. The Denver Wildlife Research Center (DWRC) (303-236-7826) is a major research facility devoted to improving methods and materials for vertebrate damage control. The Pocatello Supply Depot at Pocatello, Idaho (208-236-6920), manufactures and sells some toxicants, fumigants, and other products for wildlife damage management.

Fish and Wildlife Service

The US Fish and Wildlife Service has primary responsibility for managing endangered species and migratory birds. Contact the agency about required permits before initiating control activities that involve these species (Office of Management Authority, 800-358-2104).

State Wildlife and Fish Management Agencies

State wildlife and fish management agencies are responsible for managing most resident species of wildlife and fish, as well as migratory species while they are within state borders. Often permits are required from the state agency before species listed as game animals, furbearers, or game fishes can be controlled. Permits may also be required if species are involved that are considered rare or endangered by the state. Check with your local state wildlife and fish management agency when you obtain a permit for control from the US Fish and Wildlife Service.

Table 1. Sources of information (I), permits (P), and hands-on assistance (A) for wildlife damage control. The National Wildlife Federation *Conservation Directory* lists addresses and telephone numbers for coordinating offices for federal and state agencies. Public telephone directories list local government offices and private pest control operators.

SPECIES	USDA-APHIS-Animal Damage Control	Extension Service	US Fish and Wildlife Service	State wildlife and fish management agencies	Local animal control agencies	Private pest control operators
Mammal Predators						
Badgers	I	I		P		A
Bears	IA	I		IP		
Bobcats and lynx	IA	I		IP		
Cougars	IA	I		IP		
Coyotes	IA	I		IP		
Feral house cats	I	I		I	A	A
Feral dogs	IA	I		I	A	A
Foxes	IA	I		IP	A	
Opossums	IA	I		I	A	A
Otters	I	I		IP		
Raccoons	IA	I		IP	A	A
Skunks	IA	I		IP	A	A
Weasels	IA	I		IP		
Wolves	IA	I	P	IP		
Small Mammals						
Bats	I	I	P	I	A	A
Beavers	IA	I		IP		A
House mice	I	I			IA	A
Moles	I	I				A
Muskrats	IA	I		IP		A
Pocket gophers	I	I				A
Prairie dogs	IA	I	I	I		A
Norway rats	I	I			IA	A
Roof rats	I	I			IA	A
Rabbits	IA	I	I	IP	IA	A
Tree squirrels	I	I		P	IA	A
Voles	I	I				A
Big Game Mammals						
Bison	I	I		P		
Deer	I	I		IPA		A
Elk		I		IPA		
Feral swine	I	IA		IP		
Moose		I		IPA		
Pronghorns		I		IPA		
Birds						
Blackbirds	IA	I	I	I	I	A
Crows	IA	I	I	I		A
Ducks and geese	IA	I	IP	IP		A
Eagles	IA	I	IP	IP		
Egrets, herons, and cormorants	IA	I	IP	IP		
Hawks, falcons, and owls	IA	I	IP	IP		
Magpies	IA	I	I			
Pigeons	IA	I			I	A
House sparrows	IA	I			I	A
Starlings	IA	I			I	A
Turkeys		I		IP		
Woodpeckers	IA	I	IP	IP	I	A
Reptiles						
Alligators	I	I		IP		A
Snakes	I	I		I	I	A

Local Animal Control Authorities

The local animal control authority, public health service, or animal welfare organization, may be able to provide assistance with damage caused by urban wildlife, in situations in which humans are threatened by wildlife, and with free-ranging dogs and cats. Refer to government sections of your local public telephone directory.

Professional Pest Control Operators

Private pest control operators located throughout the United States provide a wide range of wildlife damage control supplies and services. Consult your telephone directory for local pest control operators. The National Animal Damage Control Association and the Urban Wildlife Management Association may be able to provide contacts for special control situations.

Research to Understand and Minimize Wildlife Damage

Research on ways to minimize damage caused by wild animals dates back to the nineteenth century. In the United States, most research on damaging wildlife has been conducted and/or funded by government agencies. Major research efforts date back to the establishment of the Section of Economic Ornithology within the US Department of Agriculture in 1885 (US Fish and Wildlife Service 1981). The section grew, and in 1905 became the Bureau of Biological Survey. The survey and cooperating universities conducted studies of pocket gophers and ground squirrels. The survey also supported research on predatory animals, mainly aimed at eliminating them to satisfy demands of the growing western livestock industry.

Controversy about controlling coyotes and other wild animals increased from the late 1920s through the 1970s. Opposition to control changed from a fringe position opposed to wild animal suffering in the 1930s to a well-organized, national movement concerned with environmental issues and animal welfare. The emphasis of wildlife damage control research also shifted from lethal control to nonlethal control techniques that include more studies of predator behavior.

Numbers of wildlife professionals involved in wildlife damage control declined through the 1960s and 1970s as controversy increased. By 1978 only 41 of 450 US and Canadian university and college wildlife faculty members surveyed reported an emphasis in the ecology and control of damaging vertebrates (Blaskiewicz and Kenny 1978).

In recent years, most research relating to problem wildlife has been conducted by personnel of the Denver Wildlife Research Center (DWRC) or has been supported by grants from the center. In 1986, the DWRC was transferred from the Fish and Wildlife Service to the Animal and Plant Health Inspection Service (APHIS).

The DWRC has national and international programs devoted to providing scientific information on wildlife damage, existing control practices, and alternative methods for reducing damage. About half of the staff is based in Denver; the rest are located at field stations on university campuses and other sites in the United States and cooperating countries.

The DWRC has cooperative ties with several universities. Colorado State University in Fort Collins has been a close cooperator with DWRC for many years. DWRC staff serve as instructors in some courses and advise and support research studies by university students. The DWRC has been particularly involved in short courses on wildlife damage research and management for foreign students. APHIS plans to move the DWRC headquarters to the Colorado State University campus. A master plan has been completed and construction of an animal facility was initiated in 1993.

Cornell University, in Ithaca, New York, has cooperated for five years with DWRC in conducting research on deer damage and its management. The university, along with the New York Cooperative Fish and Wildlife Research Unit, has conducted research on a variety of wildlife damage problems ranging from biological studies of pine voles to human perceptions of wildlife damage and control.

The Monell Chemical Senses Center on the Philadelphia campus of the University of Pennsylvania is a nonprofit research institute devoted exclusively to studies of taste, smell, and the common chemical sense. This institute has been involved with wildlife damage research since its inception in 1968. The DWRC has maintained a field station at the center since 1978. The center has focused on the role of the chemical sense in wildlife damage management, including bait shyness, food-aversion learning, attractancy, and repellency.

The University of Florida at Gainesville has worked cooperatively with a Gainesville-based field station of the DWRC on research leading to cultivars of blueberries that might improve resistance to depredation by some species of birds

The DWRC staff also work in collaboration with the Gainesville-based field station and Louisiana State University's Rice Research Station to study and control blackbird damage to rice. Research efforts are also devoted to the control of beaver damage in waterways.

Mississippi State University, in Starkville, has had a strong interest in wildlife damage research for many years, partly through the US Fish and Wildlife Service Cooperative Research Unit on the campus. Since the establishment of a field station of the DWRC on campus in 1988, the research has focused particularly on bird depredations to aquaculture. The Maine Cooperative Fish and Wildlife Research Unit has also had interest in cormorant depredations in aquaculture. The DWRC has assisted in the development and production of radiotelemetry equipment to allow tracking of movements of cormorants for both the Maine and Mississippi studies.

Bowling Green State University, in Ohio, has a strong research and educational program in wildlife damage management. The DWRC has cooperated in this program by sponsoring

research activities, and by classroom lectures and discussion. Plans are being developed to form close working relationships between the University and the DWRC field station at nearby Sandusky, Ohio. In the past, the field station program focused on blackbird population dynamics and damage to corn. More recent research has emphasized gull problems at airports and at sanitary landfills. The present leadership of Bowling Green State University is strongly supportive of continued programs in wildlife damage management.

North Dakota State University in Fargo has worked cooperatively with DWRC on reducing blackbird damage to sunflowers. The University has a long-term plant-breeding program that has produced two high-yield cultivars of sunflower that exhibit resistance to blackbird damage. Research at the field station is presently focused on alteration of cattail marshes to make them unsuitable as roosts for blackbirds and more suitable for other migratory birds.

Some cooperative studies are being conducted on the efficacy of DRC-1339 for blackbird control with the Jack H. Berryman Institute of Wildlife Damage Management at Utah State University, in Logan (801-797-2436). This new institute offers a broad research and graduate educational program focusing on innovative approaches to controlling wildlife damage. The purpose of the institute is to help wildlife damage management specialists and researchers do their jobs better and to foster communication.

Utah State University is also the site of a field station of DWRC that focuses primarily on predator control methods and their alternatives. The station is uniquely equipped with large penned areas for the study of coyote behavior. This station, along with its university-based cooperators, has been the source of many studies contributing to our present understanding of coyote biology, behavior, physiology, and population dynamics.

Washington State University in Pullman has had an active interest in a broad range of wildlife damage issues for many years, including the development of bird-repellent methods, animal-restraining systems, humane trapping standards, and control of rodent damage to orchards. The recent addition of a DWRC field station at the university is strengthening the program, particularly in rodent problems and their control. The Pullman station is closely tied with a DWRC field station at Olympia, which has focused for many years on wildlife damage to forests by species such as deer, mountain beavers, voles, and pocket gophers. These research programs assess the efficacy of existing control and look at repellent devices, food aversion learning, and chemical repellent systems. The work is also closely coordinated with the field station at Monell Chemical Senses Center in Philadelphia.

The University of California, at both Berkeley and Davis, as well as the University System's Research and Extension Center at Hopland, has had a strong and broad research and educational program in wildlife damage under the leadership of Dr. Walter Howard, professor emeritus of the University of California at Davis. The Berkeley scientific staff has had particular interest in deer damage and population dynamics, whereas the Hopland Center has contributed much to understanding and managing predator problems. The recent addition of a DWRC field station at the Berkeley location is providing opportunities for studies of predator behavior and population dynamics as well as alternative control approaches. Some of these projects are coordinated with studies of coyotes at Yellowstone National Park and the University of Montana at Bozeman.

In addition to field stations and collaborating scientists, DWRC has contracts with universities and other organizations to conduct research. Arizona State University in Tempe has contracted to conduct studies on food aversion learning as it relates to predator management. Several universities have participated in studies of contraception as a wildlife damage management tool. These include studies at Rutgers University in New Brunswick, New Jersey, on hormonal approaches to contraception of deer and studies at Baylor Medical College in Waco, Texas, and Pennsylvania State University in State College, Pennsylvania, on immunologically based approaches to contraception of deer. The DWRC has also supported student research at the University of Missouri-Colombia on human perceptions of goose management.

Although the DWRC continues to cooperate with universities, it has not cooperated formally with all universities that have an interest in or active research or educational programs in wildlife damage management. For example, the University of Nebraska-Lincoln has strong research and educational programs in wildlife damage management, as does Kansas State University in Manhattan. Both of these universities would be suitable candidates for closer cooperative efforts in the future. In general, cooperative research ties with universities have provided opportunities to assess new approaches to wildlife management. The ties have also served as recruitment pools for scientists and support staff for professional groups involved in wildlife damage management. The numerous cooperative ties with DWRC attest to a broad and continuing interest in wildlife damage management by many universities.

The director of the DWRC (303-236-7820), can serve as a source for further contacts with any of the universities and research programs described above.

Summary

An overview of sources of information about wildlife damage management is presented in Table 1. The table is not comprehensive because laws and services vary from state to state. Good starting places for information are local Cooperative Extension offices, state wildlife management agencies, and animal control authorities. They may refer you to USDA-APHIS-ADC or private wildlife damage control services in your area.

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WILDLIFE DISEASES AND HUMANS

INTRODUCTION

Diseases of wildlife can cause significant illness and death to individual animals and can significantly affect wildlife populations. Wildlife species can also serve as natural hosts for certain diseases that affect humans (zoonoses). The disease agents or parasites that cause these zoonotic diseases can be contracted from wildlife directly by bites or contamination, or indirectly through the bite of arthropod vectors such as mosquitoes, ticks, fleas, and mites that have previously fed on an infected animal. These zoonotic diseases are primarily diseases acquired within a specific locality, and secondarily, diseases of occupation and avocation. Biologists, field assistants, hunters, and other individuals who work directly with wildlife have an increased risk of acquiring these diseases directly from animal hosts or their ectoparasites. Plague, tularemia, and leptospirosis have been acquired in the handling and skinning of rodents, rabbits, and carnivores. Humans have usually acquired diseases like Colorado tick fever, Rocky Mountain spotted fever, and Lyme disease because they have spent time in optimal habitats of disease vectors and hosts. Therefore, some general precautions should be taken to reduce risks of exposure and prevent infection.

GENERAL PRECAUTIONS

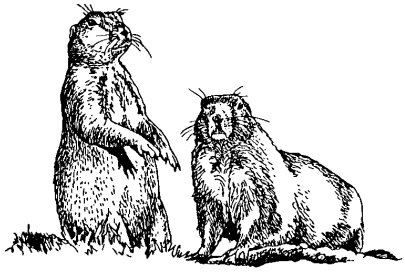
Use extreme caution when approaching or handling a wild animal that looks sick or abnormal to guard against those diseases contracted directly from wildlife. Procedures for basic personal hygiene and cleanliness of equipment are important for any activity but become a matter of major health concern when handling animals or their products that could be infected with disease agents. Some of the important precautions are:

1. Wear protective clothing, particularly disposable rubber or plastic gloves, when dissecting or skinning wild animals.
2. Scrub the work area, knives, other tools, and reusable gloves with soap or detergent followed by disinfection with diluted household bleach.
3. Avoid eating and drinking while handling or skinning animals and wash hands thoroughly when finished.
4. Safely dispose of carcasses and tissues as well as any contaminated disposable items like plastic gloves.
5. Cook meat from wild game thoroughly before eating.
6. Contact a physician if you become sick following exposure to a wild animal or its ectoparasites. Inform the physician of your possible exposure to a zoonotic disease.

Precautions against acquiring fungal diseases, especially histoplasmosis, should be taken when working in high-risk sites that contain contaminated soil or accumulations of animal feces; for example, under large bird roosts or in buildings or caves containing bat colonies. Wear protective masks to reduce or prevent the inhalation of fungal spores.

Protection from vector-borne diseases in high-risk areas involves personal measures such as using mosquito or tick repellents, wearing special clothing, or simply tucking pant cuffs into socks to increase the chance of finding crawling ticks before they attach. Additional preventive methods include checking your clothing and body and your pets for ticks and removing the ticks promptly after returning from infested sites. If possible, avoid tick-infested areas or locations with intense mosquito activity during the transmission season. Reduce outdoor exposure to mosquitoes especially in early evening hours to diminish the risk of infection with mosquito-borne diseases.

Equally important preventive measures are knowledge of the diseases present in the general area and the specific habitats and times of year that present the greatest risk of exposure. Knowledge of and recognition of the early symptoms of the diseases and the conditions of exposure are essential in preventing severe illness. Also



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

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United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

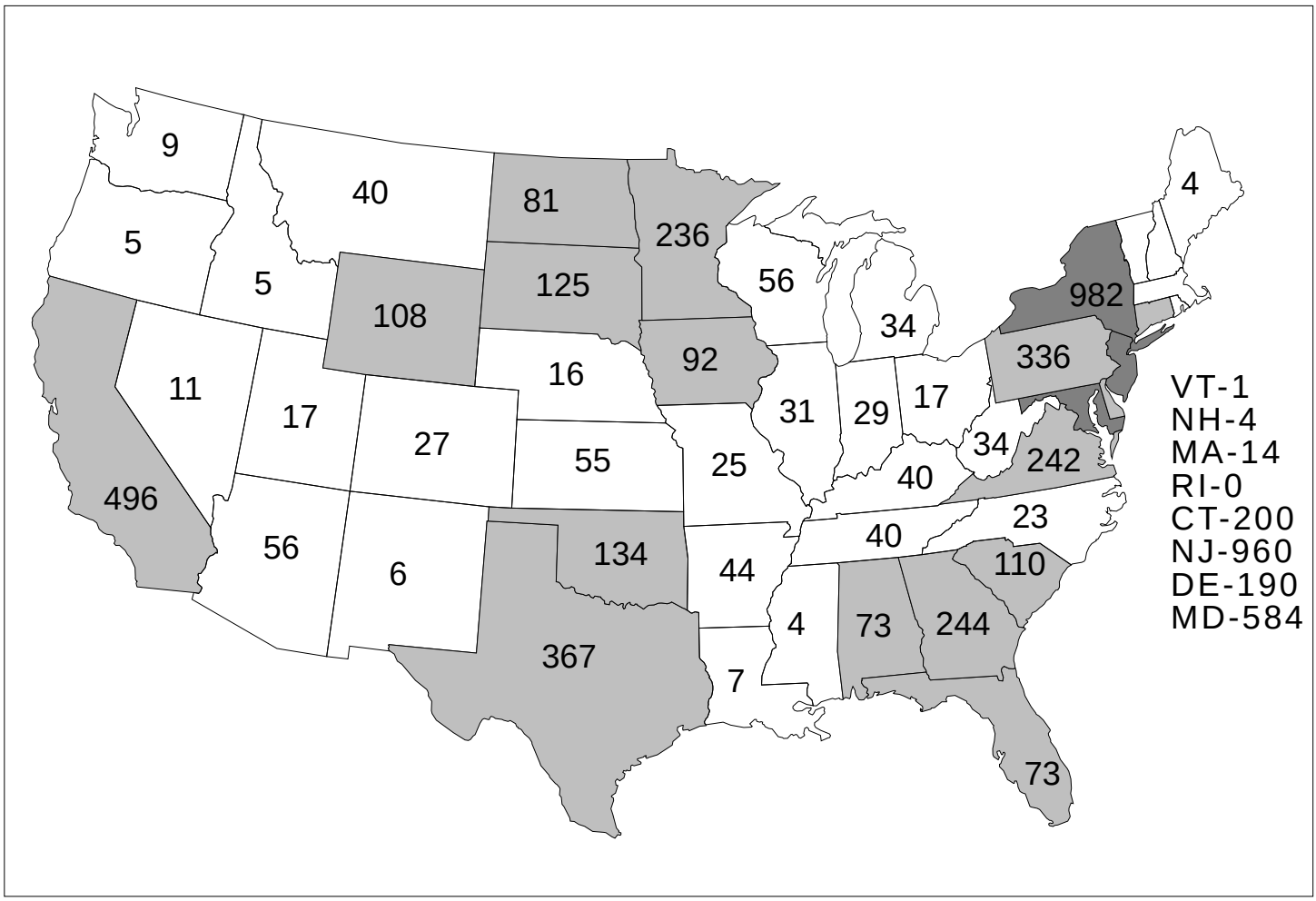

Fig. 1. Reported human cases of wildlife rabies in the United States, 1991.

important are medical evaluation and treatment with proper antibiotics. For example, if you become ill following some field activity in a known plague-endemic area and you recognize the early symptoms of the disease, seeking medical care and informing the attending physician of your possible exposure to plague will aid in the correct treatment of your illness and reduce the risk of complications or even death.

In addition to taking personal precautions, risk of acquiring vector-borne diseases can be reduced in specific locations through area-wide applications of insecticides to control mosquito or flea vectors or acaricides to control tick vectors. Reduction in host populations (for example, rodents) and their ectoparasites (fleas or ticks) may be needed to control transmission of such diseases as plague or Lyme disease. Vaccination of wildlife hosts as a means of reducing zoonotic diseases is currently being investigated and may soon be available for diseases like rabies.

WILDLIFE DISEASES OF PUBLIC HEALTH CONCERN

Directly Transmitted Diseases

Rabies

Rabies is an acute disease, caused by a virus (rhabdovirus), that can infect all warm-blooded animals, and is usually fatal. Certain carnivorous mammals and bats are the usual animal hosts (Fig. 1; Table 1). Rabies occurs throughout most of the world; only Australia and Antarctica are free of it. Most human cases have been contracted from rabies-infected dogs. In the United States, human cases have decreased to an average of one person per year (75% of cases are acquired outside the United States). Reduction in human rabies is likely linked with the intensive control of dog rabies during the 1950s and 1960s through massive vaccination campaigns, stray dog control programs, and improvement in human treatment following exposure. Nevertheless, thousands of people in the United States continue to receive treatment every year for possible exposure to rabies virus by animal bites. Most of the treatments are still due to dog and cat bites; however, these pet species have the lowest occurrence of reported rabies among all animal species tested.

Rabies in wildlife increased dramatically during the 1960s and now accounts for most of the reported animal rabies cases (91% in 1991). Some of the increase in reporting was due to real increases in the number of cases, and some was due to an increased awareness of wildlife rabies, particularly in striped skunks, raccoons, and bats. In 1991, 6,975 cases of animal rabies were reported in 49 states, the District of Columbia, and Puerto Rico. Raccoons (44.2%), striped skunks (29.7%), and various species of bats (9.9%) continued to be the major hosts. Red and gray foxes (4.6%), other wildlife species (2.8%), and domestic animals (8.9%) comprise the remainder of hosts. During the last 2 years, raccoons replaced striped skunks as the major wildlife host in the United States because of the continued expansion of raccoon rabies in the northeastern United States. Animal cases are reported throughout the year, although the number of cases reported reaches a seasonal peak for skunks in March and April, for raccoons in April, and for bats in August.

Clinical Signs. Rabies is considered almost 100% fatal once clinical signs develop. The disease progresses rapidly following the appearance of clinical signs, and the animal dies within a few days. Although abnormal behavior is not diagnostic for rabies (other diseases, like distemper, cause similar behavioral changes), atypical behavior and signs develop following brain infection, and rabies should be suspected whenever wild animals display unusual behavior.

Infected animals usually display either "furious" or "dumb" rabies, although some animals progress through both stages. Skunks, raccoons, foxes, and other canids usually have furious rabies and are unduly aggressive before convulsions and paralysis set in. Some animals, however, have dumb rabies and proceed to tremors and convulsions without agitation or aggression. Other behavioral changes include friendliness or loss of fear, appearance in the daytime for some typically nocturnal species (skunks, bats), unprovoked attacks on anything that moves (including inanimate objects), bewilderment, and aimless wandering. Unusual barking, crying, and frothing at the mouth are additional signs, which are the result of paralysis of the throat muscles. Occasionally, rabid bats are encountered prostrate or fluttering on the ground, unable to fly; they should be handled with care because they can still bite and transmit rabies. Some rabid bats, particularly solitary species like the hoary bat, are aggressive and have been known to attack people. In domestic animals, rabies should be suspected if there is any change in normal habits, such as sudden change in disposition, failure to eat or drink, running into objects, or paralysis.

Transmission. Rabies virus is transmitted primarily via the saliva during the bite of a rabid animal. However, other methods of transmission are possible. Accidental exposure of wounds or cuts to the saliva or tissues of infected animals can occur. The virus is also present in various body organs of infected animals, especially the brain and salivary glands, which poses a health hazard to persons who are field dressing or performing necropsies on these animals. In addition, aerosol exposure has occurred, although rarely, in caves containing very large populations of infected bats. Transmission between animals also occurs by ingestion of infected tissues and by transplacental passage to offspring.

When the virus enters the tissue of a susceptible animal or human, it multiplies at the bite or inoculation site and travels slowly up nerve fibers to the part of the brain that controls the bitten area. The virus multiplies there and spreads to other parts of the brain and eventually produces a variety of signs in the infected animal or person. The virus also spreads from the brain to other tissues, particularly to the salivary glands, where it multiplies and is released into the saliva. The virus is perpetuated in nature when an infected animal with virus in its saliva bites another animal.

The virus is rarely present in the salivary glands without first occurring in the brain and is present in the saliva for only a few days before clinical signs appear. Exceptions occur in a few species of bats and in a unique African virus strain found in dogs. The length of the incubation period (from the time the animal is bitten until clinical rabies appears) is usually 2 to 3 weeks, but varies from 10 days to several months.

Handling of Suspect Animals and Diagnosis. Use caution when approaching a suspected rabid animal since many are still aggressive and can bite even if paralyzed. If the animal is still alive, it should be killed humanely without damaging the head. To confirm whether an animal is infected with rabies, the animal must be submitted to the local health department or state diagnostic laboratory for testing.

Avoid exposure to any sick or dead animals that are suspected to have rabies. Handle any dead animal with gloves or with a plastic bag that can be turned inside-out to cover and contain the animal. Avoid direct skin contact with the animal. For large animals such as skunks and raccoons, remove the head cautiously and seal it in a plastic bag, avoiding contact or aerosol exposure. Seal the whole animal or head inside an additional plastic bag (double) and keep it cool at all times. Do not freeze the specimen unless a delay of several days is anticipated before it is examined for rabies. Disinfect gloves or knives that were in contact with the animal with a strong detergent or bleach or dispose of them.

For transport to the laboratory, place the double-wrapped specimen in a leak-proof container with a coolant (not wet ice). Send the container by bus or other prearranged transportation. Include information about the specimen (species, date, geographic data, behavior) and the names, addresses, and telephone numbers of the person submitting the specimen and of anyone exposed to the animal.

To test for rabies, a fluorescent antibody (FA) test is performed directly on brain tissue to distinguish rabies virus from other disease agents (like distemper virus) that could be present in the animal's brain. In some states, brain

material is inoculated into mice to demonstrate virus for those specimens that resulted in human exposure.

If a person or pet is exposed to an animal suspected of having rabies but that has not been captured, record a description of the suspect animal (species, behavior) and provide the description to public health officials or the attending physician to determine possible treatment.

Prevention and Treatment. The best treatment for rabies is prevention. Individuals at high risk of exposure to rabies, such as wildlife biologists, game wardens, animal control officers, animal handlers, and veterinarians should be vaccinated before potential exposure. Safe and highly effective vaccines are available through a physician or the local health department.

First aid should immediately be provided to a person who has been bitten by or had contact with a potentially rabid animal. Scrub the exposed site, including bite wounds, with soap and water or water alone and flush thoroughly. Then apply a strong first aid solution (iodine) or cream. First aid treatment is the most effective method of preventing infection by the rabies virus but should not preclude medical attention from a physician, hospital emergency room, or the local health department. Contact your physician or health department as soon as possible to determine dosage of rabies vaccine and whether antirabies serum is required. Inform the health care professionals about the rabid animal and the circumstances of the exposure (species of animal involved and its behavior, if the attack or bite from the animal was provoked, and what type of first aid was administered).

Hantavirus

Hantavirus includes a group of viruses that can cause a febrile illness in humans which can be accompanied by kidney, blood, or respiratory ailments and can sometimes be fatal. The febrile illness includes fever, headache, muscle aches, nausea, vomiting, and lower back pain. Field and commensal rodents are the natural reservoirs for viruses in this group and these viruses are found worldwide. Infected rodents shed virus in their urine, feces, and/or saliva and can remain chronically infected. The contaminated excreta from infected rodents are thought to be the source of virus for aerosol and direct (animal bite) transmission to other rodents and humans.

The recent discovery of a possible new hantavirus in the southwestern United States and its apparent increased virulence, has heightened the awareness of and concern for rodent-associated diseases. It produces produces respiratory distress and potential death in humans. Human cases and deaths from this viral infection were first reported in 1993 in the Four Corners area of Arizona, Colorado, New Mexico, and Utah and, more recently, throughout the United States. Preliminary information has incriminated the deer mouse (*Peromyscus maniculatus*) as the natural reservoir and source of human infection in that region. Individuals trapping and handling small rodents in this region should take increased precautions to reduce their exposure to this virus. They should at least wear surgical gloves and masks when processing rodents (contact CDC Hotline for more detailed and thorough safety information). Rodent control with careful handling and disposal of carcasses should be instituted at campsites or in cabins before they are occupied. The premises should be sprayed with detergents or diluted bleach before thorough cleaning. Wet-mopping is recommended. Dry sweeping and vacuuming may increase risk of producing airborne particles. Rodent harborage should be removed from premises and from the surrounding area. Exclude rodents where possible.

Trichinosis

Trichinosis may result in diahrrea, sudden edema of the upper eyelids, photophobia, muscle soreness and pain, skin lesions, thirst, sweating, chills, and weakness. Other respiratory and neurological symptoms may appear if treatment is delayed.

Trichinosis is contracted by eating infected meat which contains the encysted parasites. The parasites may remain infectious in meat which is raw or poorly cooked.

Trichinosis is caused by a nematode parasite which produces the disease in humans and domestic and wild animals. Evidence indicates that nearly all mammals are susceptible to infections with this parasite, which encysts in the muscle of the host and is then transmitted through consumption of infected flesh. As would be expected, the disease is most common in wild carnivores and scavengers.

As with other wildlife diseases, trichinosis is difficult to control in nature. However, certain steps can be taken to decrease the problem. Carcasses of carnivores and other meat-eating species should not be discarded in the fields or woods, but should be made unavailable by burying or other means. These carcasses also should not be fed to swine, dogs, or other domestic animals. Open garbage dumps should be replaced by the landfill type or other methods of disposal where wildlife will not have access to meat scraps. If open garbage dumps cannot be eliminated, rodent control programs should be initiated and the areas fenced to prevent scavenging by larger animals such as foxes. These steps would markedly reduce the problem of trichinosis in wildlife in the United States.

If carnivorous or omnivorous wildlife such as bears, bobcats, opossums, raccoons, or feral pigs are consumed by humans, the meat should be properly prepared by cooking, freezing, or curing to destroy any viable trichinae. Cooking to an internal temperature of 137^{o}F is deemed sufficient for pork, while freezing at 5^{o}F for 20 days, -10^{o}F for 10 days, or -20^{o}F for 6 days will kill trichinae. Curing should follow approved government regulations.

Mosquito-borne Encephalitis

Encephalitis is a disease caused by mosquito-borne viruses (arboviruses) that affect the central nervous system. Infections range from unapparent to mild, nonspecific illnesses (fever, headache, musculoskeletal pain, and malaise) to occasionally severe illness of the central nervous system resulting in permanent neurologic damage and possibly death. The four major types of encephalitis in the United States include St. Louis encephalitis (SLE), California encephalitis (CE primarily includes the LaCrosse virus [LAC]), eastern equine encephalitis (EEE), and western equine encephalitis (WEE). The distribution of these arboviruses varies (Fig. 2). SLE occurs throughout the United States (an epidemic occurred in central Florida in 1990 and Arkansas in 1991), WEE occurs west of the Mississippi River, EEE occurs east of the Mississippi River but mostly along the Atlantic and Gulf coasts and north-central states, and CE occurs in California and the eastern United States (LAC type). Human cases of arbovirus infection have a seasonal occurrence from mid- to late summer.

These distinct viruses naturally infect a variety of birds and mammals and are transmitted between animals by mosquito vectors. Occasionally, infected mosquitoes will feed on human or equine hosts that are "dead ends" for the viruses, with little or no chance of subsequent transmission to other mosquitoes. These viral infections may, however, result in severe illness or death in humans or horses (EEE and WEE). Only EEE and occasionally WEE viruses adversely affect wild vertebrates; for example, EEE causes death in ring-necked pheasants and other exotic game birds, house sparrows, red-winged blackbirds, whooping cranes, and other species. The wildlife hosts for LAC virus are the eastern chipmunk, tree squirrels, and foxes. The natural hosts for the other three viruses are mostly songbirds, although squirrels and jackrabbits may be involved in WEE transmission.

No treatment or commercial vaccine is available for humans, but vaccines for WEE and EEE are readily available for horses. The best preventive measures are personal protection against mosquito bites, especially avoiding exposure to mosquitoes during early evening hours, and the use of repellents. Mosquito populations can be reduced in an area by eliminating breeding sites for vector species. Killing adult mosquitoes with areawide applications of insecticides has been most effective in preventing epidemics.

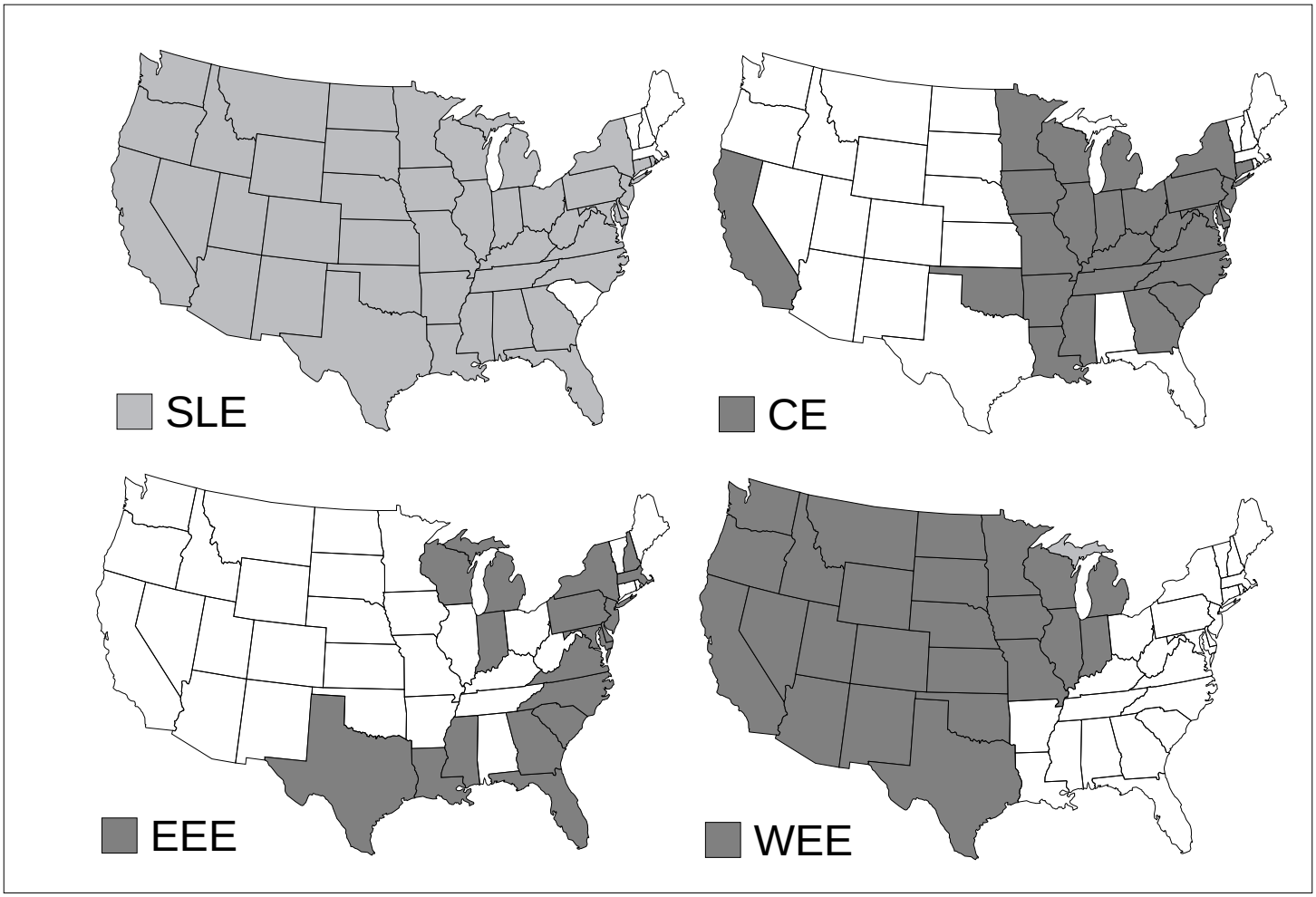

Fig. 2. Distribution of mosquito-borne encephalitis in the United States, 1964 to 1992; (a) St. Louis encephalitis (SLE); (b) California encephalitis (CE); (c) eastern equine encephalitis (EEE); and (d) western equine encephalitis (WEE).

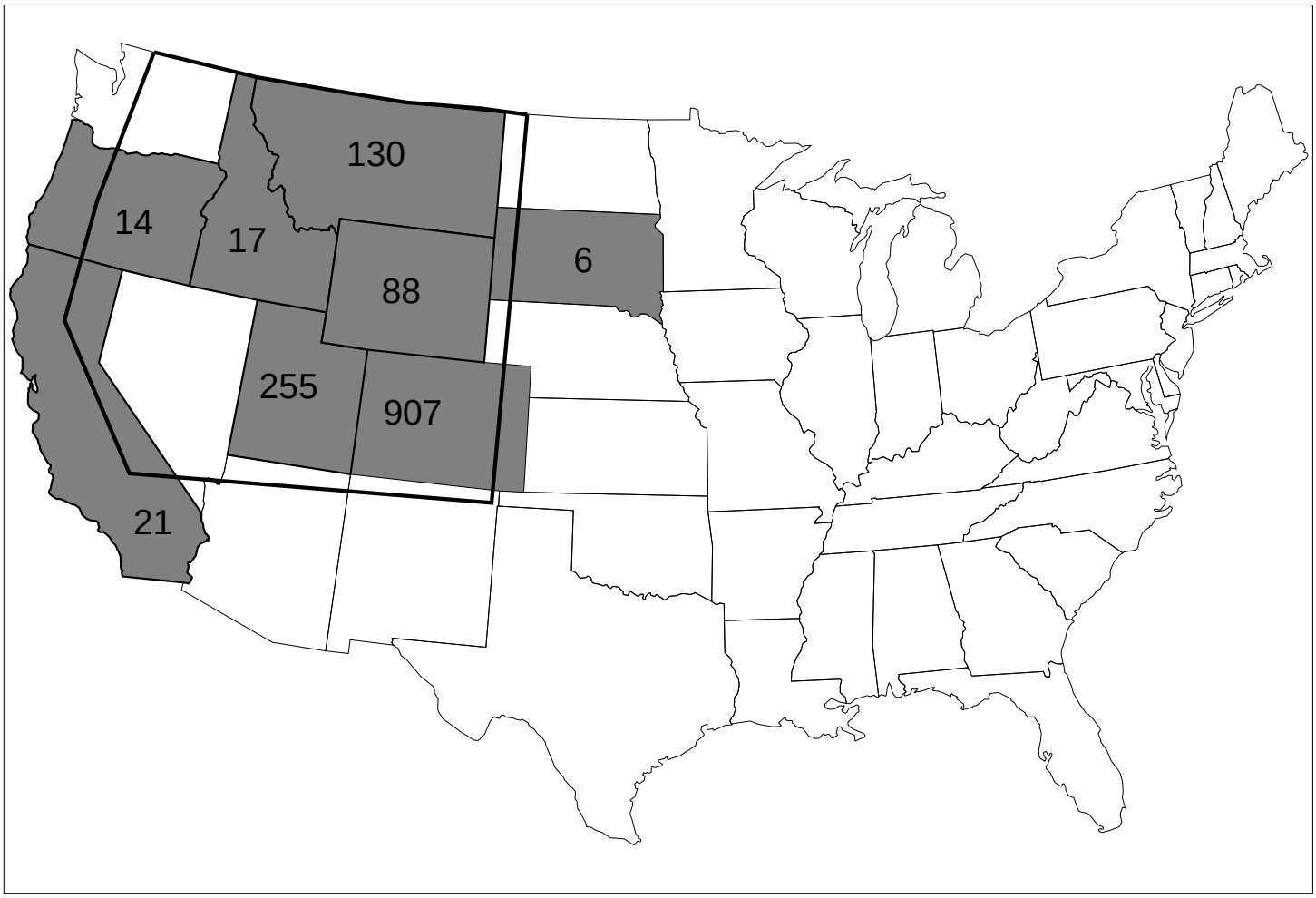

Fig. 3. Distribution of Colorado tick fever (human cases) in the United States, 1980 to 1988. (Solid line outlines distribution of *Dermacentor andersoni*.)

Tick-borne Diseases

Colorado Tick Fever

Colorado tick fever (CTF) is an acute and rather benign disease caused by a virus (coltivirus) that is transmitted to humans by ticks. Symptoms are usually limited to high fever, headache, muscle aches, and lethargy, but the symptoms are frequently biphasic and recurring. The disease is confined to the mountains or highland regions of eight western states and western Canada (Fig. 3). About 150 to 200 cases are reported each year; 1,438 cases were reported from 1980 to 1988 in eight western states, 63% of them in Colorado. CTF is transmitted to humans during the spring and early summer by the bite of the adult stage of the Rocky Mountain wood tick (*Dermacentor andersoni*) or by *D. occidentalis* in California. The virus is maintained in nature through transmission by immature stages of ticks to various species of small mammals, particularly chipmunks, ground squirrels, and deer mice during the spring and summer months. The virus survives the winter in infected tick nymphs and adults. The habitats that support the rodent hosts and tick vectors of the virus in the disease endemic region contain rocky surfaces with moderate shrub cover and scattered pines.

Avoid tick-infested habitats during spring and early summer and use personal protection against ticks. No vaccines or treatment are available.

Rocky Mountain Spotted Fever (Tick-borne Typhus)

Rocky Mountain spotted fever (RMSF) is a moderate to severe illness caused by a rickettsia (*Rickettsia rickettsii*). The disease is distinguished by a sudden onset of high fever, severe headache, muscle pain, and a red rash starting on the extremities about 3 to 6 days after onset of symptoms and extending to the palms of hands and soles of feet and then to the rest of the body. Delirium, coma, and death occur in about 1% to 2% of cases (15% to 20% in untreated cases). The disease is transmitted to humans in the United States by several hard tick (Ixodidae) species; *D. andersoni* in the Rocky Mountain region, *D. variabilis* in the east and southeast, and *Amblyomma americanum*

in the south-central states. In 1990, 649 cases of RMSF were reported from all regions of the United States, although more cases were reported in the south-Atlantic and south-central states (Fig. 4). The natural hosts for the rickettsia are a variety of wild rodents, although rabbits and wild and domestic carnivores are involved in some cases. The rickettsia survive the winter months in the tick vector and may be maintained by transovarial transmission from the female adult tick to its offspring.

Avoid tick-infested areas and use personal measures to protect against tick bites. No vaccine is presently licensed for public use, but antibiotic treatment is effective and should be initiated without waiting for laboratory confirmation of clinical diagnosis.

Lyme Disease

Lyme disease is caused by a spirochete bacterium (*Borrelia burgdorferi*) that is transmitted to humans by hard ticks. Early symptoms include a flu-like illness with headache, slight fever, muscle or joint pain, neck stiffness, swollen glands, jaw discomfort, and inflammation of the eye membranes. A diagnostic rash, erythema migrans (EM), occurs in 65% to 75% of the cases. The rapidly expanding red rash starts at the tick bite site and expands to a nearly circular lesion of about 1 to 8 inches (2 to 20 cm). It often has a bulls-eye appearance with central clearing and/or darkening around the edge. Additional smaller skin lesions may appear at other sites of the body and may last for days or weeks. Later symptoms, including heart, nervous system, and joint manifestations, may develop in untreated individuals. The joint pain and swelling usually occur one or more months after infection, may involve one or more joints, and may recur in different joints; the knee joint is most frequently affected. Domestic animals may be affected as well.

In 1992, 9,695 cases of Lyme disease were reported in 44 states (Fig. 5). Most cases were reported in the northeastern and upper midwestern states where the vector is the deer tick (*Ixodes scapularis*) and where transmission is predominately in residential communities. Other vectors are *I. pacificus* on the West Coast and possibly *A. americanum* in the Southeast and in

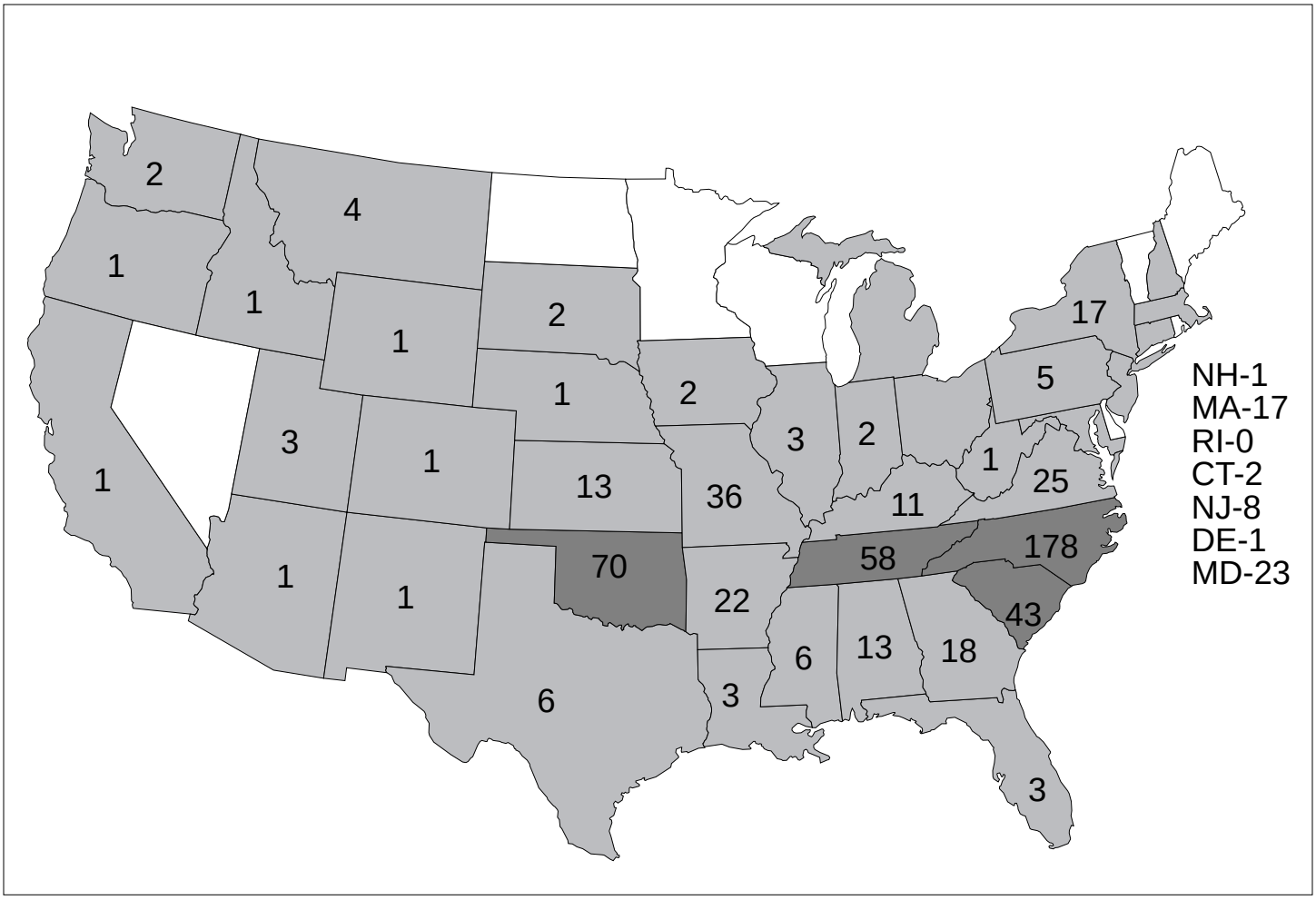

Fig. 4. Distribution of Rocky Mountain spotted fever (human cases) in the United States, 1990.

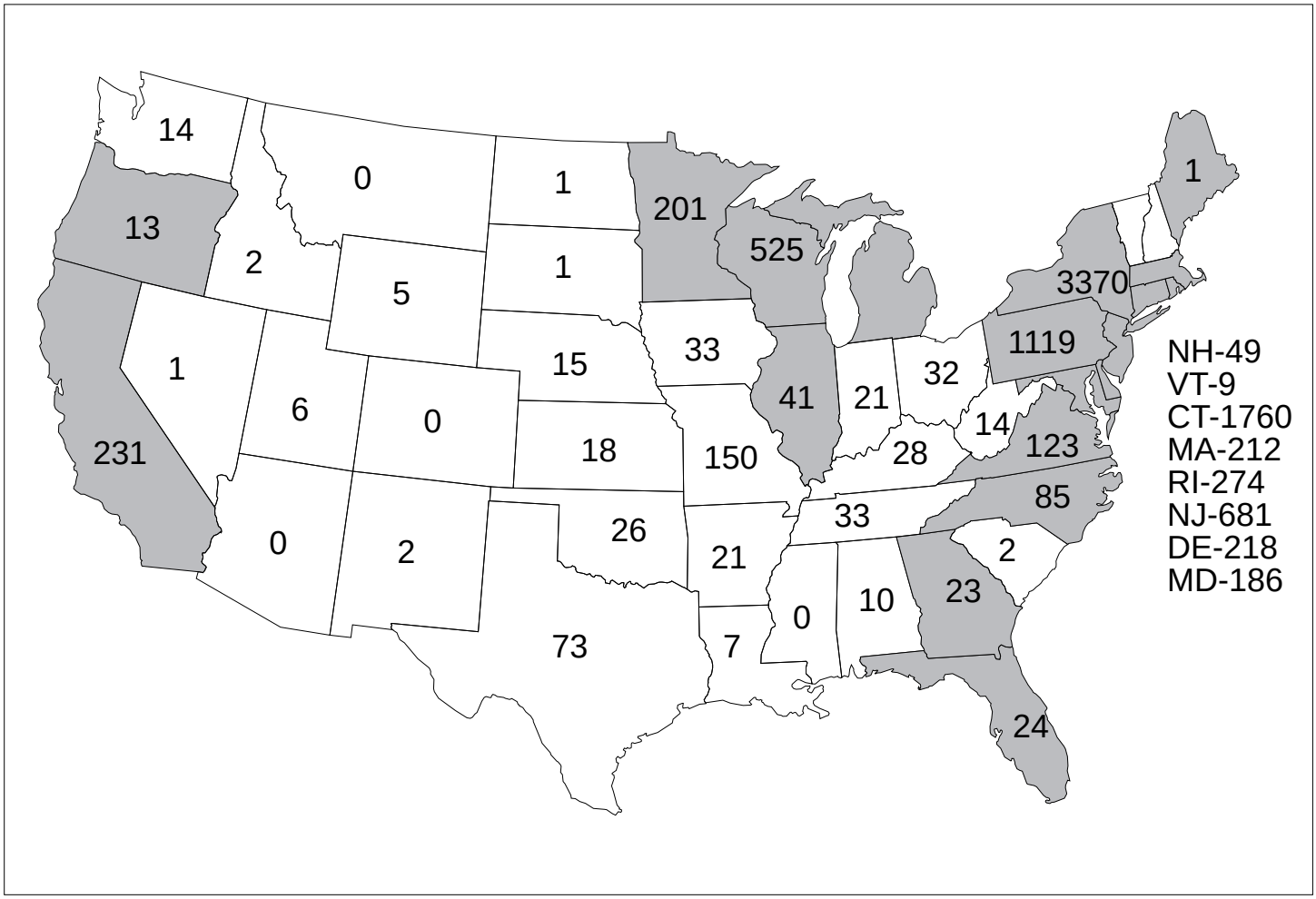

Fig. 5. Distribution of Lyme disease (human cases) in the United States, 1992.

south-central states. Transmission in these other regions of the United States may be more sporadic and occur during outdoor activities related to recreation and occupation. Acquisition of Lyme disease by humans peaks during the summer months when the tick nymphs are feeding on hosts. Because of its small size, the attached nymph frequently goes unnoticed and is not removed. The transmission cycle of Lyme disease begins when larvae acquire spirochetes while feeding on infected white-footed mice, chipmunks, other rodents, and birds. Engorged larvae drop to the ground, molt to the nymphal stage, and wait until the following summer to attach to and transmit spirochetes to susceptible rodents, birds, larger mammals, and humans. Uninfected larvae subsequently feed on these wild vertebrate hosts to complete the transmission cycle. The engorged nymphs drop to the ground and molt into adult ticks which are active during the fall and following spring and feed on large mammals, primarily deer. Deciduous forest is the predominant habitat for the tick vector and vertebrate hosts in the Northeast and Midwest. Other prime habitats include forested areas interspersed with residential development and grass and shrub areas, particularly along forest edges.

Patients treated with appropriate antibiotics during the early stages of the disease usually have rapid and complete recovery. Even patients treated during later stages generally respond well and recover. No vaccine is available except for domestic dogs. Avoid locations with ticks during seasonal activity periods, use personal measures to protect against ticks, become knowledgeable about the symptoms of Lyme disease, and seek medical care and treatment if infected.

Tularemia

Tularemia is caused by the bacteria *Francisella tularensis* and is characterized by sudden onset of high fever and chills, joint and muscle pain, and prostration. Slow-healing sores or lesions develop at the site of entry of the bacteria (or arthropod bite). Inflammation and swelling of nearby lymph nodes follow.

Tularemia is endemic throughout North America (Fig. 6). Most of the 100 to 300 cases reported each year are from the area between the Rocky Mountains and the Mississippi River (especially Arkansas and Missouri). Most cases are acquired during the summer months from vector transmis-

sion; however, a second peak of cases occurs during the winter and is probably associated with rabbit hunting and carnivore trapping.

The bacteria is maintained in rabbits, hares, rodents, and birds by tick transmission. The natural reservoir for the bacteria includes infected ticks and animal species that are less susceptible and thus survive acute infections. Hard ticks, primarily *D. andersoni*, *D. variabilis*, and *Haemaphysalis leporis-palustris*, and some flies, especially the deerfly (*Chrysops discalis*), can subsequently transmit the disease to humans. Tularemia can also be transmitted directly to humans. Transmission routes include drinking contaminated water; eating contaminated food or improperly cooked game meat; inhaling aerosols contaminated with rodent urine, feces, or dust; cuts from contaminated knives or other instruments; and scratches or bites from infected animals. Use personal protection measures against ticks and practice good sanitation procedures when handling wild animals, especially rabbits. Promptly seek medical care and treatment if symptoms develop.

Relapsing Fever

Relapsing fever can be caused by several *Borrelia* spirochete bacteria, which are related to the Lyme disease spirochete and are transmitted by soft ticks (Argasidae). Symptoms resemble Lyme disease except for the absence of the diagnostic rash and the presence of recurring fever. The most common type is caused by *B. hermsii*. Most human cases of this type of relapsing fever have been associated with log cabins or houses containing rodent nests (particularly of chipmunks and pine squirrels) and *Ornithodoros hermsi* ticks. This species of tick is active at night. Since it feeds rapidly and its bite is relatively painless, it may go unnoticed. The ticks feed on humans when the rodents disappear from the cabin nests because of rodent control measures or death from other diseases. Most human cases occur during the summer months when the cabins are in use. Sporadic cases are reported primarily in the mountainous regions of the western United States and British Columbia; 159 cases were reported during 1985 to 1991 in 10 western states (Fig. 7). Two outbreaks occurred among tourists and staff staying in cabins at the Grand Canyon in Arizona in 1973 and 1990. Inspect cabins for rodent use and nests, promptly remove nests, and treat cabins with insecticides or fumigate to kill any remaining ticks. Rodent-proof cabins to prevent rodent entry.

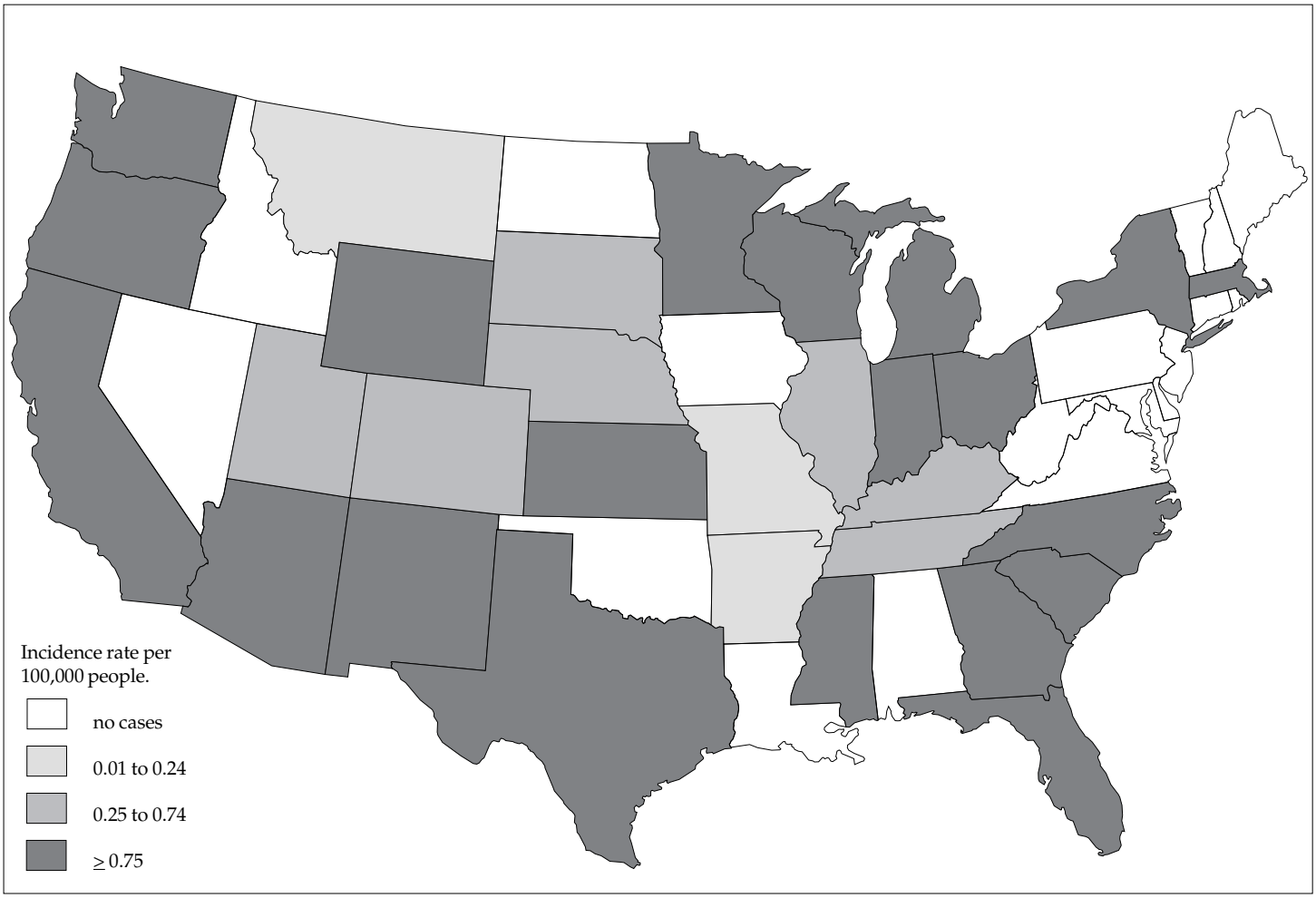

Fig. 6. Distribution of tularemia (human cases) in the United States, 1991 (191 cases reported).

Fig. 7. Distribution of relapsing fever (human cases) in the United States, 1985 to 1991.

Two other species of relapsing fever spirochetes are transmitted occasionally to humans in the western United States by *Ornithodoros* ticks. The spirochete *B. parkeri* is transmitted by *O. parkeri*, mostly in California, and *B. turicatae* by the tick *O. turicata*. Five humans were infected with *B. turicatae* in Texas in 1990 following exploration of a cave containing infected ticks. For prevention, use personal protection against tick exposure. If sick with relapsing fever, seek medical care and appropriate antibiotic treatment.

Other Tick-borne Diseases

Three other tick-borne diseases occur in the United States. Human ehrlichiosis is a recently recognized disease caused by a rickettsia, *Ehrlichia chaffeensis*. It is probably transmitted by ticks. Symptoms are similar to those of RMSF: an acute fever with headache, muscle ache, and nausea. A rash appears less frequently and for a much shorter duration. From 1986 to 1991, 262 cases and 4 fatalities were reported in 23 states, the majority occurring in Missouri and Oklahoma. Use personal protection against ticks and seek medical care and treatment if sick.

Powassan encephalitis is caused by a virus (flavivirus) which is transmitted by the ticks *I. cookei*, *D. andersoni*, and other *Ixodes* spp. Symptoms include the sudden onset of fever, sore throat, sleepiness, headache, and disorientation. Encephalitis, meningitis, and, occasionally, partial paralysis may develop. Natural hosts are marmots, sciurid rodents, rabbits, hares, carnivores, and possibly birds. Only 19 cases have been reported, all in New York, Pennsylvania, Ontario, and Quebec. Use personal protection to reduce exposure to ticks. No treatment is available.

Babesiosis is a protozoan disease with gradual onset of fever, sweating, loss of appetite, fatigue, general muscle ache, and possibly prolonged anemia. The disease can be severe and sometimes fatal. A protozoan, *Babesia microti*, is transmitted among wild rodents, particularly white-footed mice, by the tick *I. scapularis* along the coastal areas of New England and on adjacent offshore islands. This tick may be infected occasionally with both *B. microti* and the Lyme disease spirochete. Use personal protection measures to prevent tick exposure and seek medical care if sick.

Personal Protection

The following personal measures can protect against tick-transmitted diseases:

1. When possible, avoid tick-infested areas.

2. To better see crawling ticks, tuck pant legs into socks and tape the tops of socks over pant legs. Wear light-colored clothes.
3. Use tick repellent on exposed skin (DEET) or treat clothes with permethrin. Follow label instructions for use.
4. Check yourself frequently for ticks and remove them.
5. After outdoor activity, remove and wash field clothing promptly and dry clothes at a high temperature.
6. Inspect your body carefully and remove attached ticks with a pointed tweezers. Grasp ticks as close to the skin as possible and pull them loose with a slow, steady motion.
7. Inspect pets carefully for ticks and remove ticks soon after returning from the outdoors.

Flea-borne Diseases

Plague

Plague is an acute disease caused by the bacteria *Yersinia pestis*. Humans usually become infected by the bites of infected fleas but also directly from exposure to tissues or body fluids from diseased animals, especially when skinning animals. The disease is characterized by the sudden onset of fever and chills, followed by the development of swollen and painful lymph nodes (buboes) in the armpits, groin, and other areas 2 to 6 days following exposure. In addition to the bubonic form, septicemic infection may develop and involve other organs. Secondary infection of the lungs may lead to primary plague pneumonia, which then can be transmitted from person to person by aerosol. The disease may be only mild and short-lived but frequently progresses to a severe form, with 25% to 60% fatality in untreated cases. In the United States, plague is maintained in wild rodent populations in the western states by flea transmission between rodents. Sylvatic plague may persist in these animal populations with varying severity, depending on the species' resistance. Prairie dogs are susceptible to sudden die-offs. Outbreaks of plague have decimated prairie dog colonies in less than 1 to 2 years. Rabbits, hares, carnivores, and wild ungulates have also been infected occasionally. Human cases of plague are reported most frequently in New Mexico, Arizona, California, Colorado, and Oregon (Fig. 8). More than 50% of the 284 cases in the United States reported from 1970 to 1990 were in New Mexico. Use insect repellents on skin or treat field clothes with permethrin. Practice good sanitation procedures when handling animals. Seek medical care and treatment if sick.

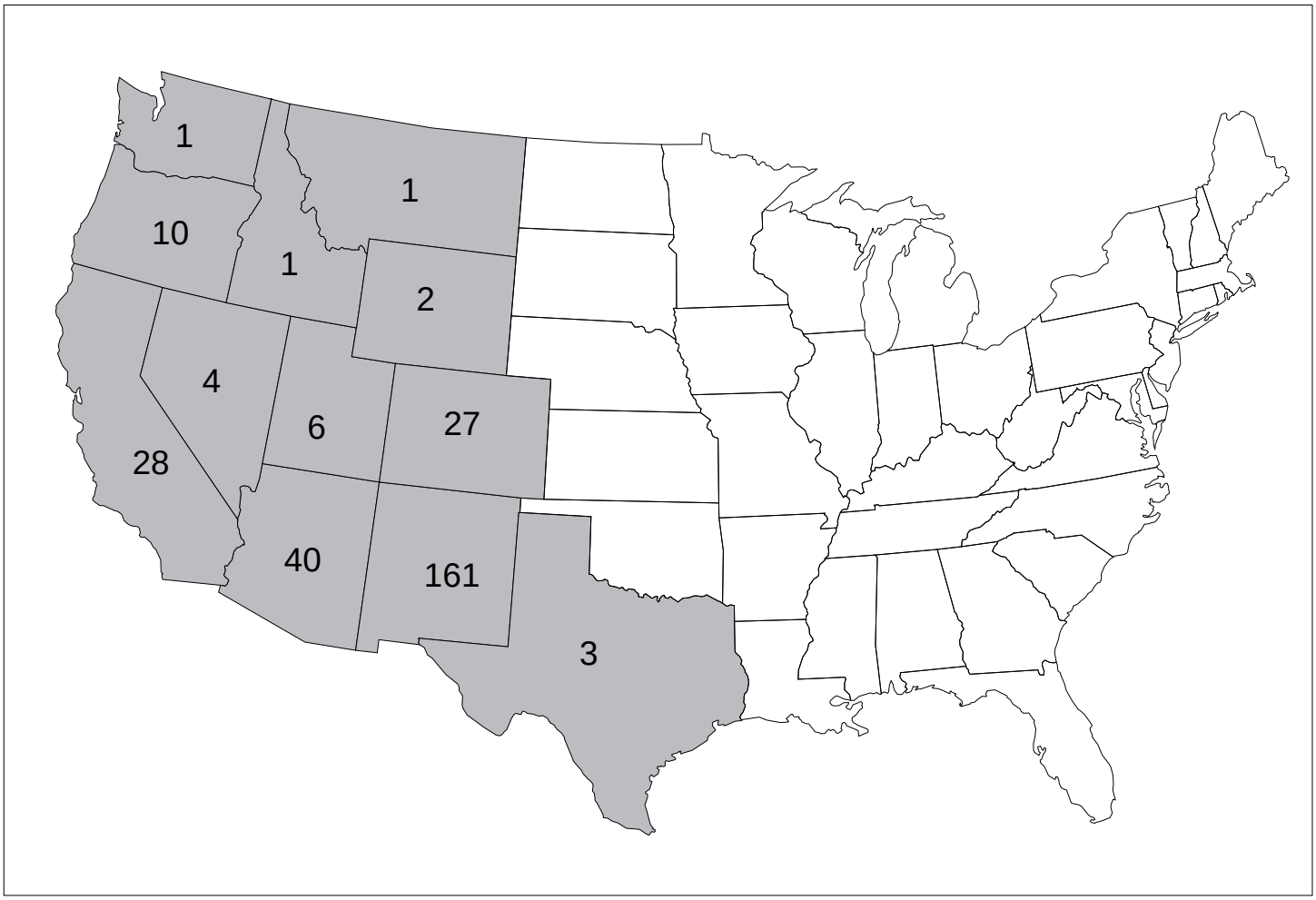

Fig. 8. Distribution of plague (human cases) in the United States, 1970 to 1990.

Murine Typhus Fever

Murine typhus fever is caused by *Rickettsia typhi*, a rickettsial organism that occurs throughout the southeastern and Gulf Coast states and southern California. Rats are the reservoir animals from which the disease reaches many humans by way of rat fleas. The oriental rat flea, *Xenopsylla cheopis*, is considered the most important vector of the disease. The causative organism enters the bloodstream when feces of infected fleas are scratched or rubbed into a flea-bite wound or other breaks in the skin. Murine typhus is similar to epidemic or louse-borne typhus, but illness is much milder and the fatality rate in untreated cases is much lower.

Commensal Rodent-borne Diseases

Rats and mice are responsible for the spread of over 35 diseases, either directly, through contamination of human food with their urine or feces, or indirectly, by way of rodent fleas and mites. Following are brief descriptions of the more common of these diseases.

Rat-bite Fever

Rat-bite fever is caused by the bacteria *Streptobacillus moniliformis*, which is found on the teeth and gums of rats. It is transferred from rats to humans by the bite of the rat. The most frequently occurring rat-bite fever in the United States is called Haverhill fever. It is similar to the rat-bite fever of the Orient called *sodoku* (caused by *Spirillus minus*).

Leptospirosis (Weil's Disease)

Leptospirosis is a mild to severe infection that is seldom fatal. Human cases of the disease result from direct or indirect contact with infected urine of rodents and other animals. The spirochetes (*Leptospira* spp., primarily *L. icterohemorrhagiae*) are found in contaminated water or on food, and may enter humans through mucous membranes or minute cuts or abrasions of the skin. Thus, Weil's disease is often found in sailors, miners, sewer workers, and fish or poultry dealers. In a recent study in Hawaii, Norway rats, roof rats, and house mice were found to have high *L. icterohemorrhagiae* carrier rates.

Symptoms of leptospirosis infection range from none to severe, with acute fatalities. Many infections are characterized by diarrhea, chills, vomiting, myalgia, and kidney damage. Prevention is the most important means of dealing with this disease. Proper sanitation, rodent-proofing, and food storage and handling are essential. Medical attention is typically required.

Salmonellosis

The *Salmonella* group of bacteria exists nearly everywhere in the environment and, unfortunately, several serotypes are pathogenic to humans and other animals. Salmonellosis can lead to severe cases of gastroenteritis (food poisoning), enteric fever septicemia (blood poisoning), and death. Food poisoning, the most common malady, is characterized by a sudden onset of abdominal pain, diahrrea, nausea, and vomiting. Due to the severity of this disease, medical attention is typically required.

Salmonella bacteria recognize few host barriers and are transmitted in many ways. One common form of transmission is through food contaminated by rat or mouse feces that contain *Salmonella* (especially *S. typhimurium*) organisms. It may also be spread by birds, which contaminate food with their feces or bacteria carried on their feet.

As with leptospirosis, the most important means of reducing the potential of this disease is through proper sanitation, rodent-proofing, and food storage and handling. Rodent control through trapping and appropriate use of toxicants may also be necessary.

Rickettsialpox

Rickettsialpox is a mild nonfatal disease resembling chicken pox. It is caused by a rickettsia (*Rickettsia akari*), which is transmitted from house mice to humans by the bite of an infected house mouse mite (*Liponyssoides sanguineus*). In this country rickettsialpox has been reported in Boston, West Hartford, New York, Cleveland, and Philadelphia.

Bird-borne Diseases

Large roosting concentrations of birds can be noisy, and the associated droppings can be a nuisance because of the objectionable odor and mess. In addition, birds may carry and transmit diseases to livestock and humans. Collections of droppings may provide a medium for bacterial and fungal growth that could pose a potential public health problem. Birds should be dispersed or controlled when they form large concentrations near human habitations and are judged to pose a threat to public health or livestock. Concentrations of birds that do not threaten human health or agriculture are usually better left undisturbed.

Histoplasmosis

Histoplasmosis is a respiratory disease in humans caused by inhaling spores from the fungus *Histoplasma capsulatum*. Birds do not spread the disease directly — spores are spread by the wind and the disease is contracted by inhalation. Bird droppings enrich the soil and promote growth of the fungus. Notable sources for histoplasmosis infection include: (1) traditional bird roosts, (2) poultry farms, (3) enclosed buildings where birds or bats have roosted, and (4) natural or organic fertilizers. In addition, the fungus can grow in various natural soils, with or without droppings. In some areas, such as the Ohio Valley, histoplasmosis is so widespread that 95% of the human population becomes infected, whether associated with birds or not.

Infection by only a few spores generally produces a mild case in humans and people are often unaware that they have contracted the disease (unless it is detected later through a skin reactivity test or lung X ray that reveals healed lesions). A more severe infection may result in an acute respiratory illness with flu-like symptoms

(in fact, histoplasmosis is often misdiagnosed as flu). The most serious infections, usually resulting from massive spore inhalation, may involve a dissemination of the fungus through the blood stream. Such cases may become chronic, recurring at later times, and affect organs other than the lungs. Treatment with an antifungal agent such as amphotericin B or imidazole ketoconazole may be prescribed in more severe cases.

Not all blackbird or starling roosts pose immediate public health problems related to histoplasmosis. The histoplasmosis fungus grows readily in the soil beneath bird roosts, but it cannot form spores under the acidic conditions of fresh droppings. An active, undisturbed roost may only give off a few spores. Old or abandoned roosts, however, can pose a significant threat to human health. After the droppings have dried out or been leached by the rain, the right conditions develop for spore release. If the soil is stirred up under dusty conditions, as may be the case in land clearing or bulldozing, massive amounts of spores may be released. Severe epidemics have occurred in association with bird roosts under such conditions.

Birds in large roosts can be dispersed by the use of various frightening devices or by roost thinning or clearing (see **Bird Dispersal Techniques**). Precautions should be taken when working around an old or abandoned roost site. It is wise to test for the presence of histoplasmosis before beginning any work. Wear a self-contained breathing apparatus or face mask with a dust filter (less than 2 microns) to prevent inhalation of the spores. Wear protective clothing, gloves, and boots that can be removed and disinfected with formalin and washed. If an area that was once a bird roost is going to be cleared or bulldozed, the area should be dampened with water or work should be done when the weather is wet or cold or both. Avoid working under dry, dusty conditions in late summer. A roost may be decontaminated by spraying it with a 3% to 5% solution of formaldehyde before clearing, but this option is very expensive.

Ornithosis (*Chlamydia psittaci, psittacosis*)

Ornithosis is an infectious respiratory disease caused by *Chlamydia psittaci,* a viruslike organism that affects humans, pets, and livestock. It usually leads to a mild pneumonia- or flu-like infection, but it can be a rapidly fatal disease (less than 1% of the cases reported in the United States). In humans many cases occur that are undetected or incorrectly diagnosed. Pigeons are most commonly associated with the transmission of ornithosis to humans. Birds have adapted to the disease and show no symptoms, but act as healthy carriers, shedding the organism in their feces, which later may become airborne as dust. The disease may also be contracted from parakeets, farm poultry, or waterfowl.

People working in dry, dusty areas where bird droppings are present, should wear face masks or respirators to avoid inhaling airborne avian fecal material. Spray work areas with water and/or disinfectants to minimize the potential for airborne infections particles. Medical attention, including antibiotic treatments are recommended for disease treatment.

Salmonellosis

The *Salmonella* group of bacteria can also be transmitted by birds. Refer to Commensal Rodent-borne Diseases (above) for additional information.

Other Bird-borne Diseases

Pigeons, starlings, sparrows, blackbirds, and other types of birds have been implicated in the transmission of various diseases of significance to humans or livestock. Starlings have been shown to be vectors of transmissible gastroenteritis (TGE) of swine. The virus can be carried in an infective state in the birds' intestines or on their feet for up to 30 hours. It is generally fatal to baby pigs and causes weight loss in adults. Starlings may also be involved in the transmission of hog cholera. Cryptococcosis is a fungal disease spread by pigeons and starlings that results in chronic, usually fatal, meningitis. Various species of birds may also play a part in the transmission of encephalitis, Newcastle disease, aspergillosis, toxoplasmosis, pseudotuberculosis, avian tuberculosis, and coccidiosis.

Conclusion

Wildlife workers tend to ignore the risks associated with handling wildlife species and working in natural environments. Diseases of wildlife or diseases present in their habitats can infect humans and some can cause serious illness or even death. Becoming aware of the potential diseases present and taking precautions to decrease exposure will greatly reduce chances of becoming infected with one of these diseases. This section provides a description of the major zoonotic diseases of wildlife in the United States that can also infect humans and gives information on disease prevention. Other diseases are briefly listed in Table 1 or can be found in one of the selected references.

You can prevent infection with zoonotic diseases and reduce the seriousness of an illness by observing the following recommendations:

1. Become aware of which zoonotic diseases are present in your area and their clinical symptoms.
2. Obtain any preexposure vaccinations that are available, particularly for rabies.
3. Take personal precautions to reduce exposure to disease agents and vectors such as ticks, mosquitoes, and fleas.
4. Practice good sanitation procedures when handling or processing animals or their products.
5. If you become ill, promptly seek proper medical treatment and inform the physician about possible exposures.

Acknowledgments

Portions of this chapter were derived from F. R. Henderson. 1983. Wildlife diseases and man. *in* R. M. Timm, *Prevention and Control of Wildlife Damage.* Univ. Nebraska Coop. Ext. Lincoln.

For Additional Information

For further information, consult the local or state health department or contact the CDC Voice Information System, Centers for Disease Control and Prevention, Atlanta, Georgia, at (404) 332-4555.

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Table 1. Some important wildlife diseases that affect humans.

Disease	*Parasite (Agent)*	*Method of Transmission*	*Wildlife Hosts*	*Type of Human Illness*
Direct				
Rabies	Virus (rhabdovirus)	Animal bite, aerosol	Striped skunk, raccoon, foxes, bats, and other mammals	Paralysis, convulsions, coma, death
Hantavirus	Virus (hantavirus)	Aerosol, animal bite	Deer mice, other wild and commensal rodents	Fever, headache, muscle aches, nausea, vomiting, back pain, respiratory syndrome
Leptospirosis	Bacteria (*Leptospira* spp.; *icterohemorrhagiae*)	Urine contamination, ingestion	Commensal and wild rodents, rabbits, fox, skunk, raccoon, opossum, deer	Fever; jaundice; neurologic; pain in abdomen, joints, or muscles; nausea; may be fatal
Brucellosis	Bacteria (*Brucella* spp.; *abortus*)	Contamination, ingestion (milk, etc.)	Hoofed animals (coyote)	Intermittent fever, chills, headache, body aches, weakness, weight loss
Rat-bite fever	Bacteria (*Streptobacillus moniliformis*)	Rodent bite	Commensal rodents	Abrupt onset with chills and fever, headache, muscle ache, followed by rash on legs and arms, arthritis
Salmonellosis	Bacteria (*Salmonella* spp.)	Ingestion of bacteria in food contaminated with feces	Rodents, swine, cattle, wild birds, poultry, pet turtles	Sudden onset of headache, fever, abdominal pain, nausea, diarrhea, vomiting
Ornithosis (Psittacosis)	Chlamydia (*Chlamydia psittaci*)	Inhalation of contaminated air	Parrot and sparrow-like birds, pigeons, waterfowl, domestic birds	Fever, chills, headache, muscle pain, loss of appetite, sweating, pneumonia
Histoplasmosis	Fungus (*Histoplasma capsulatum*)	Inhalation of spores	None, grows in soil enriched by feces under bird and bat roosts	Mild fever and influenza-like illness, pneumonia, hepatitis, endocarditis, death
Cryptococcosis	Fungus (*Cryptococcus neoformans*)	Inhalation is suspected	None, grows in droppings in pigeon nests	Meningitis; lung, liver, and bone infection; skin lesions or ulcers
Trichinosis	Nematode worm (*Trichinella spiralis*)	Ingestion of uncooked meat containing larval cysts	Swine, bear, wild and domestic carnivores, wild and domestic rodents	Nonspecific gastroenteritis, loss of appetite, nausea, diarrhea, swollen eyelids, fever, chills, muscle aches
Ascarid roundworm	Nematode (*Baylisascaris procyonis*)	Ingestion of nematode eggs (raccoon feces contamination)	Raccoon	Larval stage invades and damages body organs, including brain
Direct and Indirect				
Plague	Bacteria (*Yersinia pestis*)	Contamination from skinning animals, fleas	Wild rodents (prairie dogs, ground and tree squirrels, chipmunks), rabbits, carnivores	Fever, headache, severe discomfort, shaking chills, pain in groin or arm pits (swollen lymph nodes), death

Table 1. Some important wildlife diseases that affect humans (continued).

Disease	*Parasite (Agent)*	*Method of Transmission*	*Wildlife Hosts*	*Type of Human Illness*
Direct and Indirect				
Tularemia	Bacteria (*Francisella tularensis*)	Contamination from skinning animals, ticks, biting insects	Wild rodents, rabbits, hares, carnivores, birds, hoofed animals	Mild illness to severe meningitis, pneumonia, ulcer at inoculation site, swollen lymph nodes, death
Indirect				
Tick-borne				
Colorado tick fever	Virus (coltivirus)	Tick, *Dermacentor andersoni, D. occidentalis*	Wild rodents (sciurids, porcupine), hares, rabbits, marmots, carnivores	High fever, headache, muscle ache, lethargy, biphasic symptoms
Rocky Mountain spotted fever	Rickettsia (*Rickettsia rickettsii*)	Tick, *D. andersoni, D. variabilis, Amblyomma americanum, Haemaphysalis leporispalustris*	Wild rodents, rabbits, hares, carnivores, birds	Rapid onset, fever, headache, muscle aches, nausea, vomiting, abdominal pain, rash, loss of muscle control, possibly fatal
Ehrlichiosis	Rickettsia (*Ehrlichia chaffeensis*)	Tick, species unknown	Unknown, possibly dogs and other carnivores	Fever, headache, nausea, vomiting, muscle aches, fleeting rash
Lyme disease	Bacteria (*Borrelia burgdorferi*)	Tick, *Ixodes scapularis, I. pacificus, A. americanum*	Wild rodents (*Peromyscus*, chipmunks), raccoon, deer, rabbits, birds	Skin lesion (EM), fever, headache, fatigue, muscle ache, stiff neck, cardiac and neurologic manifestations, arthritis
Relapsing fever	Bacteria (*Borrelia hermsii, B. parkeri, B. turicatae*)	Tick, *Ornithodoros hermsi, O. parkeri, O. turicata*	Wild rodents (chipmunks, tree squirrels), particularly in cabins and caves	Rapid onset, severe headache, muscle weakness, rigor, joint pain, recurring fever
Babesiosis	Protozoa (*Babesia microti*)	Tick, *I. scapularis*	Wild rodents (white-footed mice, meadow vole)	Gradual onset, loss of appetite, fever, sweating, fatigue, general muscle aches, prolonged anemia, sometimes fatal
Tularemia (listed above)				
Mosquito-borne				
St. Louis encephalitis	Virus (flavivirus)	Mosquito, *Culex pipiens* complex, *Cx. tarsalis, Cx. nigripalpus*	Birds (mostly songbirds and waterbirds), some rodents	Fever, headache, musculoskeletal aches, malaise, low fatality
Eastern equine encephalitis	Virus (alphavirus)	Mosquito, *Culiseta melanura*, *Aedes* spp.	Birds (mostly songbirds and waterbirds), bats	Fever, intense headache, nausea, vomiting, muscle, aches, confusion, coma, high fatality

Table 1. Some important wildlife diseases that affect humans (continued).

Disease	*Parasite (Agent)*	*Method of Transmission*	*Wildlife Hosts*	*Type of Human Illness*
Indirect				
Western equine encephalitis	Virus (alphavirus)	Mosquito *Cx. tarsalis*	Birds (mostly songbirds and waterbirds), jackrabbits, rodents	Fever, headache, nausea, vomiting, malaise, loss of appetite, convulsions, low fatality
California encephalitis (LaCrosse)	Virus (bunyavirus)	Mosquito *Ae. triseriatus*	Eastern chipmunk, tree squirrel, red fox, deer mouse	Fever, irritability, headache, nausea, vomiting, loss of muscle control, confusion, coma, low fatality
Louse-borne				
Louse-borne typhus	Rickettsia (*Rickettsia prowazekii*)	Body louse *Pediculus humanus*, animal contact	Humans, flying squirrels	Onset variable, fever, headache, chills, general pains, prostration, skin rash after 5 to 6 days
Flea-borne				
Flea-borne typhus (Murine)	Rickettsia (*Rickettsia typhi*)	Rat flea *Xenopsylla cheopis*	Domestic rats, wild rodents, opossum	Fever, severe headache, chills, general pains, possibly skin rash
Plague (listed above)				

Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Beaver

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BEAVERS

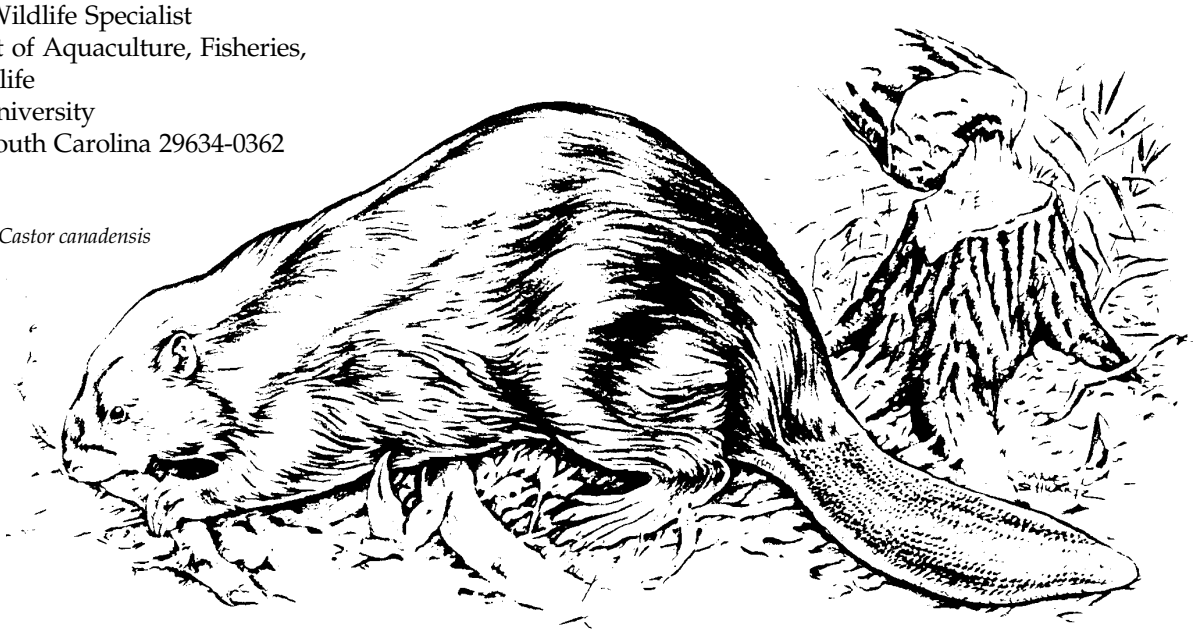


Fig. 1. Beaver, *Castor canadensis*

Damage Prevention and Control Methods

Exclusion

Fence small critical areas such as culverts, drains, or other structures.

Install barriers around important trees in urban settings.

Cultural Methods and Habitat Modification

Eliminate foods, trees, and woody vegetation where feasible.

Continually destroy dams and materials used to build dams.

Install a Clemson beaver pond leveler, three-log drain, or other structural device to maintain a lower pond level and avoid further pond expansion.

Frightening

Shooting of individuals or dynamiting or other continued destruction of lodges, bank dens, and dams, where legal, will occasionally move young colonies out of an area.

Repellents

None are registered; however, there is some evidence that repellents may be useful.

Toxicants

None are registered.

Trapping

No. 330 Conibear® traps.

Leghold traps No. 3 or larger (including coil-spring types with equivalent jaw spread and impact).

Basket/suitcase type traps are primarily used for live trapping.

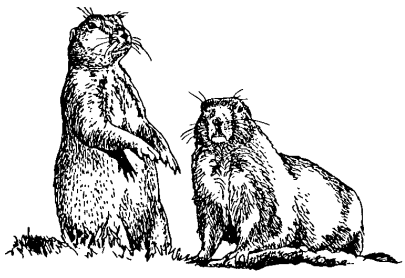
Snares can be useful, particularly in dive sets and slides where legal.

Shooting

Rarely effective (where legal) for complete control efforts and can be dangerous to humans.

Other Methods

Other methods rarely solve a beaver damage problem and may increase risks to humans and nontarget species.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

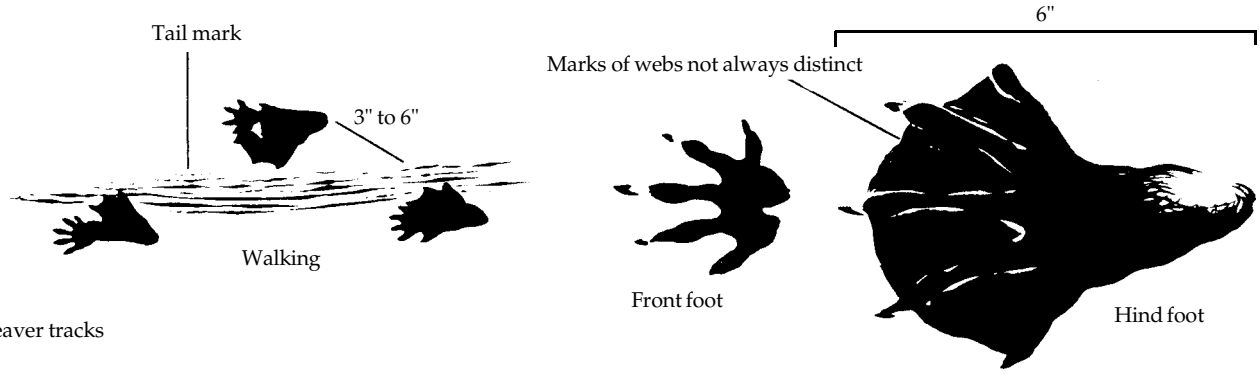


Fig. 2. Beaver tracks

Identification

The beaver (*Castor canadensis*, Fig. 1) is the largest North American rodent. Most adults weigh from 35 to 50 pounds (15.8 to 22.5 kg), with some occasionally reaching 70 to 85 pounds (31.5 to 38.3 kg). Individuals have been known to reach over 100 pounds (45 kg). The beaver is a stocky rodent adapted for aquatic environments. Many of the beaver's features enable it to remain submerged for long periods of time. It has a valvular nose and ears, and lips that close behind the four large incisor teeth. Each of the four feet have five digits, with the hind feet webbed between digits and a split second claw on each hind foot. The front feet are small in comparison to the hind feet (Fig. 2). The underfur is dense and generally gray in color, whereas the guard hair is long, coarse and ranging in color from yellowish brown to black, with reddish brown the most common coloration. The prominent tail is flattened dorso-ventrally, scaled, and almost hairless. It is used as a prop while the beaver is sitting upright (Fig. 3) and for a rudder when swimming. Beavers also use their tail to warn others of danger by abruptly slapping the surface of the water.The beaver's large front (incisor) teeth, bright orange on the front, grow continuously throughout its life. These incisors are beveled so that they are continuously sharpened as the beaver gnaws and chews while feeding, girdling, and cutting trees. The only way to externally distinguish the sex of a beaver, unless the female is lactating, is to feel for the presence of a baculum (a bone in the penis) in males and its absence in females.

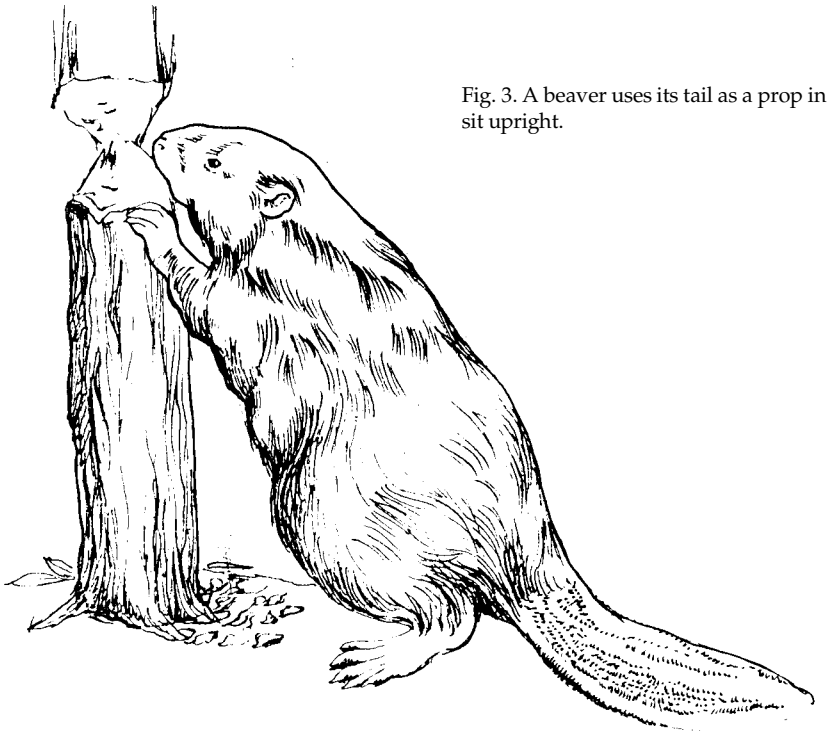
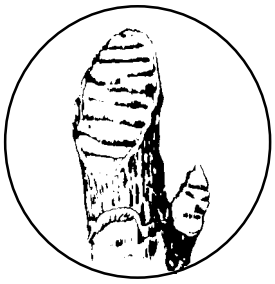


Fig. 3. A beaver uses its tail as a prop in order to sit upright.



Details of beaver cuttings.

Fig. 4. Range of the beaver in North America.

Range

Beavers are found throughout North America, except for the arctic tundra, most of peninsular Florida, and the southwestern desert areas (Fig. 4). The species may be locally abundant wherever aquatic habitats are found.

Habitat

Beaver habitat is almost anywhere there is a year-round source of water, such as streams, lakes, farm ponds, swamps, wetland areas, roadside ditches, drainage ditches, canals, mine pits, oxbows, railroad rights-of-way, drains from sewage disposal ponds, and below natural springs or artesian wells. Beavers build dams to modify the environment more to their liking. Dam building is often stimulated by running water. The length or height of a dam generally depends upon what is necessary to slow the flow of water and create a pond. In areas of flat topography, the dam may not be over 36 inches (0.9 m) high but as much as 1/4 miles (0.4 km) long. In hilly or mountainous country, the dam may be 10 feet (3 m) high and only 50 feet (15 m) long. Beavers are adaptable and will use whatever materials are available to construct dams — fencing materials, bridge planking, crossties, rocks, wire, and other metal, wood, and fiber materials. Therefore, about the only available aquatic habitat beavers avoid are those systems lacking acceptable foods, lodge or denning sites, or a suitable dam site. Some of the surrounding timber is cut down or girdled by beavers to form dams. Subsequent flooding of growing timber causes it to die, and aquatic vegetation soon begins growing. Other pioneer species (for example, willow, sweetgum, and buttonbush) soon grow around the edges of the flooded area, adding to the available food supply. The beaver thus helps create its own habitat.

Food Habits

Beavers prefer certain trees and woody species, such as aspen, cottonwood, willow, sweetgum, blackgum, black cherry, tulip poplar, and pine, depending on availability. However, they can and will eat the leaves, twigs, and bark of most species of woody plants that grow near the water, as well as a wide variety of herbaceous and aquatic plants. Beavers often travel 100 yards (90 m) or more from a pond or stream to get to corn fields, soybean fields, and other growing crops, where they cut the plants off at ground level and drag them back to the water. They eat parts of these plants and often use the remainder as construction material in the dam.

General Biology, Reproduction, and Behavior

Beavers are active for approximately 12 hours each night except on the coldest of winter nights. The phrase "busy as a beaver" is appropriate. It is not uncommon, however, to see beavers during daylight hours, particularly in larger reservoirs.

Beavers are generally monogamous; copulation may take place either in the water or in the lodge or bank den.

After a gestation period of about 128 days, the female beaver generally gives birth to 3 or 4 kittens between March and June, and nurses them for 6 weeks to 3 months. The kittens are born fully furred with their eyes partially opened and incisors erupted through the gums. They generally become sexually mature by the age of 1 1/2 years.

Beaver communicate by vocalizations, posture, tail slapping, and scent posts or mud mounds placed around the bank and dam. The beaver's castor glands secrete a substance that is deposited on mud mounds to mark territorial boundaries. These scent posts are found more frequently at certain seasons, but are found yearround in active ponds.

Fig. 5. Cross section of a beaver lodge.

Beavers have a relatively long life span, with individuals known to have lived to 21 years. Most, however, do not live beyond 10 years. The beaver is unparalleled at dam building and can build dams on fast-moving streams as well as slow-moving ones. They also build lodges and bank dens, depending on the available habitat. All lodges and bank dens have at least two entrances and may have four or more. The lodge or bank den is used primarily for raising young, sleeping, and food storage during severe weather (Fig. 5).

The size and species of trees the beaver cuts is highly variable — from a 1-inch (2.5-cm) diameter at breast height (DBH) softwood to a 6-foot (1.8-m) DBH hardwood. In some areas beavers usually cut down trees up to about 10 inches (25 cm) DBH and merely girdle or partially cut larger ones, although they often cut down much larger trees. Some beavers seem to like to girdle large pines and sweetgums. They like the gum or storax that seeps out of the girdled area of sweetgum and other species.

An important factor about beavers is their territoriality. A colony generally consists of four to eight related beavers, who resist additions or outsiders to the colony or the pond. Young beavers are commonly displaced from the colony shortly after they become sexually mature, at about 2 years old. They often move to another area to begin a new pond and colony. However, some become solitary hermits inhabiting old abandoned ponds or farm ponds if available.

Beavers have only a few natural predators aside from humans, including coyotes, bobcats, river otters, and mink, who prey on young kittens. In other areas, bears, mountain lions, wolves, and wolverines may prey on beavers. Beavers are hosts for several ectoparasites and internal parasites including nematodes, trematodes, and coccidians. *Giardia lamblia* is a pathogenic intestinal parasite transmitted by beavers, which has caused human health problems in water supply systems. The Centers for Disease Control have recorded at least 41 outbreaks of waterborne Giardiasis, affecting more than 15,000 people. For more information about Giardiasis, see von Oettingen (1982).

Fig. 6. Pine plantation in Arkansas killed in flooding caused by beavers.

Damage and Damage Identification

The habitat modification by beavers, caused primarily by dam building, is often beneficial to fish, furbearers, reptiles, amphibians, waterfowl, and shorebirds. However, when this modification comes in conflict with human objectives, the impact of damage may far outweigh the benefits.

Most of the damage caused by beavers is a result of dam building, bank burrowing, tree cutting, or flooding. Some southeastern states where beaver damage is extensive have estimated the cost at $3 million to $5 million dollars annually for timber loss; crop losses; roads, dwellings, and flooded property; and other damage. In some states, tracts of bottomland hardwood timber up to several thousand acres (ha) in size may be lost because of beaver. Some unusual cases observed include state highways flooded because of beaver ponds, reservoir dams destroyed by bank den burrows collapsing, and train derailments caused by continued flooding and burrowing. Housing developments have been threatened by beaver dam flooding, and thousands of acres (ha) of cropland and young pine plantations have been flooded by beaver dams (Fig. 6). Road ditches, drain pipes, and culverts have been stopped up so badly that they had to be dynamited out and replaced. Some bridges have been destroyed because of beaver dam-building activity. In addition, beavers threaten human health by contaminating water supplies with *Giardia.*

Identifying beaver damage generally is not difficult. Signs include dams; dammed-up culverts, bridges, or drain pipes resulting in flooded lands, timber, roads, and crops; cut-down or girdled trees and crops; lodges and burrows in ponds, reservoir levees, and dams. In large watersheds, it may be difficult to locate bank dens. However, the limbs, cuttings, and debris around such areas as well as dams along tributaries usually help pinpoint the area.

Legal Status

The legal status of beavers varies from state to state. In some states the beaver is protected except during furbearer seasons; in others it is classified as a pest and may be taken year-round when causing damage. Because of its fur value, dam building, and resulting water conservation, it is generally not considered a pest until economic losses become extensive. Fur prices for beaver in some states, particularly in the Southeast, make it hardly worth the skinning and stretching. In some northern states, trapping is prohibited near lodges or bank dens to protect and perpetuate beaver colonies. Fur prices for beaver pelts are usually much higher in these areas.

Damage Prevention and Control Methods

Exclusion

It is almost impossible as well as cost-prohibitive to exclude beavers from ponds, lakes, or impoundments. If the primary reason for fencing is to exclude beavers, fencing of large areas is not practical. Fencing of culverts, drain pipes, or other structures can sometimes prevent damage, but fencing can also promote damage, since it provides beavers with construction material for dams. Protect valuable trees adjacent to waterways by encircling them with hardware cloth, woven wire, or other metal barriers. Construction of concrete spillways or other permanent structures may reduce the impact of beavers.

Cultural Methods

Because beavers usually alter or modify their aquatic habitat so extensively over a period of time, most practices generally thought of as cultural have little impact on beavers. Where feasible, eliminate food, trees, and woody vegetation that is adjacent to beaver habitat. Continual destruction of dams and removal of dam construction materials daily will (depending on availability of construction materials) sometimes cause a colony or individual beavers to move to another site. They might, however, be even more troublesome at the new location.

The use of a three-log drain or a structural device such as wire mesh culverts (Roblee 1983) or T-culvert guards (Roblee 1987) will occasionally cause beavers to move to other areas. They all prevent beavers from controlling water levels. However, once beavers have become abundant in a watershed or in a large contiguous area, periodic reinvasions of suitable habitat can be expected to occur. Three-log drains have had varying degrees of success in controlling water levels in beaver impoundments, especially if the beaver can detect the sound of falling water or current flow. All of these devices will stimulate the beavers to quickly plug the source of water drainage.

A new device for controlling beaver impoundments and keeping blocked culverts open is the Clemson beaver pond leveler. It has proven effective in allowing continual water flow in previously blocked culverts/drains and facilitating the manipulation of water levels in beaver ponds for moist-soil management for waterfowl (Wood and Woodward 1992) and other environmental or aesthetic purposes. The device (Fig. 7) consists of a perforated PVC pipe that is encased in heavy-gauge hog wire. This part is placed upstream of the dam or blocked culvert, in the main run or deepest part of the stream. It is connected to nonperforated sections of PVC pipe which are run through the dam or culvert to a water control structure downstream. It is effective because the beavers cannot detect the sound of falling or flowing water as the pond or culvert drains; therefore, they do not try to plug the pipe. The Clemson beaver pond leveler works best in relatively flat terrain where large volumes of water from watersheds in steep terrain are not a problem.

Repellents

There are no chemical repellents registered for beavers. Past research efforts have tried to determine the effectiveness of potential repellent materials; however, none were found to be effective, environmentally safe, or practical. One study in Georgia (Hicks 1978) indicated that a deer repellent had some potential benefit. Other studies have used a combination of dam blowing and repellent soaked (Thiram 80 and/or paradichlorobenzene) rags to discourage beavers with varying degrees of success (Dyer and Rowell 1985).

Additional research is needed on repellents for beaver damage prevention.

Toxicants

None are registered. Research efforts have been conducted, however, to find effective, environmentally safe and practical toxicants. Currently there are none that meet these criteria.

Fumigants

None are registered.

Trapping

The use of traps in most situations where beavers are causing damage is the most effective, practical, and environmentally safe method of control. The effectiveness of any type of trap for beaver control is dependent on the trapper's knowledge of beaver habits, food preferences, ability to read beaver signs, use of the proper trap, and trap placement. A good trapper with a dozen traps can generally trap all the beavers in a given pond (behind one dam) in a week of trap nights. Obviously in a large watershed with several colonies, more trapping effort will be required. Most anyone with trapping experience and some outdoor "savvy" can become an effective beaver trapper in a short time. In an area where beavers are common and have not been exposed to trapping, anyone experienced in trapping can expect good success. Additional expertise and improved techniques will be gained through experience.

A variety of trapping methods and types of traps are effective for beavers, depending on the situation. Fish and wildlife agency regulations vary from

Table 1. List of materials for the Clemson Beaver Pond Leveler.

Quantity	Item
1	10' section, 10" diameter PVC pipe (Schedule 40)
1	PVC cap for 10" diameter PVC pipe (Schedule 40)
1	10" x 8" PVC pipe reducer coupling (Schedule 40)
4	86" sections, 3/4" diameter plastic roll pipe (water pipe), 160 psi grade
4	3/4" metal couplings for roll pipe
16	1/4" x 2" galvanized eyebolts
16	1/4" galvanized nuts
16	1/4" galvanized washers
16	16" sections, 8 gauge galvanized wire (medium hardness)
2	96" sections, 2" x 4" 1/2 gauge galvanized welded wire
2 lbs	Crab trap clamps (fasteners)

The above materials are required to assemble the intake device. The carrying pipe (flow pipe) may consist of 20 to 40 feet of 8-inch diameter PVC, Schedule 40 with coupling sleeves and elbows appropriate to the desired configuration.

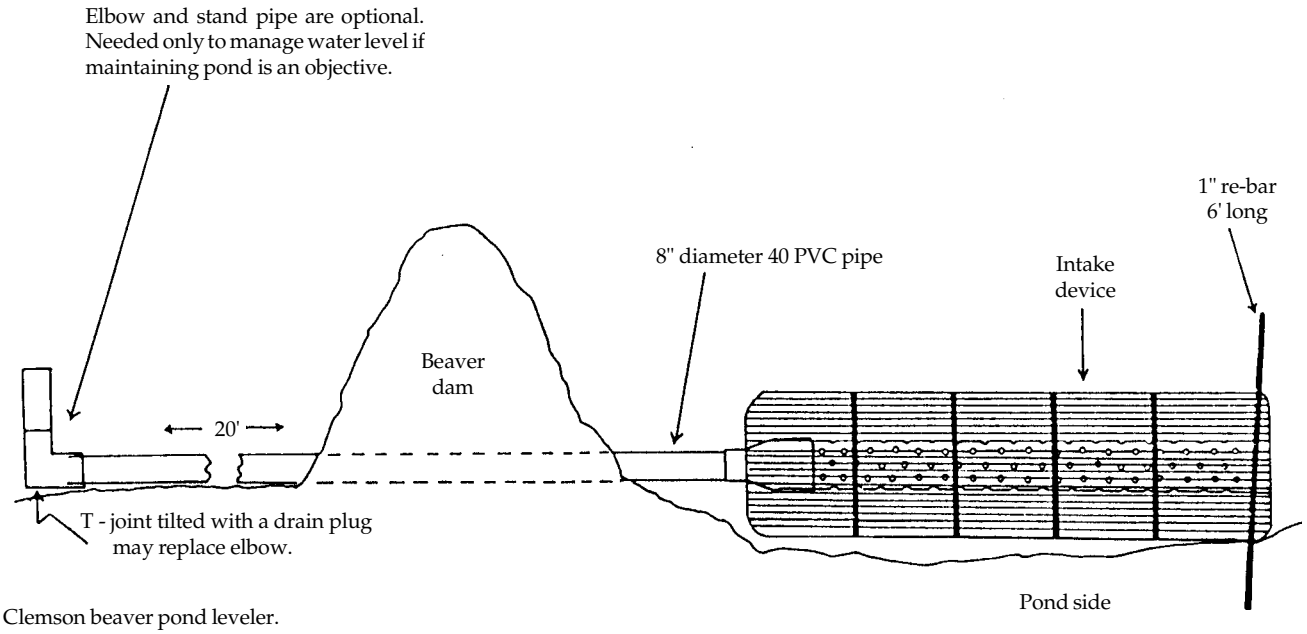


Fig. 7. Clemson beaver pond leveler.

state to state. Some types of traps and trapping methods, although effective and legal in some states, may be prohibited by law in other states. Individual state regulations must be reviewed annually before beginning a trapping program

In some states where beavers have become serious economic pests, special regulations and exemptions have been passed to allow for increased control efforts. For example, some states allow trapping and snaring of beavers and other control measures throughout the year. Others, however, prohibit trapping except during established fur trapping seasons. Some states allow exemptions for removal of beavers only on lands owned or controlled by persons who are suffering losses. In some states a special permit is required from the state fish and wildlife agency.

Of the variety of traps commonly allowed for use in beaver control, the Conibear® type, No. 330, is one of the most effective (Fig. 8). Not all trappers will agree that this type of trap is the most effective; however, it is the type most commonly used by professional trappers and others who are principally trapping beavers. This trap kills beavers almost instantly. When properly set, the trap also prevents any escape by a beaver, regardless of its size. Designed primarily for water use, it is equally effective in deep and shallow water. Only one trap per site is generally necessary, thus reducing the need for extra traps. The trap exerts tremendous pressure and impact when tripped. Appropriate care must be exercised when setting and placing

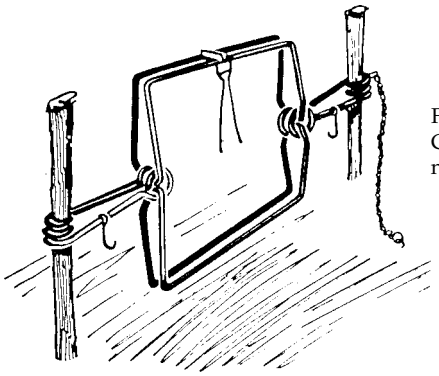


Fig. 8. Basic method of setting and staking a Conibear® 330 trap. Additional stakes are normally used (see Fig. 9).

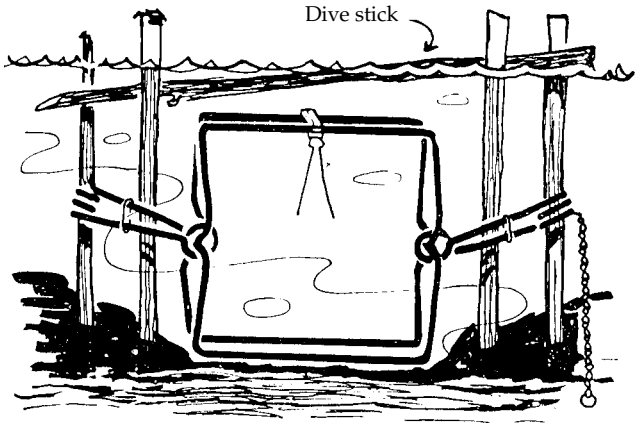


Fig. 9. Conibear trap in dive set.

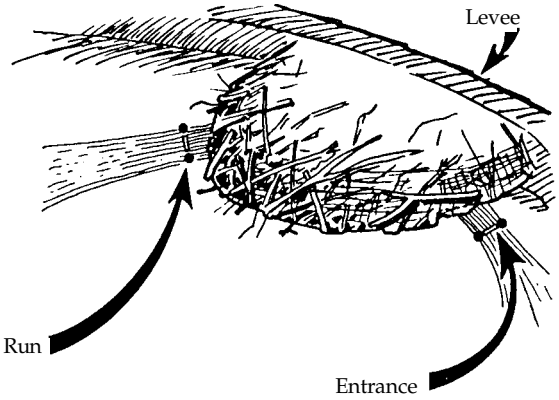


Fig. 10. Runs or underwater entrances to lodges are good places to set beaver traps.

the trap. Care should also be taken when using the Conibear® type traps in urban and rural areas where pets (especially dogs) roam free. Use trap sets where the trap is placed completely underwater.

Some additional equipment will be useful: an axe, hatchet, or large cutting tool; hip boots or waders; wire; and wire cutters. With the Conibear®-type trap, some individuals use a device or tool called "setting tongs." Others use a piece of 3/8- or 1/2-inch (9- or 13-mm) nylon rope. Most individuals who are experienced with these traps use only their hands. Regardless of the techniques used to set the trap, care should be exercised.

Earlier models of the Conibear® type of trap came with round, heavy steel coils which were dangerous to handle unless properly used in setting the trap. They are not necessary to safely set the trap. However, the two safety hooks, one on each spring, must be carefully handled as each spring is depressed, as well as during trap placement. On newer models an additional safety catch (not attached to the springs) is included for extra precaution against inadvertent spring release. The last step before leaving a set trap is to lift the safety hook attached to each spring and slide the safety hook back from the trap toward the spring eye, making sure to keep hands and feet safely away from the center of the trap. If the extra (unattached) safety catch is used, it should be removed before the safety hooks that are attached to the springs to keep it from getting in the way of the movement of the safety hooks.

Conibear®-type traps are best set while on solid ground with dry hands. Once the springs are depressed and the safety hooks in place, the trap or traps can be carried into the water for proper placement. Stakes are needed to anchor the trap down. In most beaver ponds and around beaver dams, plenty of suitable stakes can be found. At least two strong stakes, preferably straight and without forks or snags, should be chosen to place through each spring eye (Fig. 8). Additional stakes may be useful to put between the spring arms and help hold the trap in place. Do not place stakes on the outside of spring arms. Aside from serving to hold the trap in place, these stakes also help to guide the beaver into the trap. Where needed, they are also useful in holding a dive stick at or just beneath the water surface (Fig. 9). If necessary, the chain and circle attached to one spring eye can be attached to another stake. In deep water sets, a chain with an attached wire should be tied to something at or above the surface so the trapper can retrieve the trap. Otherwise the trap may be lost.

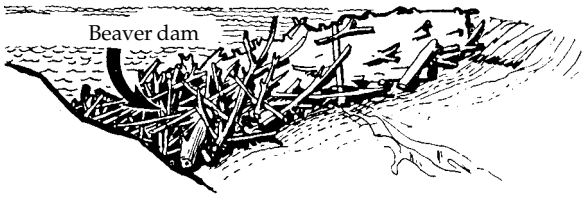
Trap Sets. There are many sets that can be made with a Conibear®-type trap (for example, dam sets, slide sets, lodge sets, bank den sets, "run"/trail sets, under log/dive sets, pole sets, under ice sets, deep water sets, drain

pipe sets), depending on the trapper's capability and ingenuity. In many beaver ponds, however, most beavers can be trapped using dam sets, lodge or bank den sets, sets in "runs"/trails, dive sets or sets in slides entering the water from places where beavers are feeding. Beavers swim both at the surface or along the bottom of ponds, depending on the habitat and water depth. Beavers also establish runs or trails which they habitually use in traveling from lodge or den to the dam or to feeding areas, much like cow trails in a pasture.

Place traps directly across these runs, staked to the bottom (Fig. 10).

Use a good stake or "walking staff' when wading in a beaver pond to locate deep holes, runs, or trails. This will prevent stepping off over waders or hip boots in winter, and will help ward off cottonmouth snakes in the summer. The staff can also help locate good dive holes under logs as you walk out runs or trails. In older beaver ponds, particularly in bottomland swamps, it is not uncommon to find runs and lodge or bank den entrances where the run or hole is 2 to 3 feet (0.6 to 0.9 m) below the rest of the impoundment bottom.

To stimulate nighttime beaver movement, tear a hole in a beaver dam and get the water moving out of a pond. Beavers quickly respond to the sound of running water as well as to the current flow. Timing is also important if you plan to make dam sets. Open a hole in the dam about 18 inches to 2 feet (46 to 60 cm) wide and 2 to 3 feet (60 to 90 cm) below the water level on the upper side of the dam in the morning. This will usually move a substantial amount of water out of the pond before evening (Fig. 11). Set traps in front of the dam opening late that same evening. Two problems can arise if you set a trap in the morning as soon as a hole is made: (1) by late evening, when the beavers become active, the trap may be out of the water and ineffective; or (2) a stick, branch, or other debris in the moving water may trip the trap, again rendering it ineffective.



Hole torn through dam to release water.

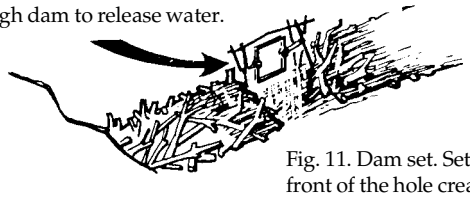


Fig. 11. Dam set. Set the trap underwater in front of the hole created in the dam. When the beaver returns to patch the hole, it will be caught in the trap.

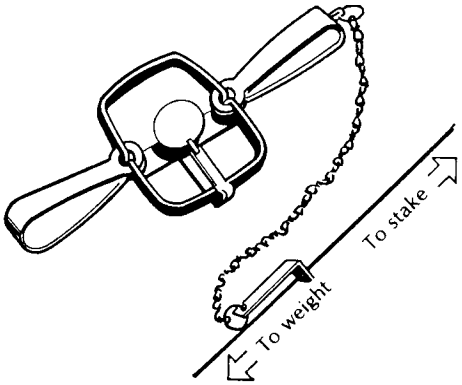
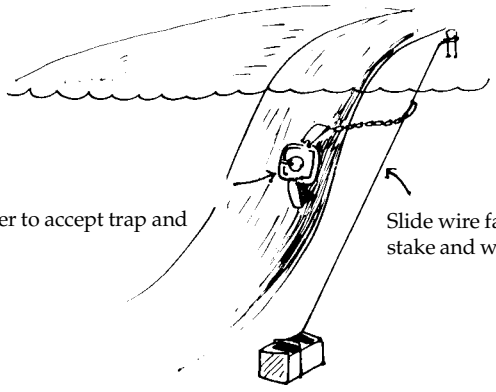


Fig. 12. Leghold trap (No. 3 or No. 4, double spring) attached to wire for drowning set.



Dig out slide under water to accept trap and springs.

Slide wire fastened to stake and weight.

Fig. 13. Leghold trap in slide set.

The best dam sets are made about 12 to 18 inches (30.8 to 45.7 cm) in front of the dam itself. Using stakes or debris on either side of the trap springs, create a funnel to make the beaver go into the jaws of the trap. Always set the trigger on the Conibear®-type trap in the first notch to prevent debris from tripping it before the beaver swims into the trap. The two heavy-gauge wire trippers can be bent outward and the trigger can be set away from the middle if necessary, to keep debris from tripping the trap. This can also keep small beaver or possibly fish or turtles from springing the trap.

Double-spring leghold traps have been used for hundreds of years and are still very effective when properly used by skilled trappers. Use at least No. 3 double (long) spring or coil spring type leghold traps or traps of equivalent size jaw spread and strength. Use a drowning set attachment with any leghold trap (Fig. 12). As the traps are tripped, the beaver will head for the water. A weight is used to hold the trapped beaver underwater so that it ultimately drowns. Some trappers stake the wire in deep water to accomplish drowning. If leghold traps are not used in a manner to accomplish drowning, there is a good likelihood that legs or toes will be twisted off or pulled loose, leaving an escaped, trap-wise beaver.

Placement is even more critical with leghold traps than with the Conibear®-type. Place leghold traps just at the water's edge, slightly underwater, with the pan, jaws, and springs covered lightly with leaves or debris or pressed gently into the pond bottom in soft mud. Make sure there is a cavity under the pan so that when the beaver's foot hits the pan, it will trigger the trap and allow the jaws to snap closed. Place traps off-center of the trail or run to prevent "belly pinching" or missing the foot or leg. With some experience, beaver trappers learn to make sets that catch beavers by a hind leg rather than a front leg. The front leg is much smaller and easier to twist off or pull out.

Sometimes it's wise, when using leghold traps, to make two sets in a slide, run, dam, or feeding place to increase trapping success and remove beavers more quickly. In some situations, a combination of trapping methods can shorten trapping time and increase success.

Trappers have come up with unique methods of making drown sets. One of the simplest and most practical is a slide wire with a heavy weight attached to one end, or with an end staked to the bottom in 3 or more feet (>0.9 m) of water. The other end of the wire is threaded through a hole in one end of a small piece of angle iron. The trap chain is attached to a hole in the other end of the angle. The end of the wire is then attached to a tree or stake driven into the bank (Fig. 13). When the beaver gets a foot or leg in the trap, it immediately dives back into the water. As the angle slides down the wire, it prevents the beaver from reaching the surface. The angle iron piece will not slide back up the wire and most often bends the wire as the beaver struggles, thus preventing the beaver from coming up for air. Trappers should be prepared to quickly and humanely dispatch a beaver that is caught in a trap and has not drowned.

The leghold trap set in lodges or bank dens is also effective, especially for trapping young beavers. Place the set on the edge of the hole where the beaver first turns upward to enter the lodge or den, or place it near the bottom of the dive hole. Keep the jaws and pan off of the bottom by pulling the springs backward so that a swimming foot will trip the pan. Stake the set close to the bottom or wire the trap to a log or root on the bottom, to avoid the need for drowning weights, wires, and angle iron pieces. Generally, more time and expertise is necessary to make effective sets with leghold traps and snares than is required with the Conibear®-type trap.

Use scent or freshly cut cottonwood, aspen, willow, or sweetgum limbs to entice beaver to leghold trap sets. Bait or scent is especially useful around scent mounds and up slides along the banks or dams. Most trappers who use Conibear®-type traps do not employ baits or scent, although they are occasionally helpful. In some states it is illegal to use bait or scent.

Several other types of traps can be used, including basket/suitcase type live traps. These are rarely used, however, except by professionals in urban areas where anti-trap sentiment or other reasons prevent the killing of beavers. These traps are difficult and cumbersome to use, and will not be further discussed here for use in beaver damage control. Any type of traps used for beavers or other animals should be checked daily.

Snaring can be a very cost-effective method for capturing beavers. Snaring equipment costs far less than trapping equipment and is more convenient to use in many situations. In addition, beavers can be captured alive by snaring and released elsewhere if desired.

Snare placement is similar to trap placement. First, look for runways and fresh sign that indicate where beaver activities are focused. Find a suitable anchor such as a large tree, log, or root within 10 feet (3 m) of the runway where the snare will be set. If necessary, anchor snares by rods driven into the ground, but this is more time consuming and less secure. Attach three 14-gauge wires to the anchor so that each can swivel freely. Cut each wire to length so they reach about 1 foot (30 cm) past the runway. Twist the wires together to form a strong braided anchor cable. Drive a supporting stake into the ground near the runway and wrap the free end of the anchor cable around it twice. Prepare a new, dyed, No. 4 beaver or coyote snare, consisting of 42 inches (107 cm) of 3/32-inch (2.4-mm) steel cable with an attached wire swivel and slide lock. Twist the free ends of the three anchor wires around the wire swivel on the end of

the snare cable. Wrap the longest anchor wire around the base of the wire swivel and crimp it onto the snare cable about 2 inches (5 cm) from the swivel. Use both the stake and the supporting anchor wire to suspend a full-sized loop about 4 inches (10 cm) above the runway. If necessary, use guide sticks or other natural debris to guide beaver into the snare.

The described snare set is very common, but there are several variations and sets that can be used. Snares are frequently placed under logs, near bank dens, and next to castor mounds. Drowning sets can be made using underwater anchors, slide cables, and slide locks.

Snares should be checked at least every 24 hours. Dispatch snared beavers with a sharp blow or shot to the head. Beavers can be chemically immobilized and transported to suitable sites for release if desired.

Snares must be used with great care to avoid capturing nontarget animals. Avoid trails or areas that are used by livestock, deer, or dogs. Check with your local wildlife agency for regulations associated with trapping and snaring. Snaring is not allowed in some states.

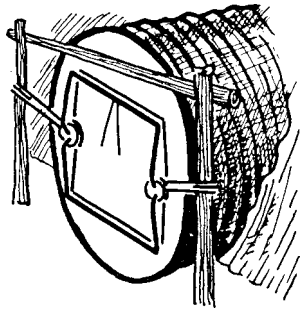
For more information about the use of snares see *A Guide to Using Snares for Beaver Capture* (Weaver et al. 1985) listed at the end of this chapter.

Shooting

In some states, because of the extent of damage caused by beavers, regulations have been relaxed to allow shooting. Some states even allow the use of a light at night to spot beavers while shooting. Before attempting to shoot beavers, check regulations, and if applicable, secure permits and notify local law enforcement personnel of your intentions.

Beavers are most active from late afternoon to shortly after daybreak, depending on the time of year. They usually retire to a lodge or bank den for the day. Therefore, if night shooting is not permitted, the early evening and early morning hours are most productive. Choice of weapons depends on the range and situation. Most shooting is done with a shotgun at close range at night. Shooting alone is generally not effective in eliminating all beaver damage in an area. It can, however, be used to quickly reduce a population.

Fig. 14. Conibear® in culvert set. When beavers are stopping up a drainage culvert, (1) clean out the pipe to get water flowing through freely; (2) set the trap at the level of the drain pipe entrance, but far enough away to clear the culvert when the beaver enters; (3) put stakes on either side to make the beaver enter the trap correctly.



Other Methods

Because of the frustration and damage beavers have caused landowners, almost every control method imaginable has been tried. These range from dynamiting lodges during midday to using snag-type fish hooks in front of dams, road culverts, and drain pipes. Such methods rarely solve a damage problem, although they may kill a few beavers and nontarget species. They are not recommended by responsible wildlife professionals. One method used occasionally along streams prone to flooding is shooting beavers that have been flooded out of lodges and bank dens. This method is often dangerous and rarely solves a damage problem.

Economics of Damage and Control

The economics of beaver damage is somewhat dependent on the extent of the damage before it has been discovered. Some beaver damage problems are *intensive*, such as damage caused by one or two beavers in a new pond, damming or stopping up a culvert or drain pipe, flooding roads, or crops. Other problems are *extensive*, such as several beaver colonies in a flatland area, responsible for the flooding of several hundred acres of marketable timber that will die unless the water is removed quickly. Generally speaking, if a culvert or drain pipe can be unstopped, a knowledgeable trapper can remove one or two beavers in a night or two and eliminate further damage in an intensive damage situation (Fig. 14). However, an extensive situation may require a concentrated effort with several trappers, dynamiting or pulling dams, and a month or more of trapping to get the water off the timber and reduce further timber losses.

Economic damage is estimated to have exceeded $40 billion in the Southeastern United States during a recent 40-year period (Arner and Dubose 1982). This would include all damage to crops, forests, roads, pastures, and other rural and urban properties.

Economically, one must assess the situation and weigh the tradeoffs: the potential loss of thousands of board feet of timber and years of regeneration versus the cost of trapping. The cost of a couple of nights' trapping and a half-day of labor to clear the culverts is much less than the cost of rebuilding a washed-out road or losing flooded crops or timber.

The most important point is that damage control should begin as soon as it is evident that a beaver problem exists or appears likely to develop. Once beaver colonies become well established over a large contiguous area, achieving control is difficult and costly. One of the most difficult situations arises when an adjacent landowner will not allow the control of beavers on their property. In this situation, one can expect periodic reinvasions of beavers and continual problems with beaver damage, even if all beavers are removed from the property where control is practiced.

Although benefits of beavers and beaver ponds are not covered in depth here, there are a number. Aside from creating fish, waterfowl, furbearer, shorebird, reptile, and amphibian habitat, the beaver in many areas is an important fur resource, as well as a food resource. For those who have not yet tried it, beaver meat is excellent table fare if properly prepared, and it can be used whether the pelts are worth skinning or not. It also makes good bait for trapping large predators.

Proper precautions, such as wearing rubber gloves, should be taken when skinning or eviscerating beaver carcasses, to avoid contracting transmissible diseases such as tuleremia.

Acknowledgments

The authors thank, for their cooperation, past and present employees of the Fish and Wildlife Service, US Department of the Interior, county extension agents with the Cooperative Extension Service in various states, cooperators with the USDA-APHIS-ADC program in a number of states, and the many landowners with beaver problems across the South. The experience gained in efforts to assist landowners with wildlife damage problems provided most of the information contained herein.

Figures 1, 2, 4 and 5 from Schwartz and Schwartz (1981).

Figure 3 by Jill Sack Johnson.

Figure 6 and 7 by the authors.

Figures 8 through 12 and 14 from Miller (1978).

Figure 13 by Jill Sack Johnson after Miller (1978).

For Additional Information

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Feral Cat

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HOUSE CATS (Feral)

Fig. 1. House cat, *Felis domesticus*

Damage Prevention and Control Methods

Exclusion

Practical for protecting small poultry and mammals.

Cultural Methods

Clean up debris, burn refuse and brush piles, seal buildings, reduce habitat and food sources.

Repellents

Many products are registered but are practical only for small areas.

Frightening

Dogs.

Toxicants

None are registered.

Fumigants

None are registered.

Trapping

Box traps.

No. 1, 1.5, or 2 leghold traps.

No. 220 Conibear® or body-gripping traps.

Snares.

Shooting

Centerfire rifles, .22 rimfire rifles, and shotguns are effective for quick removal.

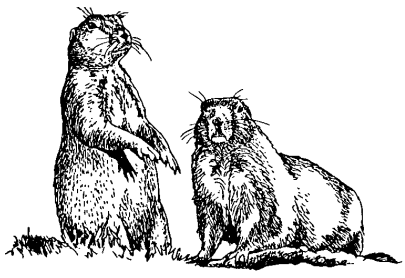
Other Methods

Responsible care by cat owners.

Identification

The cat has been the most resistant to change of all the animals that humans have domesticated. All members of the cat family, wild or domesticated, have a broad, stubby skull, similar facial characteristics, lithe, stealthy movements, retractable claws (except the cheetah), and nocturnal habits.

Feral cats (Fig. 1) are house cats living in the wild. They are small in stature, weighing from 3 to 8 pounds (1.4 to 3.6 kg), standing 8 to 12 inches (20 to 30.5 cm) high at the shoulder, and 14 to 24 inches (35.5 to 61 cm) long. The tail adds another 8 to 12 inches (20 to 30.5 cm) to their length. Colors range from black to white to orange, and an amazing variety of combinations in between. Other hair characteristics also vary greatly.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
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University of Nebraska - Lincoln

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Animal and Plant Health Inspection Service
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Range

Cats are found in commensal relationships wherever people are found. In some urban and suburban areas, cat populations equal human populations. In many suburban and eastern rural areas, feral house cats are the most abundant predators.

Habitat

Feral cats prefer areas in and around human habitation. They use abandoned buildings, barns, haystacks, post piles, junked cars, brush piles, weedy areas, culverts, and other places that provide cover and protection.

Food Habits

Feral cats are opportunistic predators and scavengers that feed on rodents, rabbits, shrews, moles, birds, insects, reptiles, amphibians, fish, carrion, garbage, vegetation, and leftover pet food.

General Biology, Reproduction, and Behavior

Feral cats produce 2 to 10 kittens during any month of the year. An adult female may produce 3 litters per year where food and habitat are sufficient. Cats may be active during the day but typically are more active during twilight or night. House cats live up to 27 years. Feral cats, however, probably average only 3 to 5 years. They are territorial and move within a home range of roughly 1.5 square miles (4 km^2). After several generations, feral cats can be considered to be totally wild in habits and temperament.

Damage

Feral cats feed extensively on songbirds, game birds, mice and other rodents, rabbits, and other wildlife. In doing so, they lower the carrying capacity of an area for native predators such as foxes, raccoons, coyotes, bobcats, weasels, and other animals that compete for the same food base. Where documented, their impact on wildlife populations in suburban and rural areas—directly by predation and indirectly by competition for food—appears enormous. A study under way at the University of Wisconsin (Coleman and Temple 1989) may provide some indication of the extent of their impact in the United States as compared to that in the United Kingdom, where Britain's five million house cats may take an annual toll of some 70 million animals and birds (Churcher and Lawton 1987). Feral cats occasionally kill poultry and injure house cats.

Feral cats serve as a reservoir for human and wildlife diseases, including cat scratch fever, distemper, histoplasmosis, leptospirosis, mumps, plague, rabies, ringworm, salmonellosis, toxoplasmosis, tularemia, and various endo- and ectoparasites.

Legal Status

Cats are considered personal property if ownership can be established through collars, registration tags, tattoos, brands, or legal description and proof of ownership. Cats without identification are considered feral and are rarely protected under state law. They become the property of the landowner upon whose land they exist. Municipal and county animal control agencies, humane animal shelters, and various other public and private "pet" management agencies exist because of feral or unwanted house cats and dogs. These agencies destroy millions of stray cats annually.

State, county, and municipal laws related to cats vary. Before lethal control is undertaken, consult local laws. If live capture is desired, consult the local animal control agency for instructions on disposal of cats.

Damage Prevention and Control Methods

Exclusion

Exclusion by fencing, repairing windows, doors, and plugging holes in buildings is often a practical way of eliminating cat predation and nuisance. Provide overhead fencing to keep cats out of bird or poultry pens. Wire mesh with openings smaller than 2.5 inches (6.4 cm) should offer adequate protection.

Cultural Methods

Cat numbers can be reduced by eliminating their habitat. Old buildings should be sealed and holes under foundations plugged. Remove brush and piles of debris, bale piles, old machinery, and junked cars. Mow vegetation in the vicinity of buildings. Elimination of small rodents and other foodstuffs will reduce feral cat numbers.

Repellents

The Environmental Protection Agency (EPA) has registered the following chemicals individually and in combination for repelling house cats: anise oil, methyl nonyl ketone, Ro-pel, and Thymol. There is little objective evidence, however, of these chemicals' effectiveness. Some labels carry the instructions that when used indoors, "disciplinary action" must reinforce the repellent effect. Some repellents carry warnings about fabric damage and possible phytotoxicity. When used outdoors, repellents must be reapplied frequently. Outdoor repellents can be used around flower boxes, furniture, bushes, trees, and other areas where cats are not welcomed. Pet stores and garden supply shops carry, or can order, such repellents. The repellents are often irritating and repulsive to humans as well as cats.

Frightening

Dogs that show aggression to cats provide an effective deterrent when placed in fenced yards and buildings where cats are not welcome.

Toxicants

No toxicants are registered for control of feral cats.

Fumigants

No fumigants are registered for control of feral house cats. Live-trapped

cats or cats in holes or culverts can be euthanized with carbon dioxide gas or pulverized dry ice (carbon dioxide) at roughly 1/2 pound per cubic yard (0.3 kg/m^3) of space.

Trapping

Live Traps. Live-trapping cats in commercial or homemade box traps (Fig. 2) is a feasible control alternative, particularly in areas where uncontrolled pets are more of a problem than wild cats. Trap openings should be 11 to 12 inches (28 to 30 cm) square and 30 inches (75 cm) or more long. Double-ended traps should be at least 42 inches (105 cm) long. The cat can be captured and turned over to animal control agencies without harm, given back to the owner with proper warnings, or euthanized by shooting, lethal injection, or asphyxiation with carbon dioxide gas. Sources for commercial traps are found in **Supplies and Materials**. Set live traps in areas of feral cat activity, such as feeding and loafing areas, travelways along fences, tree lines, or creeks, dumps, and garbage cans. Successful baits include fresh or canned fish, commercial cat foods, fresh liver, and chicken or rodent carcasses. Catnip and rhodium oil are often effective in attracting cats.

Leghold Traps. Leghold traps No. 1, 1.5, or 2 are sufficient to catch and hold feral cats (Fig. 3). These traps are particularly useful on cats that are not susceptible to box traps. Place the traps in a shallow hole the size and shape of the set trap. Cover the pan with waxed paper and then cover the trap with sifted soil, sawdust, or potting soil. Place the bait material far enough beyond the trap that the cat must step on the trap to reach it. Traps can be set at entrances to holes where cats are hiding, entryways to buildings, or near garbage cans. Domestic cats caught in leghold traps should be handled with care. Cover the cat with a blanket, sack, or coat; pin it down with body weight; and release the trap. Catch poles can also be used to subdue trapped cats.

Conibear® or Body-gripping Traps. Conibear® or body-gripping traps are lethal traps that work like

1 - Door up in grooves guiding its fall.
2 - Treadle board resting on a fulcrum. (Fulcrum made by nailing a small piece of wood across floor of trap. Weight of animal on back part of treadle depresses treadle, pulls back trigger wire and allows door to fall.)
3 - Trigger wire. (Three-gauge wire is connected to a screw eye at one side of treadle and back of fulcrum, extended along side of box to top of trap and passed through a second screw eye. When trap is set, door rests on the projecting end of trigger wire.)
4 - Back wall with 3-inch square opening. (Inside of opening is screened and provided with a tight door on outside to permit observation of captive animal and introduction of a fumigant for its disposal. Door is open when trap is set; closed when fumigant is introduced.)
5 - Uprights containing grooves in which door slides. (Grooves should be greased for easy action of door.)

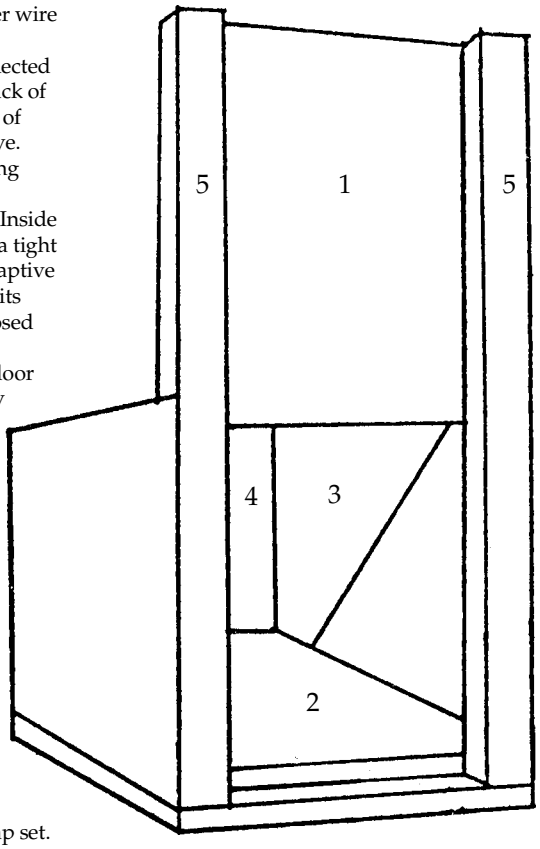

Fig. 2a. Front and partial interior of box trap set.

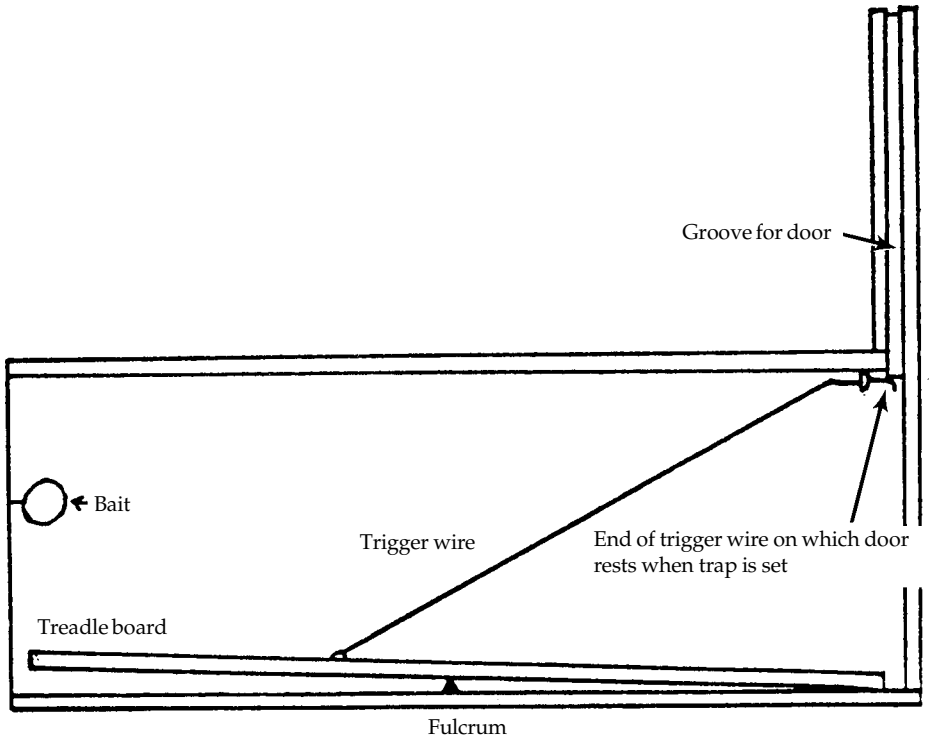

Fig. 2b. Side view of cat trap.

double-jawed mouse traps. They should be set only where no other animals will get into them. The No. 220 size is most effective for cats. Set traps in front of culverts or entry holes, in garbage cans, or boxes with the bait placed in the back (Fig. 3).

Snares. Snare sizes No. 1 and 2 are very effective as live traps or kill traps when set properly. Place snares in entrances to dens or crawlthroughs, in trails in weeds, or in garbage cans, boxes, or other restricted access arrangements where bait is placed (Fig. 4). Sources for snares are found in **Supplies and Materials**.

Shooting

Feral cats can be shot with .22 rimfire and other calibers of centerfire rifles and shotguns in rural areas where it is safe. In buildings and urban areas, powerful air rifles are capable of killing cats with close-range head shots. Cats can be lured out of heavy cover for a safe shot by using predator calls, elevated decoys of fur or feathers, or meat baits.

Other Methods

Supplemental feeding of feral or free-roaming house cats will probably have little effect in reducing their depredations on songbirds and other wildlife. Even well-fed cats will often bring home a small prey they have caught and proudly display it to their owners without eating it. Laboratory studies suggest that hunger and hunting are controlled by separate neurological centers in the cat brain, so the rate of predation is not affected by the availability of cat food.

The hunter is often the hunted. Dogs and coyotes, which are adapting to urban environments, are probably the greatest predators of cats, next to humans and cars. Feral cats are often found on the borders of human habitation. Large predators such as bobcats, mountain lions, fox, coyotes, and feral dogs eliminate cats that stray too far afield.

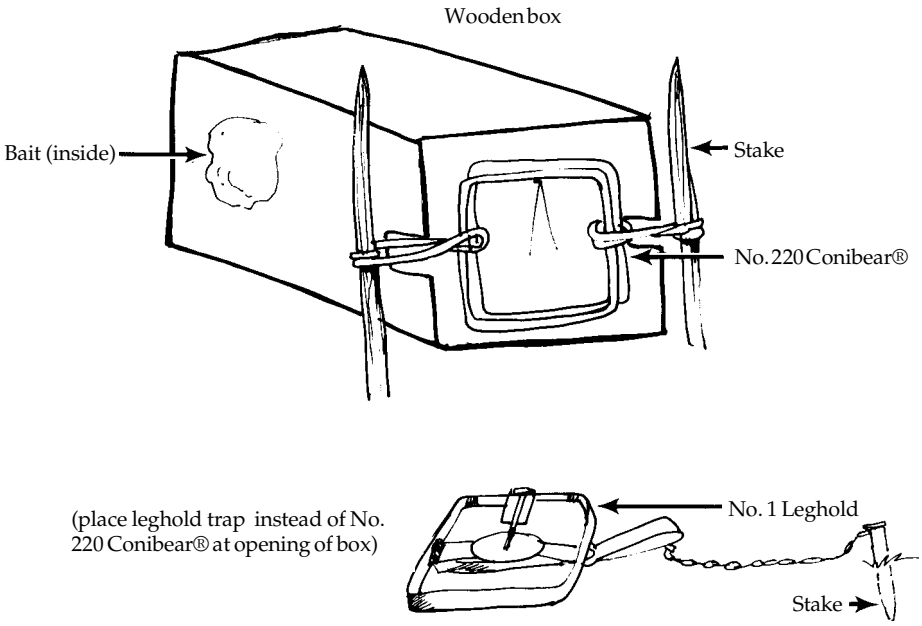

Fig. 3. Cubby set (box set) with Conibear® or leghold trap.

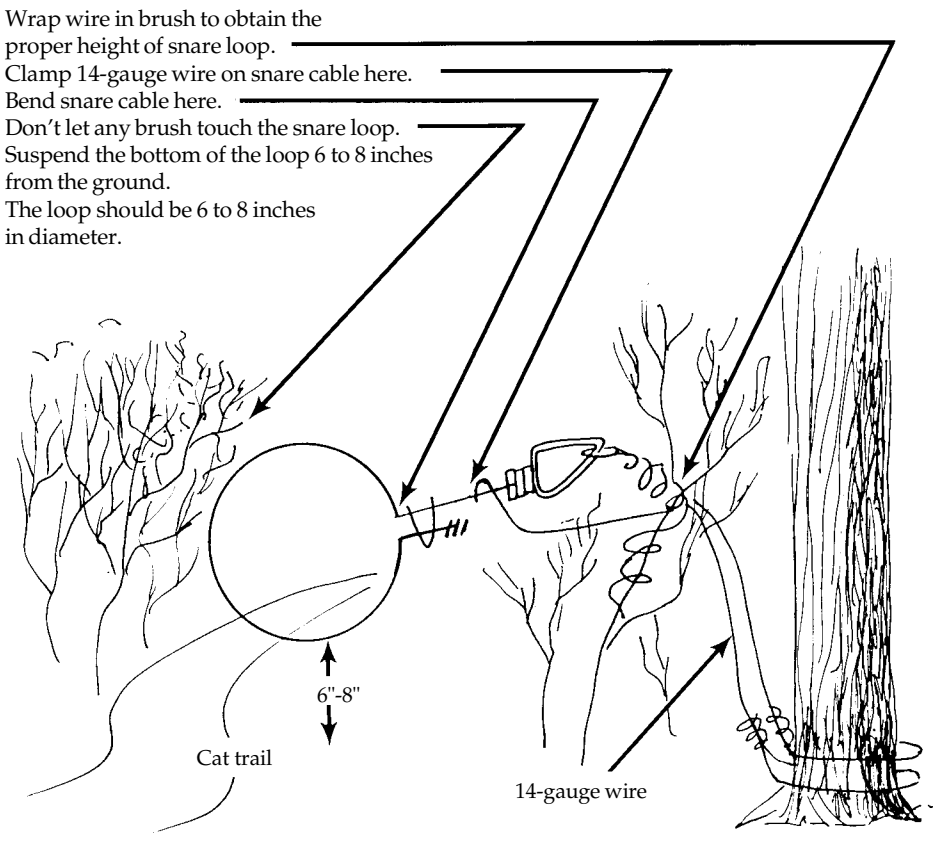

Fig. 4. Trail snare set

In the final analysis, many problems with feral cats could be avoided if cat owners would practice responsible pet ownership. The same licensing and leash laws pertaining to dogs should be applied to cats. Spaying or neutering should be encouraged for household pets not kept for breeding purposes. Neutering is not a cost-effective program for controlling feral populations. Unwanted cats should be humanely destroyed, not abandoned to fend for themselves.

Economics of Damage and Control

The place of cats in the modern urban world is certainly secure even though their reputation as rodent controllers has not been supported by objective research. Cats have replaced dogs as the most common family pet in the United States. Their owners support a growing segment of the economy in the pet food and pet supplies industries. On the other hand, feral cats are responsible for the transmission of many human and wildlife diseases and kill substantial amounts of wildlife.

Acknowledgments

I wish to acknowledge M. L. Boddicker, who was the author of the "House Cats" chapter in the 1983 edition of *Prevention and Control of Wildlife Damage.*

Figure 1 by Emily Oseas Routman.

Figure 2 adapted from Boddicker (1978), "Housecats" in F. R. Henderson, *Prevention and Control of Wildlife Damage*, Kansas State Univ., Manhattan.

Figure 3 by M. L. Boddicker, adapted by Jill Sack Johnson.

Figure 4 courtesy of Gregerson Manufacturing Co., adapted by Jill Sack Johnson.

For Additional Information

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Deer

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DEER

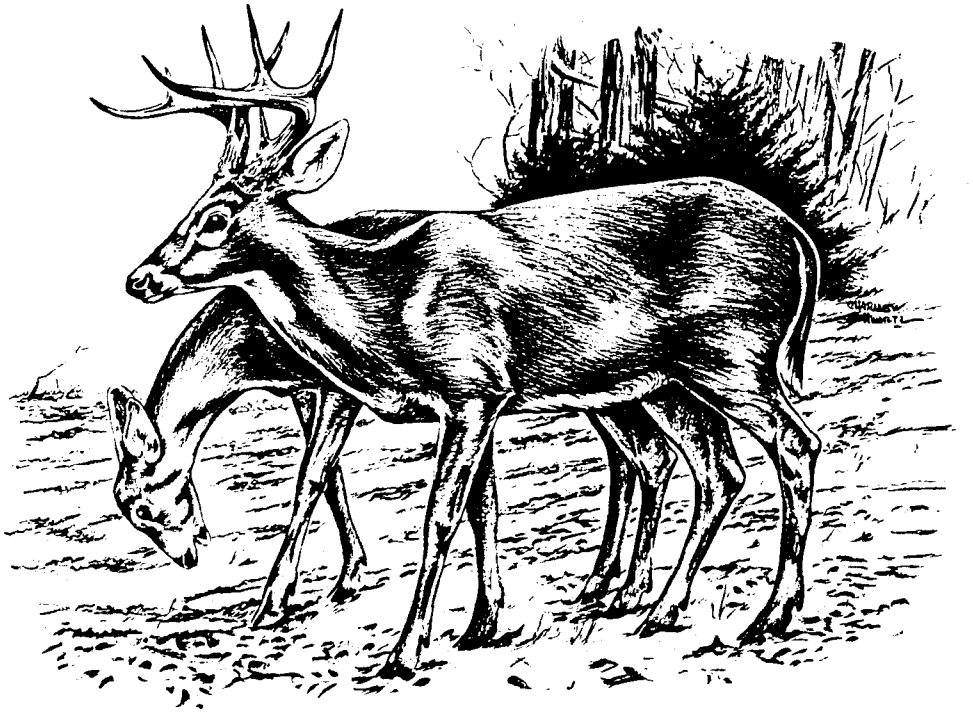


Fig. 1. White-tailed deer, *Odocoileus virginianus*

Damage Prevention and Control Methods

Exclusion

Fences provide the most consistent control:
8-foot (1.4-m) woven wire fence, Tensar®, or wooden snow fence around small plots or haystacks.

Several configurations of electric fences are available:
vertical five, seven, or nine-wire, slanted seven-wire, single strand, and others.

Individual tree protectors include:
woven wire or plastic cylinders.

Cultural Methods and Habitat Modification

Plant trees and shrubs that are resistant or less susceptible to deer damage.

Harvest crops as early as possible to reduce vulnerability.

Lure crops may divert deer away from areas that are susceptible to damage.

Habitat modification generally is not recommended.

Frightening

Gas exploders, pyrotechnics, gunfire, or tethered dogs provide temporary relief.

Repellents

A wide variety of commercial formulations is available:
area repellents--applied near plants to be protected, repel by smell;

contact repellents--applied directly to plants to be protected, repel by taste;

a few, such as Deer-Away®, possess characteristics of both groups.

Toxicants

None are registered.

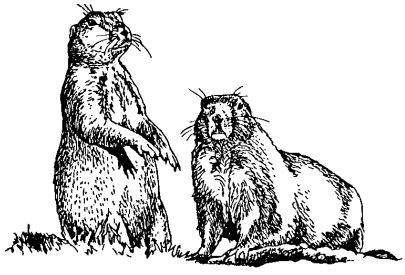
Live Capture

Deer can be live-trapped or chemically immobilized for removal by professional biologists--useful only in special cases, such as city parks.

Shooting

Sport hunting can reduce deer populations and should be encouraged.

Some states may issue permits to shoot deer outside normal sport hunting seasons.



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Introduction

Deer are probably the most widely distributed and best-recognized large mammals in North America. The white-tailed deer (*Odocoileus virginianus*) (Fig. 1) is found throughout much of North America. The mule deer *(O. hemionus)* is primarily a western species restricted to buttes, draws, and stream bottoms with sufficient forage. The black-tailed deer (*O.h. columbianus*) is a subspecies of the mule deer. Both white-tailed and mule deer are very important game animals. In 1974 about 2 million white-tailed deer were harvested by over 8 million hunters. The trend in both harvest and hunter numbers has been generally upward since then. The positive economic value of deer through license fees, meat, and hunter expenditures for equipment, food, and transportation can be measured in hundreds of millions of dollars. Hesselton and Hesselton (1982) estimated the value of each deer harvested in the United States to be $1,250. With the additional aesthetic value of deer to landowners and vacationers, importance of deer as a wildlife resource cannot be disputed.

Despite their economic and aesthetic values, deer also have a variety of negative economic impacts—they damage crops and personal property, and harbor diseases common to humans and livestock. Unlike moles, rats, and other species implicated in damage, deer cannot be casually eliminated when in conflict with humans. But neither can landowners be expected to bear the entire burden of support for this valuable public resource.

These factors often make deer damage control a difficult social and political problem as well as a biological and logistical one. Control methods are built around effective deer herd management. Thus the various state wildlife agencies are often indirectly or directly involved through subsidy of control techniques, direct damage compensation payments, or technical advice.

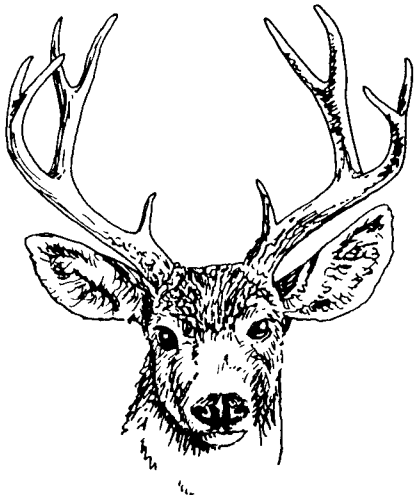
Scare devices, repellents, and shooting all have a place in deer damage control. Effective control for fields, orchards, and other large areas, however, usually depends on excluding the deer with one of several types of fences, discussed later in this chapter. Toxicants, fumigants, and in most cases, trapping, are not used in deer control.

The volume of literature on deer ecology and management exceeds that for any other wildlife species. The best single reference is Halls (1984). The following review is meant as a brief summary using the white-tailed deer as an example. The mule deer is very similar in all respects.

Identification

Deer are even-toed ungulates of the family *Cervidae*. Adult animals may weigh 50 to 400 pounds (23 to 180 kg) depending on species and location. Their general form is well-known. At birth, fawns are rust-colored with white spots. Their spotted coats are shed in 3 to 4 months and are replaced by a grayish-brown fall and winter coat. The summer coat of adult animals is reddish-brown. Underparts of the tail, belly, chin, and throat are white during all seasons. Antlers grow on males (bucks) from April to August. Antler development is nourished by a layer of soft, vascularized "velvet" on the antlers. The dried velvet layer is rubbed off and the antlers polished during the fall rut (breeding season). Antler size depends on nutrition, age, and genetics. Mule deer antlers are forked while the tines of a white-tailed deer's antlers arise from a central beam. Both mule deer and white-tails have deciduous antlers that are shed in mid-winter. The rump and tail area and facial features also differ slightly between the species (Fig. 2). Both mule and white-tailed deer lack upper incisors.

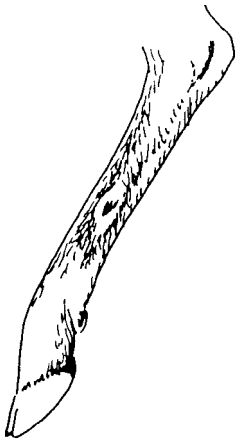
White-tailed deer

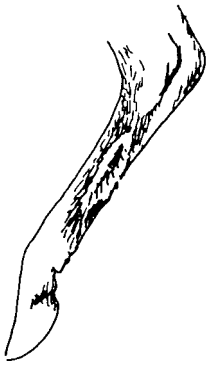


Black-tailed deer

Mule deer

Fig. 2. Comparison of antlers and facial characteristics, metatarsal glands, tails, and rump patches in three kinds of deer.





Range

The white-tailed deer is found in every state in the United States except perhaps Alaska and Utah. It occurs throughout the southern provinces of Canada, across the United States, and on into Central and South America (Fig. 3). Mule deer are common throughout western Canada, western United States, and into Mexico (Fig. 4). There are several subspecies of both deer.

Fig. 3. Range of the white-tailed deer in North America.

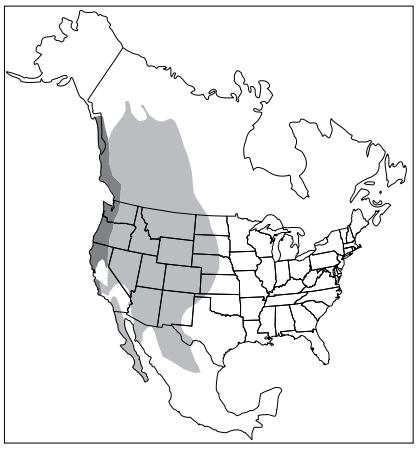


Fig. 4. Range of the mule deer (light) and black-tailed deer (dark) in North America.

Habitat

Deer are creatures of the forest edge rather than the dense, old-growth forest. They thrive in agricultural areas interspersed with woodlots and riparian habitat. They favor early successional stages which keep brush and sapling browse within reach. Dense cover is used for winter shelter and protection.

Food Habits

Browse (leaves, stems, and buds of woody plants) is generally available all year and is a staple food for deer. An extensive review of food habits can be found in Hesselton and Hesselton (1982) and in Mackie et al. (1982). Plant species vary considerably in quality and regional availability, so a list is not presented here. Forbs are eaten in spring and summer when available. Fruits and nuts (especially acorns) are seasonally very important. Grasses are relatively unimportant. Agricultural crops--corn, soybeans, small grains, alfalfa, vegetables, and fruit trees--are readily eaten when available. Local food habits studies are available in most states--consult your local wildlife agency.

Nutrient requirements and the amount of food consumed vary with age of the animal, season, and the reproductive cycle. Daily dry matter consumption averages 2% to 4% of live body weight. For adult bucks, daily consumption is greatest in spring and averages 4.4 to 6.4 pounds (2.0 to 2.9 kg) of air-dry food per day. Consumption is about half that during winter. For does, greatest daily food consumption occurs in early fall, just prior to the breeding season.

General Biology, Reproduction, and Behavior

Breeding occurs from October to January depending on latitude. Peak activity is in November. Does are in heat for 24 hours every 28 days for 2 to 3 consecutive cycles. One buck may inseminate several does. No pairing takes place. Most does breed during their second fall, although on good range up to 30% of the doe fawns (6 months old) will be bred. Gestation is about 202 days. The peak of fawn drop is in May or June. Most reproducing fawns give birth to a single fawn, but adult does typically bear twin fawns. Reproductive potential is very sensitive to nutrition. Fawns weigh 7 to 8 pounds (3.2 to 3.6 kg) at birth and increase in weight for 5 1/2 to 6 1/2 years. Adult size varies with latitude. In northern states, a mature buck may weigh 200 to 300 pounds (90 to 135 kg). A key deer buck (white-tailed deer subspecies) in Florida may weigh only 50 pounds (22.5 kg). Does average 25% to 40% less than bucks for all subspecies.

Deer are most active in early morning and evening. They have a home range of several hundred acres (ha), but this varies with season, sex, and habitat quality. In northern areas, deer gather ("yard") in dense cover for the winter. They may move long distances from summer range to a winter yard. Life expectancy is dependent on hunting pressure and regulations. Records show whitetails living 20 years, although 10 to 12 years is noteworthy in the wild.

Damage and Damage Identification

Deer damage a wide variety of row crops, forage crops, vegetables, fruit trees, nursery stock, and ornamentals, as well as stacked hay. In addition to the immediate loss of the crop being damaged, there is often residual damage in the form of future yield reduction of fruit trees or forage crops such as alfalfa. Ornamental trees or nursery stock may be permanently disfigured by deer browsing. Under high densities deer may severely impact native plant communities and impair regeneration of some forest tree species. Besides vegetative damage, deer/vehicle collisions pose a serious risk to motorists, and deer have been implicated in the distribution and transmission of Lyme disease.

Damage identification is not difficult. Because both mule deer and white-tailed deer lack upper incisors, deer often leave a jagged or torn surface on twigs or stems that they browse. Rabbits and rodents, however, leave a clean-cut surface. In addition, deer tracks are very distinctive (Fig. 5). The height of damage from the ground (up to 6 feet [1.8 m]) often rules out any mammal other than deer. Deer often are observed "in the act" of causing damage.

Legal Status

Deer are protected year-round in all states and provinces, with the exception of legal harvest during appropriate big-game hunting seasons. In cases of severe or persistent damage, some states may issue farmers special permits to shoot deer at times other than the legal hunting seasons. Regulations vary on the necessary permits and on

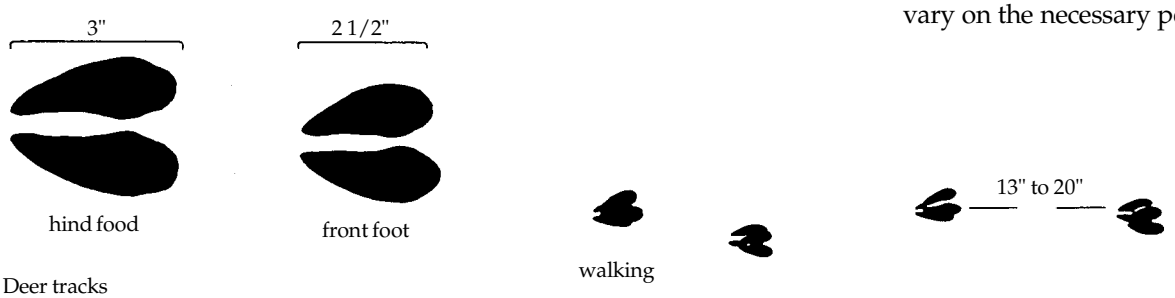


Fig. 5. Deer tracks

disposal of dead animals. The popularity of deer as game animals and the need to curb poaching have led to the development of severe penalties for illegal possession. No lethal deer control can be initiated before consulting your local state wildlife agency. By law, some states provide technical assistance or direct compensation for deer damage. This is discussed under the section on the economics of damage and control.

Damage Prevention and Control Methods

Exclusion

Where deer are abundant or crops are particularly valuable, fencing may be the only way to effectively minimize deer damage. Several fencing designs are available to meet specific needs. Temporary electric fences are simple inexpensive fences useful in protecting garden and field crops during snow-free periods. Deer are attracted to these fences by their appearance or smell, and are lured into contacting the fence with their noses. The resulting shock is a very strong stimulus and deer learn to avoid the fenced area. Permanent high-tensile electric fences provide year-round protection from deer and are best suited to high-value specialty or orchard crops. The electric shocking power and unique fence designs present both psychological and physical barriers to deer. Permanent woven-wire fences provide the ultimate deer barrier. They require little maintenance but are very expensive to build. Fencing in general is expensive. You should consider several points before constructing a fence, such as:

History of the area — assemble information on past claims, field histories, deer numbers, and movements to help you decide on an abatement method.

Deer pressure — this reflects both the number of deer and their level of dependence on agricultural crops. If deer pressure in your area is high, you probably need fences.

Crop value — crops with high market values and perennial crops where damage affects future yields and growth often need the protection fencing can provide.

Field size — in general, fencing is practical for areas of 40 acres (16 ha) or less. The cost per acre (ha) for fencing usually decreases, however, as the size of the area protected increases.

Cost-benefit analysis — to determine the cost effectiveness of fencing and the type of fence to install, weigh the value of the crop to be protected against the acreage involved, costs of fence construction and maintenance, and the life expectancy of the fence.

Rapidly changing fence technology — if you intend to build a fence yourself, supplement the following directions by consulting an expert, such as a fencing contractor. Detailed fencing manuals are also available from most fencing manufacturers and sales representatives.

Temporary Electric Fencing

Temporary electric fences provide inexpensive protection for many crops during periods without snow. They are easy to construct, do not require rigid corners, and materials are readily available. Install fences at the first sign of damage to prevent deer from establishing feeding patterns in your crops. Weekly inspection and maintenance are required. Different types of temporary electric fences are described below.

Peanut Butter Fence. The peanut butter fence is effective for small gardens, nurseries, and orchards (up to 3 to 4 acres [1.2 to 1.6 ha]) subject to moderate deer pressure. Deer are attracted by the peanut butter and encouraged to make nose-to-fence contact. After being shocked, deer learn to avoid fenced areas. Cost, excluding labor, is about $0.11 per linear foot ($0.30/m). This fence is not widely used.

To build a peanut butter fence (Fig. 6), follow the steps below.

(1) Install wooden corner posts.

(2) String one strand of 17-gauge (0.15-cm), smooth wire around the corners and apply light tension.

(3) Set 4-foot (1.2-m) 3/8-inch (1-cm) round fiberglass rods along the wire at 45-foot (14-m) intervals.

(4) Attach the wire to insulators on the rods 2 1/2 (0.75 m) feet above ground level and apply 50 pounds (22.5 kg) of tension.

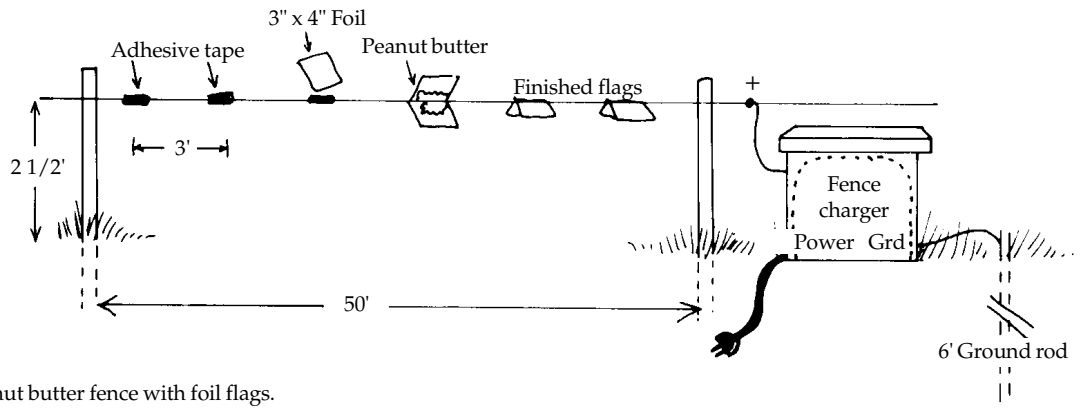


Fig. 6. The peanut butter fence with foil flags.

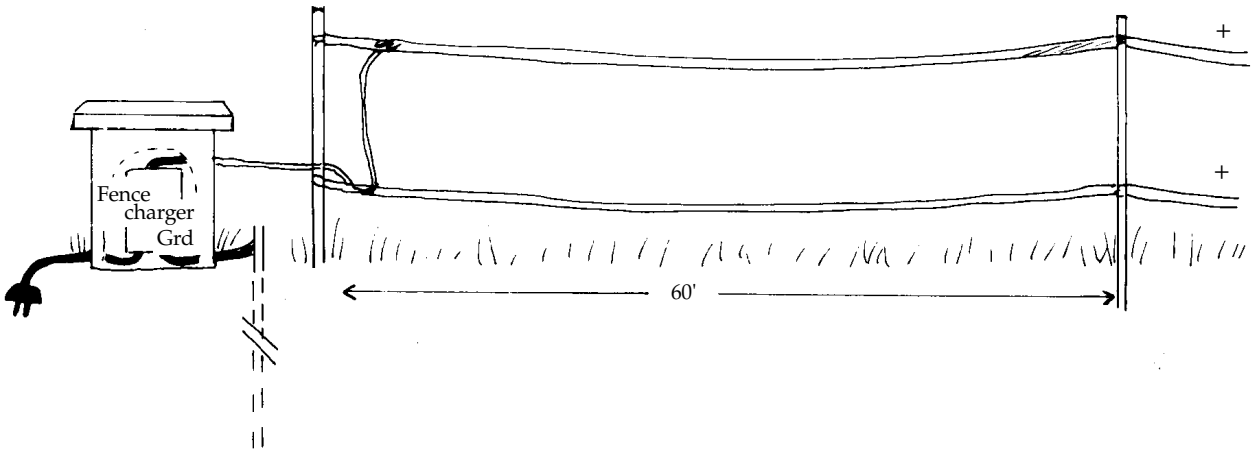


Fig. 7. The polytape fence.

(5) Attach 3 x 4-inch (7 x 10-cm) foil strips to the wire at 3-foot (1-m) intervals, using 1 x 2-inch (3 x 5-cm) strips of cloth adhesive tape.

(6) Apply a 1:1 mixture of peanut butter and vegetable oil to the adhesive tape strips and fold the foil over the tape.

(7) Connect the wire to the positive (+) post of a well-grounded fence charger.

(8) For fields larger than 1 acre (0.4 ha), it is more practical to apply the peanut butter mixture directly to the wire. You can make a simple applicator by mounting a free-spinning, 4-inch (10-cm) pulley on a shaft inside a plastic ice cream pail. Fill the pail with a peanut butter-vegetable oil mixture that has the consistency of very thick paint. Coat the entire wire with peanut butter by drawing the pulley along the wire. Apply peanut butter once a month. Attach foil flags to the fence near runways or areas of high deer pressure to make the fence more attractive.

Check the fence weekly for damage by deer and grounding by vegetation.

Polytape Fence. Various forms of polytape or polywire, such as Visible Grazing Systems® (VGS), Baygard®, and Turbo-tape® are very strong and portable. You can use these fences to protect up to 40 acres (16 ha) of vegetable and field crops under moderate deer pressure. Deer receive shocks through nose-to-fence contact and they learn to avoid fenced areas. Cost, excluding labor, is about $.11 per linear foot ($0.30/m).

To build a polytape fence (Fig. 7), follow the steps below.

(1) Drive 5/8-inch (1.6-cm) round fiberglass posts 2 feet (0.6 m) into the ground at the corners.

(2) String two strands of polytape (white or yellow are most visible) around the corners and apply light tension (one strand 2 1/2 feet (0.75 m) high can be used).

(3) Use square knots or half-hitches to make splices or to secure the polytape to corner posts.

(4) Set 4-foot (1.2-cm) 3/8-inch (1-cm) round fiberglass rods along the wires at 45-foot (14-m) intervals.

(5) Attach the two strands of polytape to insulators on the rods at 1 and 3 feet (0.3 and 0.9 m) above ground level and apply 50 pounds (22.5 kg) of tension.

(6) Connect the polytape to the positive (+) post of a well-grounded fence charger.

(7) Use the applicator described under Peanut Butter Fence (8) to apply 2-foot (0.6-m) swatches of peanut butter to the polytape every 6 feet (2 m) where deer presence is expected to be high.

To maintain the fence, check it weekly for damage by deer and grounding by vegetation.

Permanent High-Tensile Electric Fencing

High-tensile fencing can provide year-round protection from deer damage. Many designs are available to meet specific needs. All require strict adherence to construction guidelines concerning rigid corner assemblies and fence configurations. Frequent inspection and maintenance are required. High-tensile fences are expected to last 20 to 30 years. Different types of high-tensile electric fences are described below.

Offset or Double Fence. This fence is mostly for gardens, truck farms, or nurseries up to about 40 acres (0.16 ha) that experience moderate deer pressure. Deer are repelled by the shock and the three-dimensional nature of the fence. You can add wires if deer pressure increases. Cost, excluding labor, is about $.35 per linear foot ($1/m).

To build an offset or double fence (Fig. 8), follow the steps below.

For the outside fence:

(1) Install swing corner assemblies where necessary (see the section on fence construction—rigid brace assemblies [Fig. 14]).

(2) String a 12 1/2-gauge (0.26-cm) high-tensile wire around the

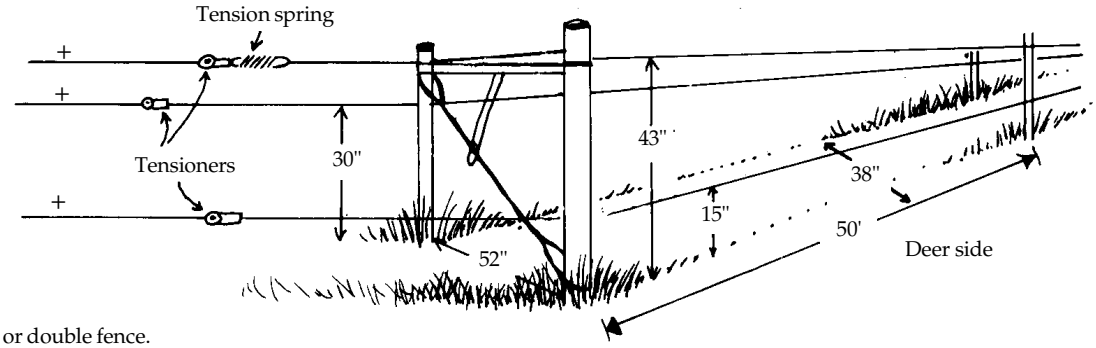


Fig. 8. The offset or double fence.

outside of the swing corner assemblies and apply light tension.

(3) Set 5-foot (1.5-m) line posts along the wire at 40- to 60-foot (12- to 18-m) intervals.

(4) Attach the wire to insulators on the line posts, 15 inches (38 cm) above ground level and apply 150 to 250 pounds (68 to 113 kg) of tension.

(5) String a second wire at 43 inches (109 cm) and apply 150 to 250 pounds (68 to 113 kg) of tension.

For the inside fence:

(6) String a wire around the inside of the swing corner assemblies and apply light tension.

(7) Set 5-foot (1.5-m) line posts along the wire at 40- to 60-foot (12- to 18-m) intervals.

(8) Attach the wire to insulators on the line posts at 30 inches (76 cm) above ground level.

(9) Attach all wires to the positive (+) post of a well-grounded, low-impedence fence charger.

(10) Clear and maintain a 6- to 12-foot (1.8- to 3.6-m) open area outside the fence so deer can see it.

Maintenance includes weekly fence and voltage checks.

Vertical Deer Fence. Vertical fences are effective at protecting large truck gardens, orchards, and other fields from moderate to high deer pressures. Because of the prescribed wire spacing, deer either attempt to go through the fence and are effectively shocked or they are physically impeded by the barrier. Vertical fences use less ground space than three-dimensional fences, but are probably less effective at inhibiting deer from jumping over fences. There is a wide variety of fence materials, wire spacings, and specific designs you can use. We recommend that you employ a local fence contractor. Costs, excluding labor, range from $0.75 to $1.50 per linear foot ($2 to $4/m).

To build a 7-wire vertical deer fence (Fig. 9), follow the steps below.

(1) Install rigid corner assemblies where necessary (see the section on fence construction—rigid brace assemblies [Fig. 14]).

(2) String a 12 1/2-gauge (0.26-cm) high-tensile wire around the corner assemblies and apply light tension.

(3) Set 8-foot (2.4-m) line posts along

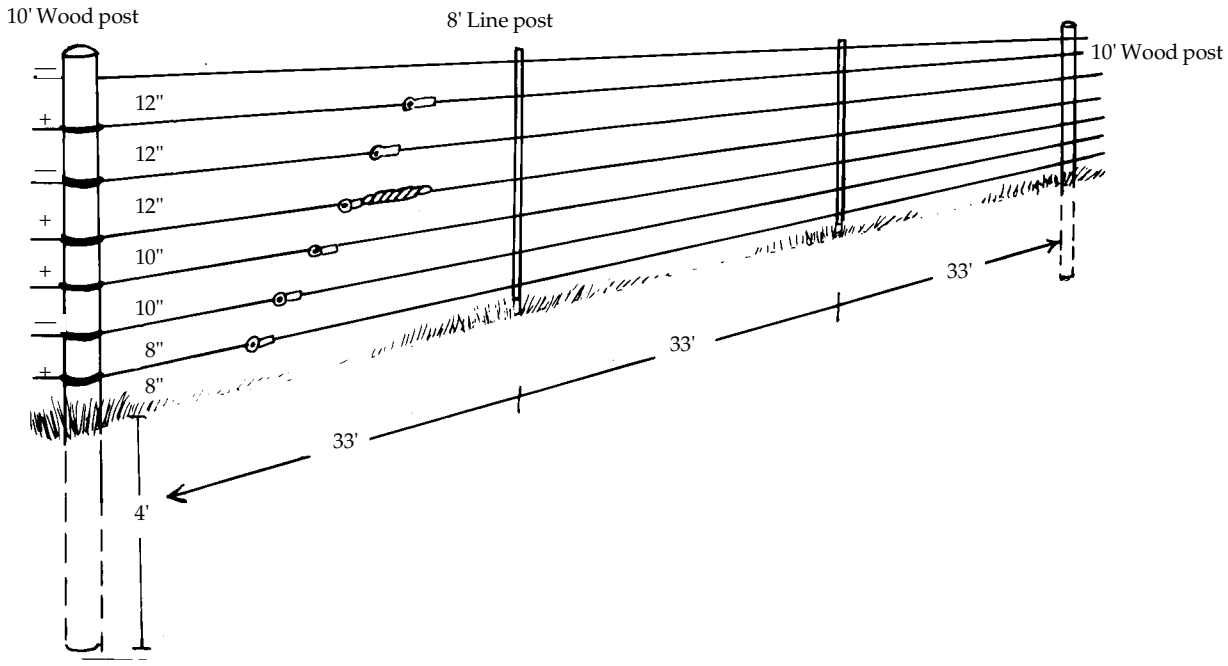


Fig. 9. The seven-wire vertical deer fence.

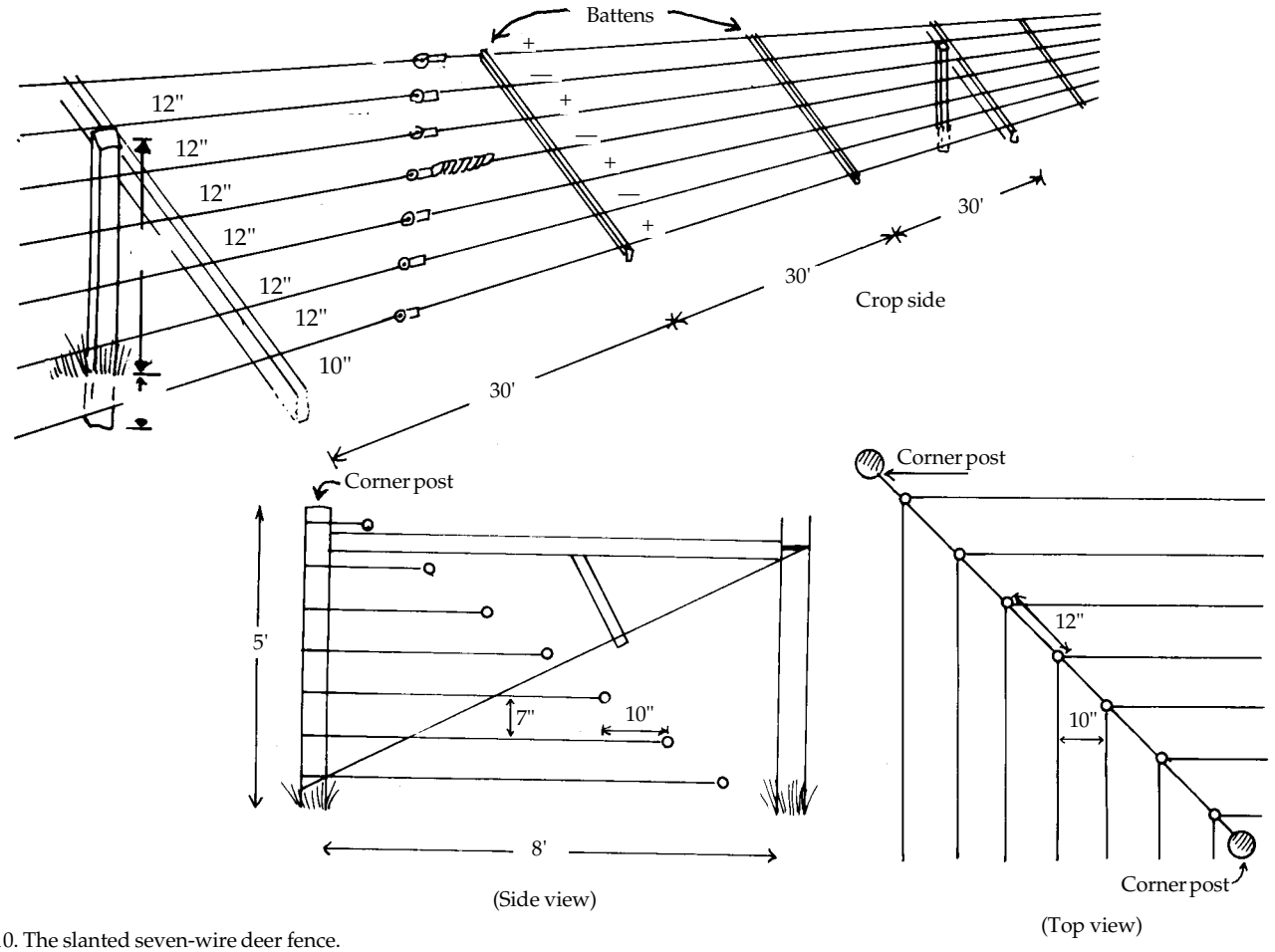


Fig. 10. The slanted seven-wire deer fence.

the wire at 33-foot (10-m) intervals.

(4) Attach a wire to insulators at 8 inches (20 cm) above ground level and apply 150 to 250 pounds (68 to 113 kg) of tension.

(5) Attach the remaining wires to insulators at the spacing indicated in figure 9 and apply 150 to 250 pounds (68 to 113 kg) of tension.

(6) Connect the second, fourth, fifth, and seventh wires from the top, to the positive (+) post of a well-grounded, low-impedence fence charger.

(7) Connect the top, third, and sixth wires directly to ground. The top wire should be negative for lightning protection.

(8) Clear and maintain a 6- to 12-foot (1.8- to 3.6-m) open area outside the fence so deer can see the fence.

Maintenance includes weekly fence inspection and voltage checks.

Slanted Seven-Wire Deer Fence. This fence is used where high deer pressures threaten moderate-to-large sized orchards, nurseries and other high-value crops. It presents a physical and psychological barrier to deer because of its electric shock and three-dimensional nature. Cost, excluding labor, is about $0.75 to $2 per linear foot ($2 to $5.50/m).

To build a slanted seven-wire deer fence (Fig. 10), follow the steps below.

(1) Set rigid, swing corner assemblies where necessary, (see the section on fence construction—rigid brace assemblies [Fig. 14]).

(2) String 12 1/2-gauge (0.26-cm) high-tensile wire around the corner assemblies and apply light tension.

(3) Set angle braces along the wire at 90-foot (27-m) intervals.

(4) Attach a wire at the 10-inch (25-cm) position and apply 150 pounds (68 kg) of tension.

(5) Attach the remaining wires at 12-inch (30-cm) intervals and apply 150 pounds (68 kg) of tension.

(6) Place fence battens at 30-foot (9-m) intervals.

(7) Connect the top, third, fifth, and bottom wires to the positive (+) post of a well-grounded, low-impedence fence charger.

(8) Connect the second, fourth, and sixth wires from the top directly to ground.

(9) Clear and maintain a 6- to 12-foot (1.8- to 3.6-m) area outside the fence so deer can see it.

Maintenance includes weekly inspection and voltage checks.

Permanent Woven-Wire Fencing

Woven-wire fences are used for year-round protection of high-value crops subject to high deer pressures. These fences are expensive and difficult to construct, but easy to maintain. Before

high-tensile electric fencing, woven-wire fences were used most often to protect orchards or nurseries where the high crop value, perennial nature of damage, acreage, and 20-year life span of the fences justified the initial costs. Cost, excluding labor, is about $2 to $4 per linear foot ($5.50 to $11/m). The high cost has resulted in reduced use of woven-wire fences.

To build a deer-proof woven-wire fence (Fig. 11), follow the steps below.

(1) Set rigid corner assemblies where necessary (see the section on Fence Construction—Rigid brace assemblies [Fig. 14]).

(2) String a light wire between two corners and apply light tension.

(3) Set 16-foot (4.9-m) posts along the wire at 40-foot (12-m) intervals, to a depth of 4 to 6 feet (1.2 to 1.8 m).

(4) Roll out an 8-foot (2.4-m) roll of high-tensile woven wire along the line posts. Attach one end at ground level to a corner post with steel staples.

(5) Apply 100 pounds (45 kg) of tension to the wire with a vehicle or fence strainers and attach the wire to line and corner posts with steel staples.

(6) Repeat steps 4 and 5 as necessary around the perimeter of the fence.

(7) Attach two strands of high-tensile smooth wire to the top of the fence to raise the height of the entire fence to 9 to 10 feet (2.7 to 3 m).

Minimal maintenance is required. Inspect for locations where deer can crawl under the fence.

Fencing Tips

Materials. Do not buy cheap materials to reduce costs. This will only reduce the effectiveness and life span of the fence. We recommend using:

(1) Round fiberglass or treated wood posts.

(2) High-quality galvanized wire and steel components. For high-tensile fences, use 11- to 14-gauge (0.31- to 0.21-cm) wire (minimum tensile strength of 200,000 pounds [90,000 kg] and a minimum breaking strength of 1,800 pounds [810 kg]), tension springs, and in-line tensioners.

(3) Compression sleeves for splicing wires and making electrical connections.

(4) Lightning arresters and diverters to protect chargers.

(5) High-quality fence chargers. Chargers must be approved by Underwriters Laboratories (UL) or the Canadian Standards Association (CSA). We highly recommend 110-volt chargers. Six- and 12-volt chargers require battery recharging every 2 to 4 weeks. Use solar panels in remote areas to charge batteries continuously. For high-tensile fences, use high-voltage, low-impedence chargers only (3,000 to 5,000 volts and current pulse duration of at most 1/1,000 second).

(6) Gates. There is no universal gate design because of the many different fence types. Gates should be electrified, well-insulated, and practical for the type of farming operation. Gates range from single strands of electrified wire with gate handles to electrified panel or tubular gates (Fig. 12).

Fence Construction. Fences must be properly constructed--do not deviate from fence construction guidelines.

(1) Prepare fencelines before construction. It is easier and less expensive to install and maintain fences on clear, level runs. Minimize corners to increase strength and reduce costs.

(2) Ensure that the electrical system is well grounded at the fence charger and every 1/2 mile (880 m) of fenceline. To ground high-tensile fences, drive four to six ground

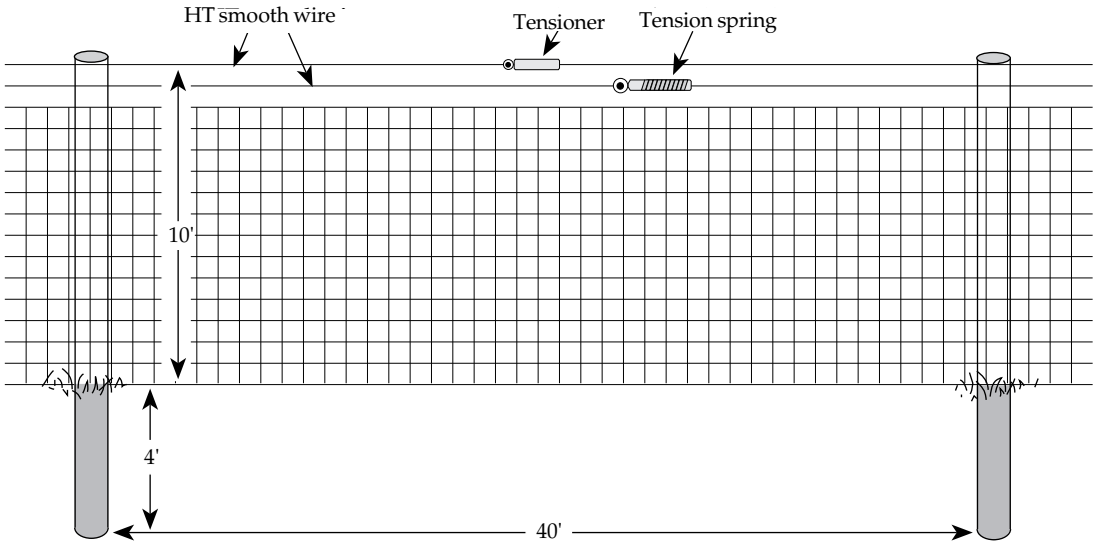


Fig. 11. The deer-proof, woven-wire fence.

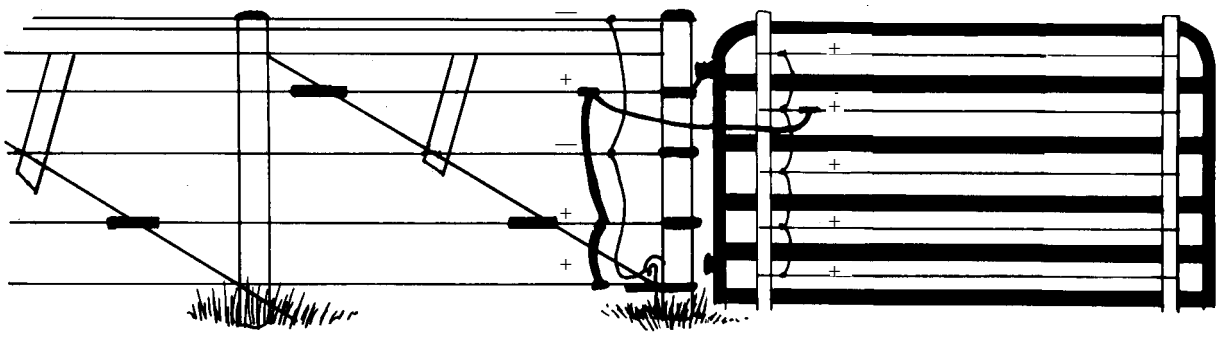


Fig. 12. Fence with electrified gate.

rods 5 to 6 feet (1.5 to 1.8 m) deep and 6 feet (1.8 m) apart. Connect the ground post of the fence charger and the negative (-) wires of the fence to the grounding system (Fig. 13).

(3) The wiring system in figure 13 illustrates a positive-negative fence. Such a design is especially useful with dry or frozen ground. A fence with all positive (hot) wires may be advantageous under general crop and soil moisture conditions. Consult with a fencing contractor or expert for the best choice for your needs.

(4) Install the grounding systems and fence charger before fence construction. Energize completed parts of the fence when you are not working on the fence to gain early protection.

(5) Rigid brace assemblies—corners, ends, and gates—make up the backbone of all high-tensile fence systems (Fig. 14). They must be entirely rigid, constructed of the best materials, and strictly conform to design guidelines. The single-span brace assembly is the basis of all high-tensile strainer assemblies, regardless of location in the fence or fence design. This basic design is then modified to create double-"H" braces, swing corners, and gate ends.

(6) Allow wires to slide freely through insulators on fence posts. Fence flexibility is necessary to endure frequent temperature changes, deer hits, and obstructions.

(7) Identify an electric fence with warning signs (Fig. 15) that are affixed at 300-foot (90-m) intervals or less.

Maintenance. Regular inspection and maintenance are necessary to ensure the effective operation and longevity of most fences.

(1) Control vegetation near fences by mowing or applying herbicides to avoid excessive fence grounding by weeds.

(2) On slopes or highly erodible soils, maintain a good sod cover

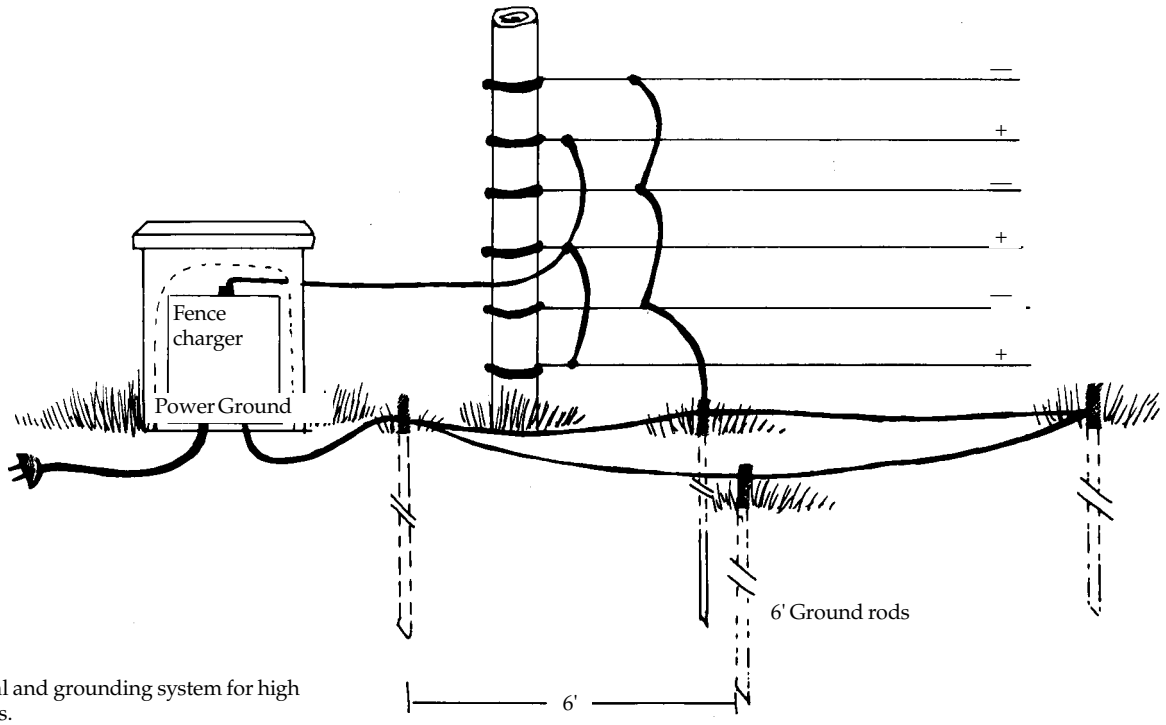
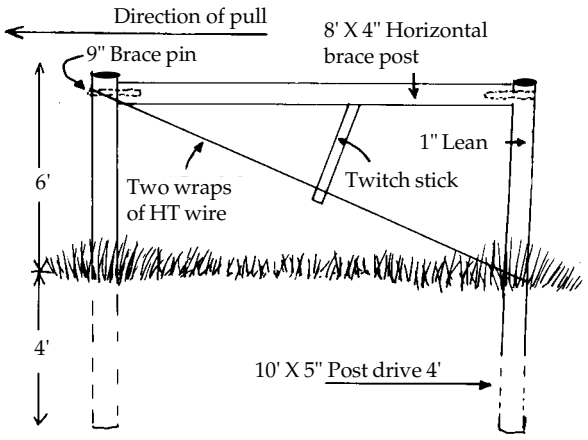
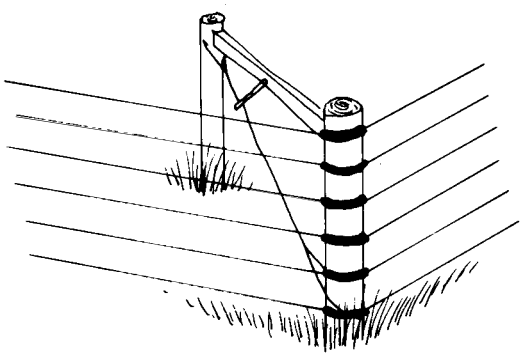


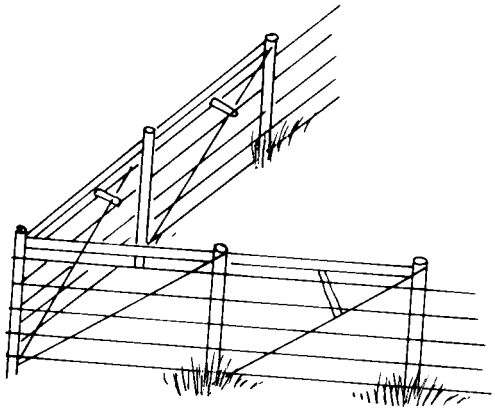
Fig. 13. Electrical and grounding system for high tensile fences.



Single span brace assembly



Swing corner
(vertical fence)



Double H brace assembly
(corner)

Fig. 14. Rigid brace assemblies.

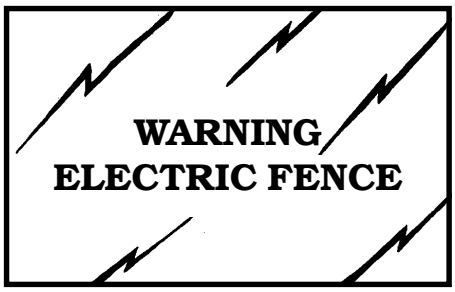


Fig. 15. Remember to attach warning signs to your electric fences.

beneath fences to avoid fenceline erosion.

(3) Always keep the fence charger on. Check the fence voltage weekly with a voltmeter. Maintain at least 3,000 volts at the furthest distance from the fence charger. Disconnect the lower wires if they are covered by snow.

(4) In late fall and early summer, adjust the fence tension (150 to 250 pounds [68 to 113 kg]) for high-tensile fences.

Tree Protectors

Use Vexar®, Tubex®, plastic tree wrap, or woven-wire cylinders to protect young trees from deer and rabbits. Four-foot (1.2-m) woven-wire cylinders can keep deer from rubbing tree trunks with their antlers.

Haystack Protection

Wooden panels have traditionally been used to exclude deer and elk from haystacks. Stockyards have also been protected by welded wire panels and woven wire. More recently haystacks have been protected by wrapping them with plastic Tensar® snow fence. The material comes in 8-foot (2.4-m) rolls and is relatively light and easy to use.

Cultural Methods and Habitat Modification

Damage to ornamental plants can be minimized by selecting landscape and garden plants that are less preferred by deer. In many cases, original landscape objectives can be met by planting species that have some resistance to

Table 1. Ornamental plants, listed by susceptibility to deer damage.[1]

Plants Rarely Damaged:

Botanical name	*Common name*
Berberis spp.	Barberry
Berberis vulgaris	Common Barberry
Betula papyrifera	Paper Birch
Buxus sempervirens	Common Boxwood
Elaeagnus angustifolia	Russian Olive
Ilex opaca	American Holly
Leucothoe fontanesiana	Drooping Leucothoe
Picea pungens	Colorado Blue Spruce
Pieris japonica	Japanese Pieris

Plants Seldom Severely Damaged:

Botanical name	*Common name*
Betula pendula	European White Birch
Calastrus scandens	American Bittersweet
Cornus sericea	Red Osier Dogwood
Cornus florida	Flowering Dogwood
Cornus kousa	Kousa Dogwood
Crataegus laevigata	English Hawthorn
Enkianthus campanulatus	Redvein Enkianthus
Fagus sylvatica	European Beech
Forsythia spp.	Forsythia
Gleditsia triacanthos	Honey Locust
Ilex cornuta	Chinese Holly
Ilex glabra	Inkberry
Juniperus chinensis	Chinese Junipers (green)
Juniperus chinensis	Chinese Junipers (blue)
Kalmia latifolia	Mountain Laurel
Kolkwitzia amabilis	Beautybush
Picea abies	Norway Spruce
Picea glauca	White Spruce
Pinus nigra	Austrian Pine
Pinus rigida	Pitch Pine
Pinus mugo	Mugo Pine
Pinus resinosa	Red Pine
Pinus sylvestris	Scots Pine
Prunus serrulata	Japanese Flowering Cherry
Salix matsudana tortuosa	Corkscrew Willow
Sassafras albidum	Common Sassafras
Syringa vulgaris	Common Lilac
Wisteria floribunda	Japanese Wisteria

Plants Occasionally Severely Damaged:

Botanical name	*Common name*
Abies concolor	White Fir
Acer griseum	Paperbark Maple
Acer rubrum	Red Maple
Acer saccharinum	Silver Maple
Acer saccharum	Sugar Maple
Aesculus hippocastanum	Common Horsechestnut
Amelanchier arborea	Downy Serviceberry
Amelanchier laevis	Allegheny Serviceberry
Campsis radicans	Trumpet Creeper
Chaenomeles speciosa	Japanese Flowering Quince
Cornus racemosa	Panicled Dogwood
Cotinus coggygria	Smokebush
Cotoneaster spp.	Cotoneaster
Cotoneaster apiculatus	Cranberry Cotoneaster
Cotoneaster horizontalis	Rockspray Cotoneaster
Cryptomeria japonica	Japanese Cedar
Forsythia (x) intermedia	Border Forsythia
Hamamelis virginiana	Common Witchhazel
Hibiscus syriacus	Rose of Sharon
Hydrangea arborescens	Smooth Hydrangea
Hydrangea anomala petiolaris	Climbing Hydrangea
Hydrangea paniculata	Panicle Hydrangea

Plants Occasionally Severely Damaged (cont.):

Botanical name	*Comomn name*
Ilex crenata	Japanese Holly
Ilex (x) meserveae	China Girl/Boy Holly
Juniperus virginiana	Eastern Red Cedar
Larix decidua	European Larch
Lonicera (x) heckrottii	Goldflame Honeysuckle
Ligustrum spp.	Privet
Magnolia (x) soulangiana	Saucer Magnolia
Metasequoia glyptostroboides	Dawn Redwood
Parthenocissus quinquifolia	Virginia Creeper
Philadelphus coronarius	Sweet Mock Orange
Pinus strobus	Eastern White Pine
Potentilla fruticosa	Bush Cinquefoil
Prunus avium	Sweet Cherry
Pseudotsuga menziesii	Douglas Fir
Pyracantha coccinea	Firethorn
Pyrus calleryana 'Bradford'	Bradford Callery Pear
Pyrus communis	Common Pear
Quercus alba	White Oak
Quercus prinus	Chestnut Oak
Quercus rubra	Northern Red Oak
Rhododendron spp.	Deciduous Azaleas
Rhododendron carolinianum	Carolina Rhododendron
Rhododendron maximum	Rosebay Rhododendron
Rhus typhina	Staghorn Sumac
Rosa multiflora	Multiflora Rose
Rosa rugosa	Rugosa Rose
Salix spp.	Willows
Spiraea (x) bumalda	Anthony Waterer Spiraea
Spiraea prunifolia	Bridalwreath Spiraea
Syringa (x) persica	Persian Lilac
Syringa reticulata	Japanese Tree Lilac
Syringa villosa	Late Lilac
Tilia cordata 'Greenspire'	Greenspire Littleleaf Linden
Tilia americana	Basswood
Tsuga canadensis	Eatsern Hemlock
Tsuga caroliniana	Carolina Hemlock
Viburnum (x) *juddii*	Judd Viburnum
Viburnum rhytidophyllum	Leatherleaf Viburnum
Viburnum plicatum tomemtosum	Doublefile Viburnum
Viburnum carlesii	Koreanspice Viburnum
Weigela florida	Oldfashion Weigela

Plants Frequently Severely Damaged:

Botanical name	*Common name*
Abies balsamea	Balsam Fir
Abies fraseri	Fraser Fir
Acer platanoides	Norway Maple
Cercis canadensis	Eastern Redbud
Chamaecyparis thyoides	Atlantic White Cedar
Clematis spp.	Clematis
Cornus mas	Cornelian Dogwood
Euonymus alatus	Winged Euonymus
Euonymus fortunei	Wintercreeper
Hedera helix	English Ivy
Malus spp.	Apples
Prunus spp.	Cherries
Prunus spp.	Plums
Rhododendron spp.	Rhododendrons
Rhododendron spp.	Evergreen Azaleas
Rhododendron catawbiense	Catawba Rhododendron
Rhododendron periclymenoides	Pinxterbloom Azalea
Rosa (x) hybrid	Hybrid Tea Rose
Sorbus aucuparia	European Mountain Ash
Taxus spp.	Yews
Taxus baccata	English Yew
Taxus brevifolia	Western Yew
Taxus cuspidata	Japanese Yew
Taxus (x) media	English/Japanese Hybrid Yew
Thuja occidentalis	American Arborvitae

[1]from M. J. Fargione, P. D. Curtis, and M. E. Richmond. 1991. Resistance of woody ornamental plants to deer damage. Cornell Coop. Ext. Fact Sheet. Ithaca, NY. 4 pp.

deer damage. Table 1 provides a list of plants, ranked by susceptibility to deer damage. This list, developed by researchers at Cornell University, is applicable for most eastern and northern states. A similar list with a western emphasis was produced by Cummings et al. (1980).

Harvest crops as early as possible to reduce the period of vulnerability to deer. Plant susceptible crops as far from wooded cover as possible to reduce the potential for severe damage. Habitat modification is not recommended. Destruction of wooded or brushy cover in hopes of reducing deer use would destroy valuable habitat for other wildlife. Also, since deer forage over a large area it is unlikely that all available deer cover would be on a farmer's or rancher's land.

Lure crops have been planted to attract deer away from highways and crop fields where deer traditionally caused damage. Their effectiveness has been variable and concern has been raised that an artificial food source may eventually increase deer densities and resultant problems. Specific recommendations are not yet available regarding plant selection, timing, and proximity of lure crops.

Contraception

Promising research on the use of chemosterilants and immunocontraception to reduce or eliminate reproduction is underway. Specificity, efficacy, and delivery of contraceptive agents, however, continue to be problems. The use of contraception for herd control will be best suited to urban parks, refuges, and other discrete areas. It is unlikely that contraception can or will be applied in rural/agricultural landscapes.

Frightening

One of the keys to success with frightening devices and repellents is to take action at the first sign of a problem. It is difficult to break the movements or behavioral patterns of deer once they have been established. Also, use frightening devices and repellents at those times when crops are most susceptible to damage, for example, the silking to tasseling stages for field corn or the blossom stage for soybeans.

Gas exploders set to detonate at regular intervals are the most commonly used frightening devices for deer. They can be purchased for $200 to $500 from several commercial sources (see **Supplies and Materials**). The devices are sometimes available on loan from wildlife refuges or agencies as they are frequently used to control waterfowl damage. To maximize the effectiveness of exploders, move them every few days and stagger the firing sequence. Otherwise, the deer quickly become accustomed to the regular pattern. The noise level can be increased by raising exploders off the ground. Motion-activated firing mechanisms are now being explored to increase the effectiveness of exploders. Success depends on many factors and can range from good to poor. A dog on a long run or restricted by an electronic invisible fence system can keep deer out of a limited area, but care and feeding of the dog can be time-consuming. Free-running dogs are not advisable and may be illegal.

Shell crackers, fireworks, and gunfire can provide quick but temporary relief from deer damage. Equip mobile units with pyrotechnics, spotlights, and two-way radios. Patrol farm perimeters and field roads at dusk and throughout the night during times of the year when crops are most susceptible to damage. Such tactics cannot be relied on for an entire growing season.

Repellents

Repellents are best suited for use in orchards, gardens, and on ornamental plants. High cost, limitations on use, and variable effectiveness make most repellents impractical on row crops, pastures, or other large areas. Success with repellents is measured in the reduction, not total elimination, of damage.

Repellents are described by mode of actions as "contact" or "area." Contact repellents, which are applied directly to the plants, repel by taste. They are most effective when applied to trees and shrubs during the dormant period. New growth that appears after treatment is unprotected. Contact repellents may reduce the palatability of forage crops and should not be used on plant parts destined for human consumption. Hinder® is an exception in that it can be applied directly on edible crops.

Area repellents are applied near the plants to be protected and repel deer by odor alone. They are usually less effective than contact repellents but can be used in perimeter applications and some situations where contact repellents cannot.

During the winter or dormant season, apply contact repellents on a dry day when temperatures are above freezing. Treat young trees completely. It will be more economical to treat only the terminal growth of older trees. Be sure to treat to a height of 6 feet (1.8 m) above expected maximum snow depth. During the growing season, apply contact repellents at about half the concentration recommended for winter use.

The effectiveness of repellents will depend on several factors. Rainfall will dissipate some repellents, so reapplication may be necessary after a rain. Some repellents do not weather well even in the absence of rainfall. Deer's hunger and the availability of other more palatable food will have a great effect on success. In times of food stress, deer are likely to ignore either taste or odor repellents. When using a commercial preparation, follow the manufacturer's instructions. Don't overlook new preparations or imaginative ways to use old ones. The following discussion of common repellents is incomplete and provided only as a survey of the wide range of repellent formulations available. The repellents are grouped by active ingredient. Trade names and sample labels for some products are provided in the **Supplies and Materials** section.

Deer-Away® Big Game Repellent *(37% putrescent whole egg solids).* This contact (odor/taste) repellent has been used extensively in western conifer plantations and reported in field

studiesto be 85% to 100% effective. It is registered for use on fruit trees prior to flowering, as well as ornamental and Christmas trees. Apply it to all susceptible new growth and leaders. Applications weather well and are effective for 2 to 6 months. One gallon (3.8 l) of liquid or 1 pound (0.45 kg) of powder costs about $32 and covers 400, 3-inch (7.6-cm) saplings or 75, 4-foot (1.2-m) evergreens.

Hinder® *(15% ammonium soaps of higher fatty acids).* This area repellent is one of the few registered for use on edible crops. You can apply it directly to vegetable and field crops, forages, ornamentals, and fruit trees. Its effectiveness is usually limited to 2 to 4 weeks but varies because of weather and application technique. Reapplication may be necessary after heavy rains. For small fields and orchards, you can treat the entire area. For larger areas, apply an 8- to 15-foot (2.4- to 4.6-m) band around the perimeter of the field. Apply at temperatures above 32°F (0° C). Four gallons (15.2 l) of liquid cost about $80, and when mixed with 100 gallons (380 l) of water will cover 1 acre (0.4 ha). Hinder is compatible for use with most pesticides.

Thiram *(7% to 42% tetramethylthiuram disulfide).* Thiram, a fungicide that acts as a contact (taste) deer repellent, is sold under several trade names--Bonide Rabbit-Deer Repellent®, Nott's Chew-Not, and Gustafson 42-S®, among others. It is most often used on dormant trees and shrubs. A liquid formulation is sprayed or painted on individual trees. Although Thiram itself does not weather well, adhesives such as Vapor Gard® can be added to increase its resistance to weathering. Thiram-based repellents also protect trees against rabbit and mouse damage. Two gallons (7.6 l) of 42% Thiram cost about $50 and when mixed with 100 gallons (380 l) of water will cover 1 acre (0.4 ha). Cost varies with the concentration of Thiram in the product.

Miller's Hot Sauce® Animal Repellent *(2.5% capsaicin).* This contact (taste) repellent is registered for use on ornamentals, Christmas trees, and fruit trees. Apply the repellent with a backpack or trigger sprayer to all susceptible new growth, such as leaders and young leaves. Do not apply to fruit-bearing plants after fruit set. Vegetable crops also can be protected if sprayed prior to the development of edible parts. Weatherability can be improved by adding an anti-transpirant such as Wilt-Pruf® or Vapor Gard®. Hot Sauce and Vapor Gard® cost about $80 and $30 per gallon (3.8 l) respectively. Eight ounces (240 ml) of Hot Sauce and two quarts (1.9 l) of anti-transpirant mixed with 100 gallons (380 l) of water will cover 1 acre (0.4 ha).

Tankage *(putrefied meat scraps).* Tankage is a slaughterhouse by-product traditionally used as a deer repellent in orchards. It repels deer by smell, as will be readily apparent. To prepare containers for tankage, remove the tops from aluminum beverage cans, puncture the sides in the middle of the cans to allow for drainage and attach the cans to the ends of 4-foot (1.2 m) stakes. Drive the stakes into the ground, 1 foot (0.3 m) from every tree you want to protect or at 6-foot (1.8-m) intervals around the perimeter of a block. Place 1 cup (225 g) of tankage in each can. You can use mesh or cloth bags instead of cans. You may have to replace the containers periodically because fox or other animals pull them down occasionally. Tankage is available by bulk ($335 per ton [$302/mt]) or bag ($20 per 50 pounds [22.5 kg]). When prepared for hanging on stakes, it costs about $0.20 per 1 ounce (28 g) bag and 300 bags will cover 2 acres (0.8 ha).

Ro-pel® *(benzyldiethyl [(2,6 xylylcarbamoyl) methyl] ammonium saccharide (0.065%), thymol (0.035%).* Ro-pel® is reported to repel deer with its extremely bitter taste. Apply Ro-pel® once each year to new growth. It is not recommended for use on edible crops. Spray at full strength on nursery and Christmas trees, ornamentals, and flowers. One gallon (3.8 l) costs $50 and covers about 1 acre (0.4 ha) of 8- to 10-foot (2.4- to 3.0-m) trees.

Hair Bags *(human hair).* Human hair is an odor (area) repellent that costs very little but has not consistently repelled deer. Place two handfuls of hair in fine-mesh bags (onion bags, nylon stockings). Where severe damage occurs, hang hair bags on the outer branches of individual trees with no more than 3 feet (0.9 m) between individual bags. For larger areas, hang several bags, 3 feet (0.9 m) apart, from a fence or cord around the perimeter of the area to be protected. Attach the bags early in spring and replace them monthly through the growing season. You can get hair at local barber shops or salons.

Bar Soap. Recent studies and numerous testimonials have shown that ordinary bars of soap applied in the same manner as hair bags can reduce deer damage. Drill a hole in each bar and suspend it with a twist tie or soft cord. Each bar appears to protect a radius of about 1 yard (1 m). Any inexpensive brand of bar soap will work. Ready-to-use bars cost about $0.20 each.

Toxicants

No toxicants are registered for deer control. Poisoning of deer with any product for any reason is illegal and unlikely to be tolerated by the public.

Herd Reduction

Overall reduction in a state's deer population might reduce deer damage, but public opinion generally does not favor this approach. Damage may result from a few problem deer or at locations close to a winter deer yard or other exceptional habitat. Thus, a local reduction in deer population may be appropriate.

Live Capture

In special cases, such as city parks, refuges, or suburban neighborhoods, it may be necessary or desirable to capture deer alive and move them to other areas. Deer can be captured safely with rocket nets, drop-door box traps, or tranquilizer guns, but these techniques are expensive, time-consuming, and require the expertise

of professional wildlife biologists. Live capture and relocation is seldom a practical alternative unless delicate public relations problems mandate live removal as the only choice. During 1982, 15 deer were removed from a Milwaukee, Wisconsin nature area using chemical immobilization. Total cost was about $100 per deer but other more recent removal operations have been more expensive, up to $400 per deer or more. In addition to high costs, the survival of relocated deer is usually low. Live removal is seldom justified.

Shooting

Effective use of the legal deer season is probably the best way to control deer populations. By permitting hunting, landowners provide public access to a public resource while at the same time reducing deer damage problems. Because of the daily and seasonal movements of deer, only rarely does a single landowner control all the land a deer uses. As a result, neighboring landowners should cooperate. Landowners, the state wildlife agency, and local hunters should reach a consensus about a desirable population level for an area before deer are removed.

Mechanisms for managing deer population levels in a specific area already exist in most states. Either-sex seasons, increased bag limits, antlerless-only permits, special depredation seasons, and a variety of other management techniques have been used successfully to reduce deer numbers below levels achieved by traditional "bucks only" regulations.

Shooting permits issued by some states allow for removal of problem deer where they are causing damage during nonhunting season periods. Use of bait, spotlights, and rifles may increase success but techniques must be consistent with the specifications of the permits. In areas where shooting normally is prohibited, such as parks and densely populated areas, a skilled shooter under permit is probably preferable to costly attempts at live removal.

Economics of Damage and Control

A national survey conducted by USDA's National Agricultural Statistics Service in 1992 identified deer damage as the most widespread form of wildlife damage. Forty percent of the farmers reporting had experienced deer damage. No estimate exists of nationwide annual crop losses to deer, but damage estimates have been made for some states. In Wisconsin, a 1984 survey of farmers suggested minimum statewide deer damage of $36.7 million annually. A similar study in Pennsylvania estimated the annual crop loss at $16 to $30 million. The situation is similar in most agricultural states with moderate to high deer densities. Estimates by Hesselton and Hesselton (1982) suggest that the cost of deer-vehicle collisions may exceed $100 million each year in the United States and Canada. In fact, the cost of deer/vehicle collisions was estimated at $100 million in Wisconsin alone in 1990.

Deer also damage nurseries, landscape plantings, and timber regeneration. However, as established earlier, deer are a valuable public resource. Cost estimates for control techniques were presented with the appropriate techniques. A cost/benefit analysis is always advisable before initiating a control program.

Two additional economic aspects are worth consideration. One involves farmer tolerance for deer damage. Two summaries of social science research related to deer damage (Pomerantz et al. 1986, and Siemer and Decker 1991) demonstrated that a majority of farmers were willing to tolerate several hundred dollars in deer damage in exchange for the various benefits of having deer on their land. Thus "total damage" figures are misleading because only a small percentage of the farmers statewide or nationwide are suffering sufficient damage to warrant control or compensation.

The second economic consideration involves state-funded programs of subsidies for damage control materials or direct compensation for crop losses. Such programs can be very costly but are probably necessary where large deer herds are maintained in agricultural landscapes. As an example, the Wisconsin Wildlife Damage Program expended $2.25 million in 1992 for abatement materials, claims, and administration. The program is a collaborative effort of the Wisconsin Department of Natural Resources, USDA-APHIS-ADC, and Wisconsin counties and is very effective. Individual states vary greatly, however, in their degree of financial or technical assistance. Consult your state wildlife agency for information on compensation or cost-sharing programs. Also, many states have local publications on deer and deer damage--Pennsylvania, Wisconsin, Minnesota, Michigan, and New York, for example. Consult your local Extension office or state wildlife agency.

Acknowledgments

Figures 1 and 5 from Schwartz and Schwartz (1981).

Figure 2 by Charles W. Schwartz, published in Wallmo (1978), copyrighted by the Wildlife Management Institute and adapted by Emily Oseas Routman.

Figures 3 and 4 adapted from Burt and Grossenheider (1976) by Jill Sack Johnson.

Figures 6 through 15 are from Craven and Hygnstrom (1993), "Controlling Deer Damage in Wisconsin," University of Wisconsin Extension publication G3083.

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Feral Dog

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FERAL DOGS

Fig. 1. Feral dog, *Canis familiaris*

Damage Prevention and Control Methods

Exclusion

Net wire fences.

Electric fences.

Frightening

Yard lights, effigies, pyrotechnics.

Electronic Guard.

Livestock guarding animals.

Repellents

Several products are registered but are practical only for small areas.

Capsaicin and anise oil may protect humans from attack by dogs.

Toxicants

Sodium cyanide in M-44 ejector devices.

Fumigants

None are registered.

Trapping

Live traps.

No. 3 or 4 steel leghold traps.

Cable neck snares.

Shooting

Hunting from the air.

Hunting from the ground.

Other Methods

Eliminate food supplies.

Destroy dens.

Catch poles.

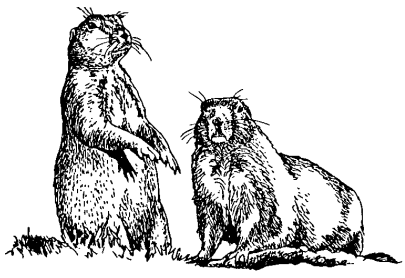
Jab sticks.

Cultural Considerations

Public education.

Dog control laws.

Professional carnivore damage control specialists.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

Identification

In appearance, most feral dogs (Fig. 1) are difficult, if not impossible, to distinguish from domestic dogs. Like domestic dogs, feral dogs (sometimes referred to as wild or free-ranging dogs) manifest themselves in a variety of shapes, sizes, colors, and even breeds. McKnight (1964) noted German shepherds, Doberman pinschers, and collies as breeds that often become feral. Most feral dogs today are descendants of domestic dogs gone wild, and they often appear similar to dog breeds that are locally common.

The primary feature that distinguishes feral from domestic dogs is the degree of reliance or dependence on humans, and in some respect, their behavior toward people. Feral dogs survive and reproduce independently of human intervention or assistance. While it is true that some feral dogs use human garbage for food, others acquire their primary subsistence by hunting and scavenging like other wild canids.

Feral and domestic dogs often differ markedly in their behavior toward people. Scott and Causey (1973) based their classification of these two types by observing the behavior of dogs while confined in cage traps. Domestic dogs usually wagged their tails or exhibited a calm disposition when a human approached, whereas most feral dogs showed highly aggressive behavior, growling, barking, and attempting to bite. Some dogs were intermediate in their behavior and couldn't be classified as either feral or domestic based soley on their reaction to humans. Since many feral dogs have been pursued, shot at, or trapped by people, their aggressive behavior toward humans is not surprising. Gipson (1983) described the numerous lead pellets imbedded under the skin of a feral dog caught in Arkansas as a testament to its relationship with people.

Feral dogs are usually secretive and wary of people. Thus, they are active during dawn, dusk, and at night much like other wild canids. They often travel in packs or groups and may have rendezvous sites like wolves. Travel routes to and from the gathering or den sites may be well defined. Food scraps and other evidence of concentrated activity may be observed at gathering sites.

The appearance of tracks left by feral dogs varies with the size and weight of the animal. Generally, dog tracks are rounder and show more prominent nail marks than those of coyotes, and they are usually larger than those of foxes. Since a pack of feral dogs likely consists of animals in a variety of sizes and shapes, the tracks from a pack of dogs will be correspondingly varied, unlike the tracks of a group of coyotes. The publication by Acorn and Dorrance (1990) contains a comparative illustration of canid tracks.

Range

Feral dogs are the most widespread of the wild canids. They may occur wherever people are present and permit dogs to roam free or where people abandon unwanted dogs. Feral dogs probably occur in all of the 50 states, Canada, and Central and South America. They are also common in Europe, Australia, Africa, and on several remote ocean islands, such as the Galapagos.

Home ranges of feral dogs vary considerably in size and are probably influenced by the availability of food. Dog packs that are primarily dependent on garbage may remain in the immediate vicinity of a dump, while other packs that depend on livestock or wild game may forage over an area of 50 square miles (130 km^2) or more.

Habitat

Feral dogs are often found in forested areas or shrublands in the vicinity of human habitation. Some people will not tolerate feral dogs in close proximity to human activity; thus they take considerable effort to eliminate feral dogs in such areas. Feral dogs may be found on lands where human access is limited, such as military reservations and large airports. They may also live in remote sites where they feed on wildlife and native fruits. The only areas that do not appear to be suitable for feral dogs are places where food and escape cover are not available, or where large native carnivores, particularly wolves, are common and prey on dogs.

Food Habits

Like coyotes, feral dogs have catholic diets and are best described as opportunistic feeders. They can be efficient predators, preying on small and large animals, including domestic livestock. Many rely on carrion, particularly road-killed animals, crippled waterfowl, green vegetation, berries and other fruits, and refuse at garbage dumps.

General Biology, Reproduction, and Behavior

Feral dogs are highly adaptable, social carnivores. Most are about the size of a coyote or slightly larger. Many breeds of dogs are capable of existing in the wild, but after a few generations of uncontrolled breeding, a generalized mongrel tends to develop. Often it has a German shepherd or husky-like appearance. Feral dogs on the Galapagos Islands resemble the original introduced breeds: hounds, pointers, and Borzoi.

Gipson (1983) suggested that family groups of feral dogs are more highly organized than previously believed. Pup rearing may be shared by several members of a pack. Survival of pups born during autumn and winter has been documented, even in areas with harsh winter weather. Gipson found that only one female in a pack of feral dogs studied in Alaska gave birth during two years of study, even though other adult females were present in the pack. The breeding female gave birth during late September or early October during both years. It is noteworthy that all pups from both litters had similar color markings, suggesting that

the pups had the same father. Adult males of different colors were present in the pack.

Nesbitt (1975) commented on the rigid social organization of a pack of feral dogs where nonresident dogs were excluded, including females in estrus. In one instance, Nesbitt used three separate female dogs in estrus as bait (dogs were chained in the back of a corral-type trap) over a 59-day period and captured no feral dogs. He then baited the same trap with carrion, and a pack of feral dogs, including four adult males, entered the trap within 1 week.

Hybridization between feral dogs and other wild canids can occur, but nonsynchronous estrus periods and pack behavior (that is, excluding nonresident canids from membership in the pack) may preclude much interbreeding.

Dens may be burrows dug in the ground or sheltered spots under abandoned buildings or farm machinery. Feral dogs commonly use former fox or coyote dens.

Damage and Damage Identification

Livestock and poultry can be victims of harassment, injury, and death from both domestic and feral dogs. Distinguishing between livestock killed by domestic or feral dogs and that killed by coyotes may be difficult since the mode of attack can be similar. Coyotes usually attack an animal at the throat; domestic dogs are relatively indiscriminate in how and where they attack. Sometimes, however, dogs kill the way coyotes do, and young and inexperienced coyotes may attack any part of the body of their prey as dogs would. The survival of feral dogs, much like that of other wild canids, depends on their ability to secure food. Therefore feral dogs are usually adept predators. Unlike most domestic dogs, feral dogs rely on their prey for food, and thus consume much of what they kill. Feral dogs favor the hindquarters and viscera (liver, spleen, heart, lungs).

When domestic dogs attack domestic animals, they may injure or kill several, but they seldom consume their victims. Rather, they leave the impression that they were involved in vicious play rather than an attempt to obtain food. The most diagnostic characteristic of injuries caused by dogs is usually the slashing and biting of prey animals over much of their bodies. Wade and Bowns (1983) and Acorn and Dorrance (1990) present a detailed pictorial and descriptive aid to identifying predators that damage livestock.

Feral dogs may become skilled at hunting in groups for small game such as rabbits and hares and large game including deer and even moose. Some wildlife managers feel that feral dogs are a serious threat to deer, especially in areas with heavy snows (Lowry 1978). Others have found no evidence that feral dogs pose a significant threat to deer (Causey and Cude 1980). Clearly, the impact of feral dogs, both on livestock and wildlife, varies by location and is influenced by factors such as availability of other food, the number of dogs, and competition by other predators.

Feral dogs may feed on fruit crops including melons, berries, and grapes, and native fruits such as persimmons and blackberries. Damage to melons is similar to that caused by coyotes. The side of a ripe melon is usually bitten open and the insides eaten.

Feral dogs commonly kill house cats, and they may injure or kill domestic dogs. In areas where people have not hunted and trapped feral dogs, the dogs may not have developed fear of humans, and in those instances such dogs may attack people, especially children. This can be a serious problem in areas where feral dogs feed at and live around garbage dumps near human dwellings. Such situations occur most frequently around small remote towns.

On the Galapagos Islands, feral dogs have significantly impacted native populations of tortoises, iguanas, and birds.

Legal Status

State and local laws concerning feral and free-ranging dogs vary considerably, but most states have some regulations. Many states, particularly those in the west, permit individuals to shoot dogs that are chasing or killing game animals or livestock. State agencies or agriculture departments usually are responsible for controlling feral dogs in rural areas. No states consider feral dogs to be game animals. Most cities have animal control agents to pick up abandoned and free-ranging domestic dogs.

Damage Prevention and Control Methods

Exclusion

Protect livestock and poultry from feral and domestic dogs with well-maintained net fences. Horizontal spacing of the mesh should be less than 6 inches (15 cm); vertical spacing should be less than 4 inches (10 cm). Barbed wire at ground level or a buried wire apron will discourage dogs from digging under the fence. The fence should be about 6 feet (1.8 m) high to hinder animals from jumping over. The effectiveness of fences can be increased by adding one or more electrically charged wires along the bottom and top. Charged wires are positioned so that the intruding dog encounters them before digging under or climbing over the fence.

Electric fences consisting of up to 12 alternating ground and charged wires have been effective at deterring dogs (Dorrance and Bourne 1980). Other configurations have also been successful (Shelton 1984, deCalesta 1983). Electric fences must be checked regularly to ensure that the wires are sufficiently charged. Maintenance of fences may be difficult in areas with drifting snow and where large wild animals are common. Moose and bears can be particularly destructive to electric fences.

Fencing is one of the most beneficial investments in dealing with predator

damage and livestock management if practicality warrants its use.

Frightening

Several visual and auditory devices (yard lights, effigies, loud music, pyrotechnics) have been used to frighten coyotes from livestock pens and pastures, and are likely to be effective with feral dogs.

Researchers at the Denver Wildlife Research Center developed and tested a device called the Electronic Guard, a combination strobe light and siren that periodically activates during the night. The noise and light have been effective in reducing coyote predation on flocks of sheep. Similar results could reasonably be anticipated with feral dogs.

Guarding dogs that have been reared with livestock and trained to remain with them can be a deterrent to depredating feral dogs (Green and Woodruff 1991). Since a pack of feral dogs is quite capable of killing other dogs, more than one guarding dog may be needed where feral dogs are a threat. Donkeys and llamas have also been used to keep dogs away from livestock.

Repellents

Methyl nonyl ketone, mostly in granular form or in liquid sprays, is widely used to prevent urination or defecation by dogs in yards and storage areas. Several other chemicals are registered for repelling dogs including anise oil, Bitrex, capsaicin, d-linonene, dried blood, essential oils, napthalene, nicotene, Ropel, Thiram, Thymol, and tobacco dust. These chemicals may be useful in keeping feral dogs from establishing scent stations or relieving themselves on selected sites, but they probably have little value in protecting livestock or poultry. Capsaicin (oleoresin of capsicum) and oil of anise may be effective in protecting humans from attack by dogs.

Toxicants

There are no toxicants widely used for controlling feral dogs in the United States. The USDA-APHIS-ADC program holds a Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 3 registration for sodium cyanide used in M-44 delivery devices. Although the product label for M-44 cyanide capsules lists wild dogs among the canids that can be controlled when they are preying on livestock (others include coyotes and red and gray foxes), ADC policy prohibits using M-44s for specifically killing dogs. Some dogs are killed by M-44s when they are being used to kill coyotes, but dogs are not the target animal. In addition, at least one state has a law prohibiting ADC from using M-44s to intentionally kill dogs.

Several states hold their own registrations for using M-44s, and their policy with regard to feral dogs may be different from that of ADC. Consult state and local regulations with respect to M-44 use. In all instances, M-44s can only be used by certified applicators.

Toxic collars containing Compound 1080 (sodium monofluoroacetate) placed on domestic animals may kill depredating dogs if the dogs puncture the collar during an attack. The collars, however, are only registered for use against coyotes.

Fumigants

No fumigants are registered for the control of feral dogs.

Trapping

Live traps are generally effective in capturing feral dog pups and occasionally adult dogs. Steel leghold traps (No. 3 or 4) are convenient and effective for trapping wild dogs. Carrion and scent baits used to lure coyotes to traps may be effective in attracting feral dogs. Nontarget species or pets inadvertently captured can be released. Caution should be exercised when approaching a dog in a trap, since feral dogs may be vicious when confined, and even pet dogs may bite under those circumstances. Cable neck snares may be set at openings in fences or along narrow trails used by dogs. Use care when setting snares because they may kill pets or livestock that are caught.

Shooting

Aerial shooting is one of the most efficient control techniques available for killing feral dogs. Where a pack of damaging feral dogs is established, it may be worthwhile to trap one or two members of the pack, fit them with radio transmitters, and release them. Feral dogs are highly social, and by periodically locating the radio-tagged dogs with a radio receiver, it is possible to locate other members of the group. When other members of the pack are destroyed, the radioed dogs can be located and shot. This technique has been used effectively by the Alaska Department of Fish and Game to eliminate packs of problem wolves.

Hunting from the ground has been used to control feral dogs. A predator call may lure dogs within rifle range. Establishing a shooting blind can be helpful, especially along a trail used by dogs, near a den, a garbage dump, or a large animal carcass.

Other Methods

Fencing garbage dumps, burying garbage in sanitary landfills frequently, or removing livestock carrion may help reduce local feral dog populations. Locating and destroying dens, especially when pups are present, may also be helpful. Use catch poles to capture and restrain feral dogs. Dart guns and jab sticks can be used to administer tranquilizing or euthanizing agents.

Cultural Considerations

The long-term solution to most problems caused by unconfined dogs, including feral dogs, is responsible dog ownership and effective local dog management programs. Many depredation problems can be solved by confining dogs to kennels or to the owner's property. Dog breeding must be controlled. Unwanted dogs should be placed for adoption or destroyed rather than abandoned, since the latter leads to the formation of free-living, feral populations.

Dog management programs should include the following: (1) public educa-

tion about proper care and confinement of dogs; (2) laws that identify that dog owners are legally responsible for damage caused by dogs; (3) laws that prohibit abandonment of unwanted dogs and require humane disposal of unwanted dogs; (4) holding facilities and personnel trained to handle unwanted or nuisance dogs; and (5) assistance by professional control specialists where feral dogs are established.

Economics of Damage and Control

Feral dogs may destroy livestock and poultry valued at thousands of dollars. In such instances, the costs of controlling dogs may be warranted. Boggess and his co-workers (1978) examined 5,800 claims of domestic livestock lost to dogs and coyotes in Iowa between 1960 and 1974. Dogs were considered responsible for 49% of the reported sheep losses, 45% of the cattle losses, 66% of the swine losses, and 82% of the poultry losses. Denny (1974) conducted a nationwide survey of state departments of agriculture, wildlife conservation agencies, and related agencies to determine problems caused by unconfined dogs. Damage to wildlife, especially deer, small game, and birds was considered the primary problem caused by dogs. Damage to game animals may be a serious local problem. In view of the value placed on game animals by hunters and other wildlife enthusiasts, local control to benefit wild game may be economically justified. The second most serious problem reported was damage to livestock.

Acknowledgments

Figure 1 drawn by Reneé Lanik, University of Nebraska-Lincoln.

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Nutria

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NUTRIA

Fig. 1. Nutria (*Myocastor coypus*)

Damage Prevention and Control Methods

Exclusion

Protect small areas with partially buried fences.

Wire tubes can be used to protect baldcypress or other seedlings but are expensive and difficult to use.

Use sheet metal shields to prevent gnawing on wooden and styrofoam structures and trees near aquatic habitat.

Install bulkheads to deter burrowing into banks.

Cultural Methods and Habitat Modification

Improve drainage to destroy travel lanes.

Manage vegetation to eliminate food and cover.

Contour stream banks to control burrowing.

Plant baldcypress seedlings in the fall to minimize losses.

Restrict farming, building construction, and other "high risk" activities to upland sites away from water to prevent damage.

Manipulate water levels to stress nutria populations.

Frightening

Ineffective.

Repellents

None are registered. None are effective.

Toxicants

Zinc phosphide on carrot or sweet potato baits.

Fumigants

None are registered. None are effective.

Trapping

Commercial harvest by trappers.

Double longspring traps, Nos. 11 and 2, as preferred by trappers and wildlife damage control specialists.

Body-gripping traps, for example, Conibear® Nos. 160-2 and 220-2, and locking snares are most effective when set in trails, den entrances, or culverts.

Live traps should be used when leghold and body-gripping traps cannot be set.

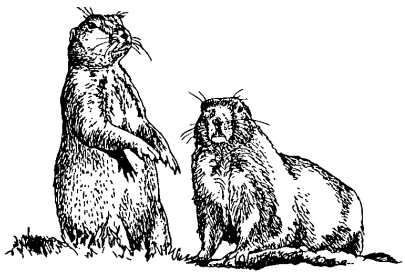
Long-handled dip nets can be used to catch unwary nutria.

Shooting

Effective when environmental conditions force nutria into the open. Night hunting is illegal in many states.

Other Methods

Available control techniques may not be applicable to all damage situations. In these cases, safe and effective methods must be tailored to specific problems.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

Identification

The nutria (*Myocastor coypus,* Fig. 1) is a large, dark-colored, semiaquatic rodent that is native to southern South America. At first glance, a casual observer may misidentify a nutria as either a beaver (*Castor canadensis*) or a muskrat (*Ondatra zibethicus*), especially when it is swimming. This superficial resemblance ends when a more detailed study of the animal is made. Other names used for the nutria include coypu, nutria-rat, South American beaver, Argentine beaver, and swamp beaver.

Nutria are members of the family Myocastoridae. They have short legs and a robust, highly arched body that is approximately 24 inches (61 cm) long. Their round tail is from 13 to 16 inches (33 to 41 cm) long and scantily haired. Males are slightly larger than females; the average weight for each is about 12 pounds (5.4 kg). Males and females may grow to 20 pounds (9.1 kg) and 18 pounds (8.2 kg), respectively.

The dense grayish underfur is overlaid by long, glossy guard hairs that vary in color from dark brown to yellowish brown. The forepaws have four well-developed and clawed toes and one vestigial toe. Four of the five clawed toes on the hind foot are interconnected by webbing; the fifth outer toe is free. The hind legs are much larger than the forelegs. When moving on land, a nutria may drag its chest and appear to hunch its back. Like beavers, nutria have large incisors that are yellow-orange to orange-red on their outer surfaces.

In addition to having webbed hind feet, nutria have several other adaptations to a semiaquatic life. The eyes, ears, and nostrils of nutria are set high on their heads. Additionally, the nostrils and mouth have valves that seal out water while swimming, diving, or feeding underwater. The mammae or teats of the female are located high on the sides, which allows the young to suckle while in the water. When pursued, nutria can swim long distances under water and see well enough to evade capture.

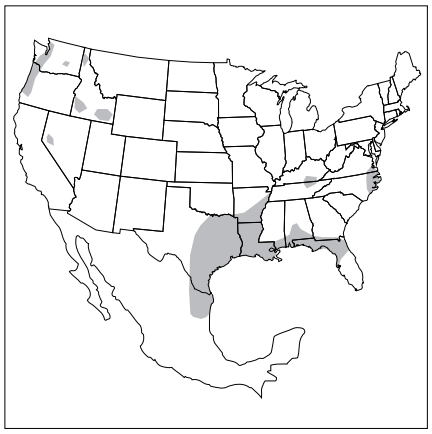


Fig. 2. Range of the nutria introduced in North America.

Range

The original range of nutria was south of the equator in temperate South America. This species has been introduced into other areas, primarily for fur farming, and feral populations can now be found in North America, Europe, the Soviet Union, the Middle East, Africa, and Japan. *M. c. bonariensis* was the primary subspecies of nutria introduced into the United States.

Fur ranchers, hoping to exploit new markets, imported nutria into California, Washington, Oregon, Michigan, New Mexico, Louisiana, Ohio, and Utah between 1899 and 1940. Many of the nutria from these ranches were freed into the wild when the businesses failed in the late 1940s. State and federal agencies and individuals translocated nutria into Alabama, Arkansas, Georgia, Kentucky, Maryland, Mississippi, Oklahoma, Louisiana, and Texas, with the intent that nutria would control undesirable vegetation and enhance trapping opportunities. Nutria were also sold as "weed cutters" to an ignorant public throughout the Southeast. A hurricane in the late 1940s aided dispersal by scattering nutria over wide areas of coastal southwest Louisiana and southeast Texas.

Accidental and intentional releases have led to the establishment of widespread and localized populations of nutria in various wetlands throughout the United States. Feral animals have been reported in at least 40 states and three Canadian provinces in North America since their introduction. About one-third of these states still have viable populations that are stable or increasing in number. Some of the populations are economically important to the fur industry. Adverse climatic conditions, particularly extreme cold, are probably the main factors limiting range expansion of nutria in North America. Nutria populations in the United States are most dense along the Gulf Coast of Louisiana and Texas (Fig. 2).

Habitat

Nutria adapt to a wide variety of environmental conditions and persist in areas previously claimed to be unsuitable. In the United States, farm ponds and other freshwater impoundments, drainage canals with spoil banks, rivers and bayous, freshwater and brackish marshes, swamps, and combinations of various wetland types can provide a home to nutria. Nutria habitat, in general, is the semiaquatic environment that occurs at the boundary between land and permanent water. This zone usually has an abundance of emergent aquatic vegetation, small trees, and/or shrubs and may be interspersed with small clumps and hillocks of high ground. In the United States, all significant nutria populations are in coastal areas, and freshwater marshes are the preferred habitat.

Food Habits

Nutria are almost entirely herbivorous and eat animal material (mostly insects) incidentally, when they feed on plants. Freshwater mussels and crustaceans are occasionally eaten in some parts of their range. Nutria are opportunistic feeders and eat approximately 25% of their body weight daily. They prefer several small meals to one large meal.

The succulent, basal portions of plants are preferred as food, but nutria also eat entire plants or several different parts of a plant. Roots, rhizomes, and tubers are especially important during winter. Important food plants in the

United States include cordgrasses (*Spartina* spp.), bulrushes (*Scirpus* spp.), spikerushes (*Eleocharis* spp.), chafflower (*Alternanthera* spp.), pickerelweeds (*Pontederia* spp.), cattails (*Typha* spp.), arrowheads (*Sagittaria* spp.), and flatsedges (*Cyperus* spp.). During winter, the bark of trees such as black willow (*Salix nigra*) and baldcypress (*Taxodium distichum*) may be eaten. Nutria also eat crops and lawn grasses found adjacent to aquatic habitat.

Because of their dexterous forepaws, nutria can excavate soil and handle very small food items. Food is eaten in the water; on feeding platforms constructed from cut vegetation; at floating stations supported by logs, decaying mats of vegetation, or other debris; in shallow water; or on land. In some areas, the tops of muskrat houses and beaver lodges may also be used as feeding platforms.

General Biology, Reproduction, and Behavior

General Biology

In the wild, most nutria probably live less than 3 years; captive animals, however, may live 15 to 20 years. Predation, disease and parasitism, water level fluctuations, habitat quality, highway traffic, and weather extremes affect mortality. Annual mortality of nutria is between 60% and 80%.

Predators of nutria include humans (through regulated harvest), alligators (*Alligator mississippiensis*), garfish (*Lepisosteus* spp.), bald eagles (*Haliaeetus leucocephalus*), and other birds of prey, turtles, snakes such as the cottonmouth (*Agkistrodon piscivorus*), and several carnivorous mammals.

Nutria densities vary greatly. In Louisiana, autumn densities of about 18 animals per acre (44/ha) have been found in floating freshwater marshes. In Oregon, summer densities in freshwater marshes may be 56 animals per acre (138/ha). Sex ratios range from 0.6 to 1.6 males per female.

In summer, nutria live on the ground in dense vegetation, but at other times of the year they use burrows. Burrows may be those abandoned by other animals such as armadillos (*Dasypus novemcinctus*), beavers, and muskrats, or they may be dug by nutria. Underground burrows are used by individuals or multigenerational family groups.

Burrow entrances are usually located in the vegetated banks of natural and human-made waterways, especially those having a slope greater than 45°. Burrows range from a simple, short tunnel with one entrance to complex systems with several tunnels and entrances at different levels. Tunnels are usually 4 to 6 feet (1.2 to 1.8 m) long; however, lengths of up to 150 feet (46 m) have been recorded. Compartments within the tunnel system are used for resting, feeding, escape from predators and the weather, and other activities. These vary in size, from small ledges that are only 1 foot (0.3 m) across to large family chambers that measure 3 feet (0.9 m) across. The floors of these chambers are above the water line and may be covered with plant debris discarded during feeding and shaped into crude nests.

In addition to using land nests and burrows, nutria often build flattened circular platforms of vegetation in shallow water. Constructed of coarse emergent vegetation, these platforms are used for feeding, loafing, grooming, birthing, and escape, and are often misidentified as muskrat houses. Initially, platforms may be relatively low and inconspicuous; however, as vegetation accumulates, some may attain a height of 3 feet (0.9 m).

Reproduction

Nutria breed in all seasons throughout most of their range, and sexually active individuals are present every month of the year. Reproductive peaks occur in late winter, early summer, and mid-autumn, and may be regulated by prevailing weather conditions.

Under optimal conditions, nutria reach sexual maturity at 4 months of age. Female nutria are polyestrous, and nonpregnant females cycle into estrus ("heat") every 2 to 4 weeks. Estrous is maintained for 1 to 4 days in most females. Sexually mature males can breed at any time because sperm is produced throughout the year.

The gestation period for nutria ranges from 130 to 132 days. A postpartum estrus occurs within 48 hours after birth and most females probably breed again during that time.

Litters average 4 to 5 young, with a range of 1 to 13. Litter sizes are generally smaller during winter, in suboptimal habitats, and for young females. Females often abort or assimilate embryos in response to adverse environmental conditions.

Young are precocial and are born fully furred and active. They weigh approximately 8 ounces (227 g) at birth and can swim and eat vegetation shortly thereafter. Young normally suckle for 7 to 8 weeks until they are weaned.

Behavior

Nutria tend to be crepuscular and nocturnal, with the start and end of activity periods coinciding with sunset and sunrise, respectively. Peak activity occurs near midnight. When food is abundant, nutria rest and groom during the day and feed at night. When food is limited, daytime feeding increases, especially in wetlands free from frequent disturbance.

Nutria generally occupy a small area throughout their lives. In Louisiana, the home range of nutria is about 32 acres (13 ha). Daily cruising distances for most nutria are less than 600 feet (183 m), although some individuals may travel much farther. Nutria move most in winter, due to an increased demand for food. Adults usually move farther than young. Seasonal migrations of nutria may also occur. Nutria living in some agricultural areas move in from marshes and swamps when crops are planted and leave after the crops are harvested.

Nutria have relatively poor eyesight and sense danger primarily by hearing. They occasionally test the air for scent. Although they appear to be

clumsy on land, they can move with surprising speed when disturbed. When frightened, nutria head for the nearest water, dive in with a splash, and either swim underwater to protective cover or stay submerged near the bottom for several minutes. When cornered or captured, nutria are aggressive and can inflict serious injury to pets and humans by biting and scratching.

Damage and Damage Identification

Kinds of Damage

Nutria damage has been observed throughout their range. Most damage is from feeding or burrowing. In the United States, most damage occurs along the Gulf Coast of Louisiana and Texas. The numerous natural and human-made waterways that traverse this area are used extensively for travel by nutria.

Burrowing is the most commonly reported damage caused by nutria. Nutria are notorious in Louisiana and Texas for undermining and breaking through water-retaining levees in flooded fields used to produce rice and crawfish. Additionally, nutria burrows sometimes weaken flood control levees that protect low-lying areas. In some cases, tunneling in these levees is so extensive that water will flow unobstructed from one side to the other, necessitating their complete reconstruction.

Nutria sometimes burrow into the styrofoam flotation under boat docks and wharves, causing these structures to lean and sink. They may burrow under buildings, which may lead to uneven settling or failure of the foundations. Burrows can weaken roadbeds, stream banks, dams, and dikes, which may collapse when the soil is saturated by rain or high water or when subjected to the weight of heavy objects on the surface (such as vehicles, farm machinery, or grazing livestock). Rain and wave action can wash out and enlarge collapsed burrows and compound the damage.

Nutria depredation on crops is well documented. In the United States, sugarcane and rice are the primary crops damaged by nutria. Grazing on rice plants can significantly reduce yields, and damage can be locally severe. Sugarcane stalks are often gnawed or cut during the growing season. Often only the basal internodes of cut plants are eaten. Other crops that have been damaged include corn, milo (grain sorghum), sugar and table beets, alfalfa, wheat, barley, oats, peanuts, various melons, and a variety of vegetables from home gardens and truck farms.

Nutria girdle fruit, nut, and shade trees and ornamental shrubs. They also dig up lawns and golf courses when feeding on the tender roots and shoots of sod grasses. Gnawing damage to wooden structures is common. Nutria also gnaw on styrofoam floats used to mark the location of traps in commercial crawfish ponds.

At high densities and under certain adverse environmental conditions, foraging nutria can significantly impact natural plant communities. In Louisiana, nutria often feed on seedling baldcypress and can cause the complete failure of planted or naturally-regenerated stands. Overutilization of emergent marsh plants can damage stands of desirable vegetation used by other wildlife species and aggravate coastal erosion problems by destroying vegetation that holds marsh soils together. Nutria are fond of grassy arrowhead (*Sagittaria platyphylla*) tubers and may destroy stands propagated as food for waterfowl in artificial impoundments.

Nutria can be infected with several pathogens and parasites that can be transmitted to humans, livestock, and pets. The role of nutria, however, in the spread of diseases such as equine encephalomyelitis, leptospirosis, hemorrhagic septicemia (Pasteurellosis), paratyphoid, and salmonellosis is not well documented. They may also host a number of parasites, including the nematodes and blood flukes that cause "swimmer's-itch" or "nutria-itch" (*Strongyloides myopotami* and *Schistosoma mansoni*), the protozoan responsible for giardiasis (*Giardia lamblia*), tapeworms (*Taenia* spp.), and common liver flukes (*Fasciola hepatica*). The threat of disease may be an important consideration in some situations, such as when livestock drink from water contaminated by nutria feces and urine.

Damage Identification

The ranges of nutria, beavers, and muskrats overlap in many areas and damage caused by each may be similar in appearance. Therefore, careful examination of sign left at the damage site is necessary to identify the responsible species.

On-site observations of animals and their burrows are the best indicators of the presence of nutria. Crawl outs, slides, trails, and the exposed entrances to burrows often have tracks that can be used to identify the species. The hind foot, which is about 5 inches (13 cm) long, has four webbed toes and a free outer toe. A drag mark left by the tail may be evident between the footprints (Fig. 3).

Droppings may be found floating in the water, along trails, or at feeding sites. These are dark green to almost black in color, cylindrical, and approximately 2 inches (5 cm) long and 1/2 inch (1.3 cm) in diameter. Additionally, each dropping usually has deep, parallel grooves along its entire length (Fig. 4).

Trees girdled by nutria often have no tooth marks, and bark may be peeled from the trunk. The crowns of seedling trees are usually clipped (similar to rabbit [*Sylvilagus* spp.] damage) and discarded along with other woody portions of the plant.

In rice fields, damage caused by nutria, muskrats, and Norway rats (*Rattus norvegicus*) can be confused. Nutria and muskrats damage rice plants by clipping stems at the water line in flooded fields; Norway rats reportedly clip stems above the surface of the water (E. A. Wilson, personal communication).

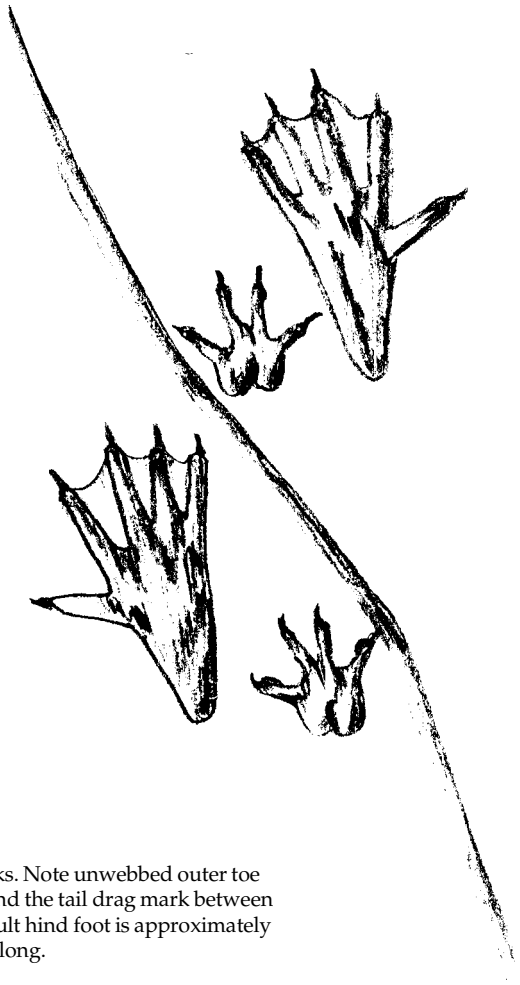


Fig. 3. Nutria tracks. Note unwebbed outer toe on the hind foot and the tail drag mark between the tracks. The adult hind foot is approximately 5 inches (12.7 cm) long.

Fig. 4. Nutria dropping in relation to a 2-inch (5.1-cm) camera lens cover. Note longitudinal grooves along the length of the dropping.

Legal Status

Nutria are protected as furbearers in some states or localities because they are economically important. Permits may be necessary to control animals that are damaging property. In other areas, nutria have no legal protection and can be taken at any time by any legal means. Consequently, citizens experiencing problems with nutria should be familiar with local wildlife laws and regulations. Complex problems should be handled by professional wildlife damage control specialists who have the necessary permits and expertise to do the job correctly. Your state wildlife agency can provide the names of qualified wildlife damage control specialists and information on pertinent laws and regulations.

Damage Prevention and Control Methods

Preventive measures should be used whenever possible, especially in areas where damage is prevalent. When control is warranted, all available techniques should be considered before a control plan is implemented. The objective of control is to use only those techniques that will stop or alleviate anticipated or ongoing damage or reduce it to tolerable levels. In most cases, successful control will depend on integrating a number of different techniques and methods.

Timing and location of control activities are important factors governing the success or failure of any control project. Control in sugarcane, for example, is best applied during the growing season, after damage has started. At this time, nutria in affected areas are relatively stationary and concentrated in drainages adjacent to fields. Conversely, efforts to protect rice field levees or the shorelines of southern lakes and ponds should be initiated during the winter when animals are mobile and concentrated in major ditches and other large bodies of water.

Nutria are best controlled where they are causing damage or where they are most active. Baiting is sometimes used to concentrate nutria in specific locations where they can be controlled more easily. After the main concentrations of nutria are removed, control efforts should be directed at removing wary individuals.

Exclusion

Fences, walls, and other structures can reduce nutria damage, but high costs usually limit their use. As a general rule, barriers are too expensive to be used to control damage to agricultural crops. Low fences (about 4 feet [1.2 m]) with an apron buried at least 6 inches (15 cm) have been used effectively to exclude nutria from home gardens and lawns. Sheet metal shields can be used to prevent gnawing damage to wooden and styrofoam structures and trees. Barriers constructed of sheet metal can be expensive to erect and unsightly.

Protect baldcypress and other seedlings with hardware cloth tubes around individual plants or wire mesh fencing around the perimeter of a stand. Extensive use of these is neither practical nor cost-effective. Plastic seedling protectors are not effective in controlling damage to baldcypress seedlings because nutria can chew through them.

Sheet piling, bulkheads, and riprap can effectively protect stream banks from burrowing nutria. Installation requires heavy equipment and is expensive. Use is usually restricted to industrial or commercial applications.

Cultural Methods and Habitat Modification

Land that is well-drained and free of dense, weedy vegetation is generally unattractive to nutria. Use of other good farming practices, such as precision land leveling and weed management, can minimize nutria damage in agricultural areas.

Draining and Grading. Any drainage that holds water can be used by nutria as a travel route or home site. Consequently, eliminate standing water in drainages to reduce their attractiveness to nutria. This may be extremely difficult or impossible to accomplish in low-lying areas near coastal marshes and permanent bodies of water. Higher sites, such as those used for growing sugarcane and other crops, are better suited for this type of management.

On poorly drained soils, contour small ditches to eliminate low spots and sills and enhance rapid drainage. Use precision leveling on well-drained soils to eliminate small ditches that are occasionally used by nutria.

Grading and bulldozing can destroy active burrows in the banks of steep-sided ditches and waterways. In addition, contour bank slopes at less than 45° to discourage new burrowing. Sculpting rice field levees to make them gently sloping is similarly effective. Continued deep plowing of land undermined by nutria can destroy shallow burrow systems and discourage new burrowing activity.

Vegetation Control. Eliminate brush, trees, thickets, and weeds from fence lines and turn rows that are adjacent to ditches, drainages, waterways, and other wetlands to discourage nutria. Burn or remove cleared vegetation from the site. Brush piles left on the ground or in low spots can become ideal summer homes for nutria.

Water Level Manipulation. Many low-lying areas along the Gulf Coast are protected by flood control levees and pumps that can be used to manipulate water levels. By dropping water levels during the summer, stressful drought conditions that cause nutria to concentrate in the remaining aquatic habitat can be simulated, thus increasing competition for food and space, exposure to predators, and emigration to other suitable habitat. Raising water levels in winter will force nutria out of their burrows and expose them to the additional stresses of cold weather. Water level manipulation is expensive to implement and has not yet been proven to be effective. Nevertheless, this method should be considered when a comprehensive nutria control program is being developed.

Other Cultural Methods. Alternate field and garden sites should be considered in areas where nutria damage has occurred on a regular basis. New fields, gardens, and slab-on-grade buildings should be located as far as possible from drainages, waterways, and other water bodies where nutria live.

Late-planted baldcypress seedlings are less susceptible to damage by nutria than those planted in the spring. For this reason, plant unprotected seedlings in the early fall when alternative natural foods are readily available.

Frightening

Nutria are wary creatures and will try to escape when threatened. Loud noises, high pressure water sprays, and other types of harassment have been used to scare nutria from lawns and golf courses. The success of this type of control is usually short-lived and problem animals soon return. Consequently, frightening as a control technique is neither practical nor effective.

Repellents

No chemical repellents for nutria are currently registered. Other rodent repellents (such as Thiram) may repel nutria, but their effectiveness has not been determined. Use of these without the proper state and federal pesticide registrations is illegal.

Toxicants

Zinc Phosphide. Zinc phospide is the only toxicant that is registered for controlling nutria. Zinc phosphide is a Restricted Use Pesticide that can only be purchased and applied by certified pesticide applicators or individuals under their direct supervision. It is a grayish-black powder with a heavy garlic-like smell and is widely used for controlling a variety of rodents. When used properly, zinc phosphide poses little hazard to nontarget species, humans, pets, or livestock.

Zinc phosphide is highly toxic to wildlife and humans, so all precautions and instructions on the product label

should be carefully reviewed, understood, and followed precisely. Use an approved respirator and wear elbow-length rubber gloves when handling this chemical to prevent accidental poisoning. Mix and store baits treated with zinc phosphide only in well-ventilated areas to reduce exposing humans to chemical fumes and dust. When possible, mix zinc phosphide at the baiting site to avoid having to store and transport treated baits. Never transport mixed bait or open zinc phosphide containers in the cab of any vehicle. Store unused zinc phosphide in a dry place in its original watertight container because moisture causes it to deteriorate. Immediately wash off any zinc phosphide that gets on the skin.

Past studies have shown that zinc phosphide can kill over 95% of the nutria present along waterways when applied to fresh baits at a 0.75% (7,500 ppm) rate. Today, the use of zinc phosphide at this concentration is illegal. Federal and state registrations, however, allow lower rates to be used. For example, the label held by USDA-APHIS-ADC (EPA Reg. No. 56228-9) allows for a maximum 0.67% (6,700 ppm) treatment rate. At this rate, approximately 94 pounds (42.7 kg) of bait can be treated with 1 pound (0.4 kg) of 63.2% zinc phosphide concentrate.

Where to Bait. The best places to bait nutria are in waterways, ponds, and ditches where permanent standing water and recent nutria sign are found. Baiting in these areas increases efficiency and reduces the likelihood that nontarget animals will be affected. Small chunks of unpeeled carrots, sweet potatoes, watermelon rind, and apples can be used as bait.

The best baiting stations for large waterways are floating rafts spaced 1/4 to 1/2 mile (0.4 to 0.8 km) apart throughout the damaged area. In ponds, use one raft per 3 acres (1.2 ha). Rafts measuring 4 feet (1.2 m) square or 4 x 8 feet (1.2 x 2.4 m) are easily made from sheets of 3/8- to 3/4-inch (1.0- to 1.9- cm) exterior plywood and 3-inch (7.6-cm) styrofoam flotation. Install a thin wooden strip around the perimeter of the raft's surface to keep bait from rolling into the water. The raft should float 1 to 4 inches (2.5 to 10.2 cm) above the surface and should be anchored to the bottom with a heavy weight or tied to the shore (Fig. 5).

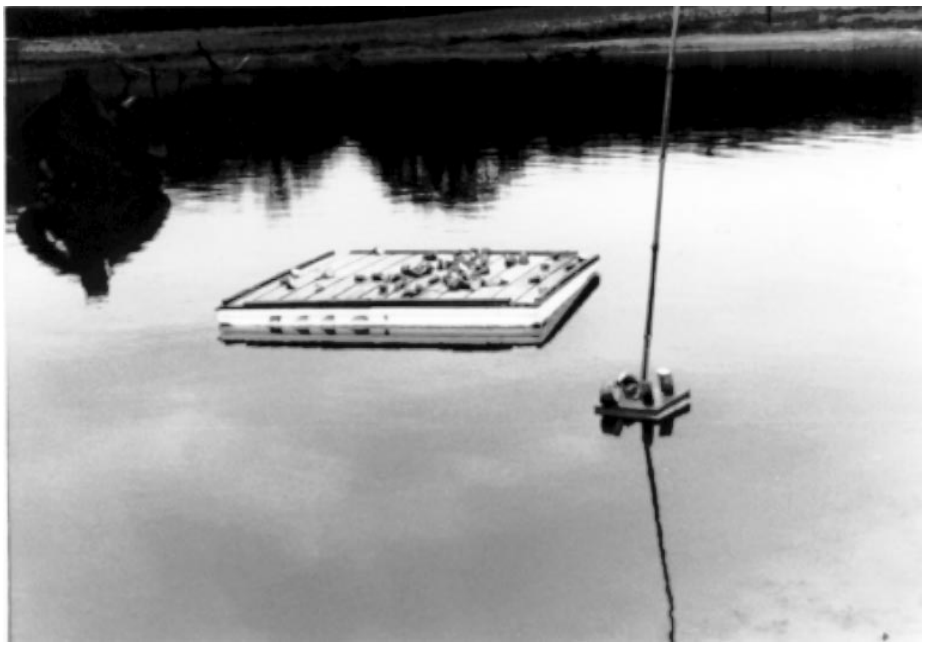


Fig. 5. Examples of a 4-foot (1.2-m) square raft (left) and a 6-inch (15.2-cm) square baiting board, which are used to concentrate nutria for shooting, trapping, or poisoning. These baiting platforms are constructed of plywood and styrofoam and baited with sweet potatoes.

In small ditches or areas where nutria densities are low, use 6-inch (15.2-cm) square floating bait boards made of wood and styrofoam, in lieu of rafts (Fig. 5). These can be maintained in place with a long slender anchoring pole made of bamboo, reed, or other suitable material that is placed through a hole in the center of the platform. This allows the board to move up and down as water levels change. Attach baits to small nails driven into the surface of the platform. Bait boards should be spaced 50 to 100 feet (15.2 to 30.5 m) apart in areas where nutria are active.

Other natural sites surrounded by water can also be baited for nutria. Small islands, exposed tree stumps, floating logs, and feeding platforms are excellent baiting sites. Avoid placing baits on muskrat houses and beaver lodges. Baits can be attached to trees, stumps, or other structures with small nails and should be kept out of the water.

Baiting on the ground should only be used when water sites are unsuitable or lacking. Ground baiting is justified and effective when eliminating the last few nutria in a local population. Use care when ground baiting because baits may be accessible to nontarget animals and humans. Place ground baits near sites of nutria activity, such as trails and entrances to burrows.

Prebaiting. Prebaiting is a crucial step when using zinc phosphide because it leads to nutria feeding at specific sites on specific types of food (such as the baits; carrots or sweet potatoes are preferred). Nutria tend to be communal feeders, and if one nutria finds a new feeding spot, other nutria in the area will also begin feeding there.

To prebait, lightly coat small (approximately 2-inch [5.1-cm] long) chunks of untreated bait with corn oil. Place the bait at each baiting station in late afternoon, and leave it overnight. Use no more than 10 pounds (4.5 kg) of bait per raft, 4 pieces of bait per baiting board, or 2 to 5 pieces at other sites at one time. Prebaiting should continue at least 2 successive nights after nutria begin feeding at a baiting site. Large

(more than 1 week) gaps in the prebaiting sequence necessitate that the process be started over.

Observations of prebaited sites will help you decide how the control program should proceed. If nontarget animals are feeding at these sites (as determined by sign or actual observations of animals), then prebaiting should start over at another location. Prepare and apply zinc phosphide-treated baits when nutria become regular users of prebaited baiting stations and nontarget animals are not a problem.

Applying Zinc Phosphide. Prepare zinc phosphide baits as needed to prevent deterioration. Treated baits are prepared in 10-pound (4.5-kg) batches (enough to treat one raft) by using the following ingredients: 10 pounds (4.5 kg) of bait (carrots or sweet potatoes are preferred), prepared as for prebaiting; 1 fluid ounce or 2 tablespoons (30 ml) of corn oil; and 1.7 ounces or 7.5 tablespoons (48.2 g) of 63.2% zinc phosphide concentrate.

To prepare treated baits, add corn oil to the bait in a 5 gallon (18.9 l) plastic or metal container. Stir the mixture until the bait is lightly coated with corn oil. Sprinkle zinc phosphide over the mixture and stir until the bait is uniformly coated. Treated baits have a shiny black appearance and should be dried for about 1 hour in a well-ventilated area until the color changes to a dull gray. Properly dried baits are weather-resistant and remain toxic until they deteriorate. Although treated baits can survive light rain, they should not be used when heavy rains are expected or on open water that is subject to heavy wave action.

The amount of untreated bait eaten the last night of prebaiting determines how much treated bait should be used on the first night. When all or most of the untreated prebait is gone from baiting stations by morning, the same amount of treated bait is used on the stations the following night (e.g., up to 10 pounds [4.5 kg] per raft, 4 pieces per baiting board, and 2 to 5 pieces at other sites). When smaller quantities are eaten, reduce the amount of treated bait that is used per station proportionately. When only a few pieces of prebait on a raft are eaten, the raft should be removed and replaced with several scattered baiting boards.

The quantity of treated bait eaten each treatment night is the quantity that should be put out the following afternoon. Continue baiting until no more bait is being taken. Most nutria can be controlled after 4 nights of baiting. When densities are high, control may require more time.

Post-Control Procedures. Usually only 25% of the poisoned nutria die where they can be found. Many nutria die in dens, dense vegetation, and other inaccessible areas. Carcasses of nutria killed with zinc phosphide should be collected as soon as possible and disposed of by deep burial or burning to prevent exposure of domestic and wild scavengers to undigested stomach material containing zinc phosphide. Dispose of any leftover treated bait in accordance with label directions.

Cessation of damage is the best indicator that zinc phosphide is controlling problem animals. You can quantify the reduction in nutria activity by putting out untreated bait at baiting stations after the last application of zinc phosphide. The amount eaten at this time is compared to the amount of bait eaten on the last night of prebaiting.

Fumigants

Several fumigants are registered for controlling burrowing rodents but none are registered for use against nutria. Some, such as aluminum phosphide, may have potential as nutria control agents, but their efficacy has not been scientifically demonstrated. Carbon monoxide gas pumped into dens has reportedly been used to kill nutria, but this method is neither practical nor legal because it is not registered for this purpose.

Trapping

Commercial Harvest. Damage to crops, levees, wetlands, and other resources is minimal in areas where nutria are harvested by commercial trappers. The commercial harvest of nutria on private and public lands should be encouraged as part of an overall program to manage nutria-caused damage. Landowners may be able to obtain additional information on nutria management, trapping, and a list of licensed trappers in their area from their state wildlife agency.

Leghold traps. Leghold traps are the most commonly used traps for catching nutria. Double longspring traps, No. 11 or 2, are preferred by most trappers; however, the No. 1 1/2 coilspring, No. 3 double longspring, or the soft-catch fox trap can also be used effectively. Legholds are more efficient and versatile than body-grip traps and are highly recommended for nutria control work. Leghold traps should be used with care to prevent injury to children and pets.

Several ways of setting leghold traps are effective. Set traps just under the water where a trail enters a ditch, canal, or other body of water. Make trail sets by placing a trap offset from the trail's center line so that nutria are caught by the foot. Traps can be lightly covered with leaves or other debris to hide them, but nutria are easily captured in unconcealed traps.

Bait can be used to lure nutria to leghold sets. Nutria use their teeth to pick up large pieces of food; therefore, bait should be placed beside, rather than inside, the trap jaws. Leghold traps are also effective when set on floating rafts that have been prebaited for a short period of time.

Use drowning sets when deep water is available. Otherwise, stake leghold traps to the ground, or anchor them to solid objects in the water or on land (such as floating logs, stumps, or trees and shrubs). Nutria caught in non-drowning leghold sets should be humanely dispatched with a shot or hard blow to the head. Nontarget animals should be released.

Live Traps. Nutria are easily captured in single- or double-door live traps that measure 9 x 9 x 32 inches (22.8 x 22.8 x 81.3 cm) or larger. Use

Fig. 6. Hand-caught nutria must be handled carefully to avoid being bitten or clawed.

these when leghold and body-grip traps cannot be set or when animals are to be translocated. Bait live traps with sweet potatoes and carrots and place them along active trails or wherever nutria or their sign are seen. A short line of baits leading to the entrance of a live trap will increase capture success. Live traps placed on floating rafts will effectively catch nutria but prebaiting is necessary. A large raft can hold up to 8 traps. Unwanted nutria should be destroyed with a shot or blow to the head. Nontarget animals should be released.

Floating, drop-door live traps catch nutria but are bulky and cumbersome to use. The same is true for expensive suitcase-type beaver traps. Unwary nutria can be captured using a long-handled dip net. This method should only be used by trained damage control professionals who should take special precautions to prevent being bitten or clawed (Fig. 6). Live nutria can be immobilized with an injection of ketamine hydrochloride. Funnel traps are not effective for controlling nutria.

Body-gripping Traps. The Conibear® trap, No. 220-2, is the most commonly used body-gripping trap for controlling nutria. Nos. 160-2 and 330-2 Conibear® traps can also be used. Place sets in trails, at den entrances, in culverts, and in narrow waterways. Large body-grip traps can be dangerous and should be handled with extreme caution. These traps should not be set in areas frequented by children, pets, or desirable wildlife species.

Other Traps. Use locking snares to catch nutria when other traps cannot be set. Snares are relatively easy to set, safer than leghold and body-grip traps, and almost invisible to the casual observer. Snares constructed with 3/32-inch (0.2-cm) diameter, flexible (7 x 7-winding) stainless steel or galvanized aircraft cable are suitable for catching nutria. Ready-made snares and components (for example, cable, one-way cable locks, swivels, and cable stops) for making homemade snares can be purchased from trapping suppliers.

Place set snares in trails and other travel routes, feeding lanes, trails, and bank slides. Snares do not kill the animals they catch, so anchor the snare securely. Check snares frequently because they are often knocked down by nutria and other animals. Snared nutria should be dispatched with a shot or blow to the head. Release any nontarget animals that are captured.

Shooting

Shooting can be used as the primary method of nutria control or to supplement other control techniques. Shooting is most effective when done at night with a spotlight, however, night shooting is illegal in many states and should not be done until proper permits have been obtained. Once shooting has been approved by the proper authorities, nutria can be shot from the banks of waterways and other bodies of water or from boats. In some cases, 80% of the nutria in an area can be removed by shooting with a shotgun or small caliber rifle, such as the .22 rimfire. Care should be taken when shooting over open water to prevent bullets from ricocheting.

Shooting at Bait Stations. Baits can attract large numbers of nutria to floating rafts, baiting boards, and other areas where they can be shot. Shooting from dusk to about 10:00 p.m. for 3 consecutive nights is effective once a regular feeding pattern has been established. Feeding sites should be lit continuously by a spotlight and easily visible to the shooter from a vehicle or other stationary blind. At night, nutria can be located by their red-shining eyes and the V-shaped wake left by swimming animals. As many as 4 to 5 nutria per hour may be taken by this method. Shooters should wait 2 to 3 weeks before shooting nutria at the same site again.

Boat Shooting. Shooting can also be done in the late afternoon or early evening from a small boat paddled slowly along waterways and large ditches or along the shores of small lakes and ponds. Nutria are especially vulnerable to this method when water levels are extremely high or vegetative

cover is scarce. At times, animals can be stimulated to vocalize or decoyed to a boat or blind by making a "maw" call, which imitates the nutria's nocturnal feeding and assembly call. This call can be learned from someone who knows it or by listening to nutria vocalizations at night. Nutria become wary quickly, so limit shooting to no more than 3 nights, followed by 2 to 3 weeks of no activity.

Bank Shooting. Nutria can be shot by slowly stalking along the banks of ditches and levees; this can be an effective control method where nutria have not been previously harassed. Unlike night shooting from a boat or blind, bank shooting is most effective at twilight, both in the evening and morning. Several nutria can usually be shot the first night, however, success decreases with each successive night of shooting. Daytime shooting from the bank of a waterway is effective in some situations.

Economics of Damage and Control

Nutria can have either positive or negative values. They are economically important furbearers when their pelts provide income to commercial trappers. Conversely, they are considered pests when they damage property.

From 1977 to 1984, an average of 1.3 million nutria pelts were harvested annually in the United States. Based on prices paid to Louisiana trappers during this period, these pelts were worth about $7.3 million.

The estimated value of sugarcane and rice damaged by nutria each year has ranged from several thousand dollars to over a million dollars. If losses of other resources are added to this amount, the estimated average loss would probably exceed $1 million annually.

Management plans developed for nutria should be comprehensive and should consider the needs of all stakeholders. Regulated commercial trapping should be an integral part of any management scheme because it can provide continuous, long-term income to trappers; maintain acceptable nutria densities; and reduce damage to tolerable levels.

The value of the protected resource must be compared with the cost of control when determining whether nutria control is economically feasible. Most people will not control nutria if costs exceed the value of the resource being protected or if control will adversely impact income derived from trapping. Of course, there are exceptions, especially when the resource has a high sentimental or aesthetic value to the owner or user.

Acknowledgments

This chapter is a revision of an earlier chapter written by Evans (1983). Kinler et al. (1987) and Willner (1982) were the primary sources consulted for biological information on nutria.

Figures 1 and 3 by Peggy A. Duhon of Lafayette, Louisiana.

Figure 2 from Willner (1982) and reprinted with permission of The Johns Hopkins University Press, Baltimore, Maryland.

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Opossum

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OPOSSUMS

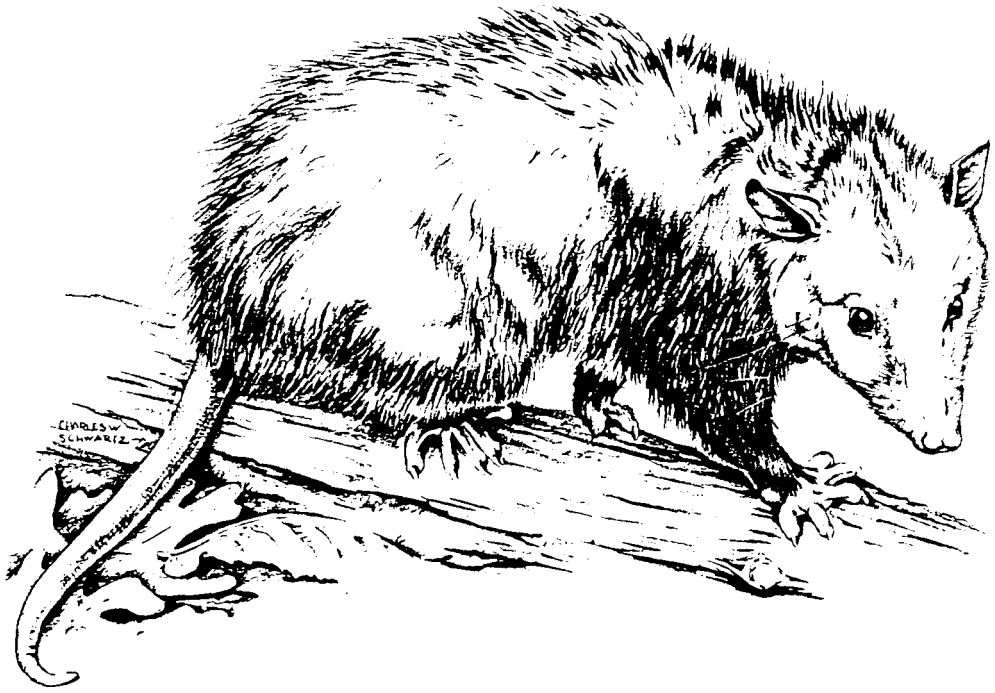


Fig. 1. Opossum, *Didelphis virginiana*

Damage Prevention and Control Methods

Exclusion

Practical where opossums are entering structures.

Habitat Modification

Remove cover and plug burrows to reduce frequency of visits by opossums.

Frightening

Generally not practical.

Repellents

None are registered.

Toxicants

None are registered.

Fumigants

None are registered.

Trapping

Leghold traps.

Box traps.

Cage traps.

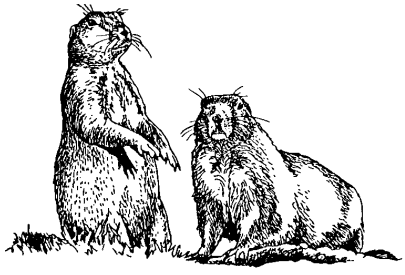
Body-gripping (kill) traps.

Shooting

Effective where firearms are permitted. Use a shotgun with No. 6 shot or a .22-caliber rifle.

Identification

An opossum *(Didelphis virginiana)* is a whitish or grayish mammal about the size of a house cat (Fig. 1). Underfur is dense with sparse guard hairs. Its face is long and pointed, its ears rounded and hairless. Maximum length is 40 inches (102 cm); the ratlike tail is slightly less than half the total length. The tail may be unusually short in northern opossums due to loss by frostbite. Opossums may weigh as much as 14 pounds (6.3 kg); males average 6 to 7 pounds (2.7 to 3.2 kg) and females average 4 pounds (6.3 kg). The skull is usually 3 to 4 inches (8 to 10 cm) long and contains 50 teeth — more than are found in any other North



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

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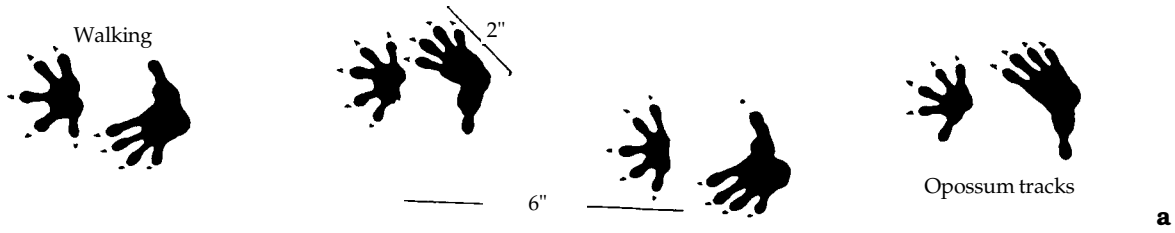
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee



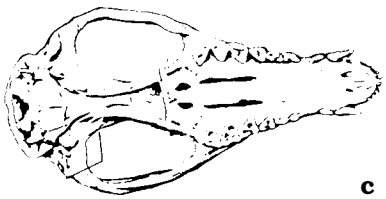


Fig. 2. Opossum sign and characteristics: (a) tracks, (b) droppings, and (c) skull.

American mammal. Canine teeth (fangs) are prominent. Tracks of both front and hind feet look as if they were made by little hands with widely spread fingers (Fig. 2). They may be distinguished from raccoon tracks, in which hind prints appear to be made by little feet. The hind foot of an opossum looks like a distorted hand.

Range

Opossums are found in eastern, central, and west coast states. Since 1900 they have expanded their range northward in the eastern United States. They are absent from the Rockies, most western plains states, and parts of the northern United States (Fig. 3).

Habitat

Habitats are diverse, ranging from arid to moist, wooded to open fields. Opossums prefer environments near streams or swamps. They take shelter in burrows of other animals, tree cavities, brush piles, and other cover. They sometimes den in attics and garages where they may make a messy nest.

Food Habits

Foods preferred by opossums are animal matter, mainly insects or carrion. Opossums also eat considerable amounts of vegetable matter, especially fruits and grains. Opossums living near people may visit compost piles, garbage cans, or food dishes intended for dogs, cats, and other pets.

General Biology, Reproduction, and Behavior

Opossums usually live alone, having a home range of 10 to 50 acres (4 to 20 ha). Young appear to roam randomly until they find a suitable home range. Usually they are active only at night. The mating season is January to July in warmer parts of the range but may start a month later and end a month earlier in northern areas. Opossums may raise 2, rarely 3, litters per year. The opossum is the only marsupial in North America. Like other marsupials, the blind, helpless young develop in a pouch. They are born 13 days after mating. The young, only 1/2 inch (1.3 cm) long, find their way into the female's pouch where they each attach to one of 13 teats. An average of 7 young are born. They remain in the pouch for 7 to 8 weeks. The young remain with the mother another 6 to 7 weeks until weaned.

Most young die during their first year. Those surviving until spring will breed in that first year. The maximum age in the wild is about 7 years.

Although opossums have a top running speed of only 7 miles per hour (11.3 km/hr), they are well equipped to escape enemies. They readily enter burrows and climb trees. When threatened, an opossum may bare its teeth, growl, hiss, bite, screech, and exude a smelly, greenish fluid from its anal glands. If these defenses are not successful, an opossum may play dead.

When captured or surprised during daylight, opossums appear stupid and inhibited. They are surprisingly

Fig. 3. Range of the opossum in North America.

intelligent, however. They rank above dogs in some learning and discrimination tests.

Damage

Although opossums may be considered desirable as game animals, certain individuals may be a nuisance near homes where they may get into garbage, bird feeders, or pet food. They may also destroy poultry, game birds, and their nests.

Legal Status

Laws protecting opossums vary from state to state. Usually there are open seasons for hunting or trapping opossums. It is advisable to contact local wildlife authorities before removing nuisance animals.

Damage Prevention and Control Methods

Exclusion

Prevent nuisance animals from entering structures by closing openings to cages and pens that house poultry. Opossums can be prevented from climbing over wire mesh fences by installing a tightly stretched electric fence wire near the top of the fence 3 inches (8 cm) out from the mesh. Fasten garbage can lids with a rubber strap.

Traps

Opossums are not wary of traps and may be easily caught with suitable-sized box or cage traps (Fig. 4). No. 1 or 1 1/2 leghold traps also are effective. Set traps along fences or trailways. Dirt hole sets or cubby sets are effective (Fig. 5). A dirt hole is about 3 inches (8 cm) in diameter and 8 inches (20 cm) deep. It extends into the earth at a 45° angle. The trap should be set at the entrance to the hole. A cubby is a small enclosure made of rocks, logs, or a box. The trap is set at the entrance to the cubby. The purpose of the dirt hole or cubby is to position the animal so

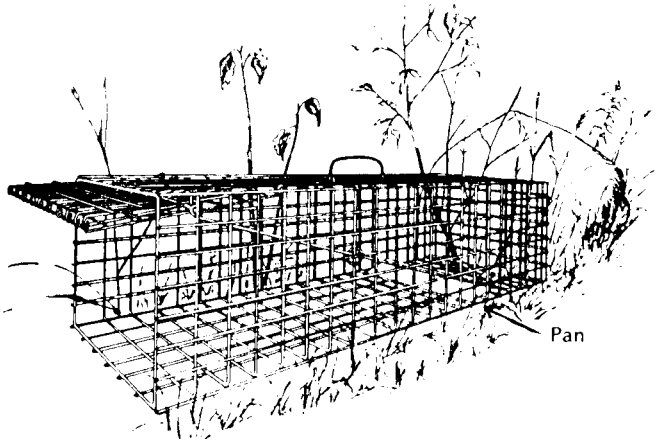
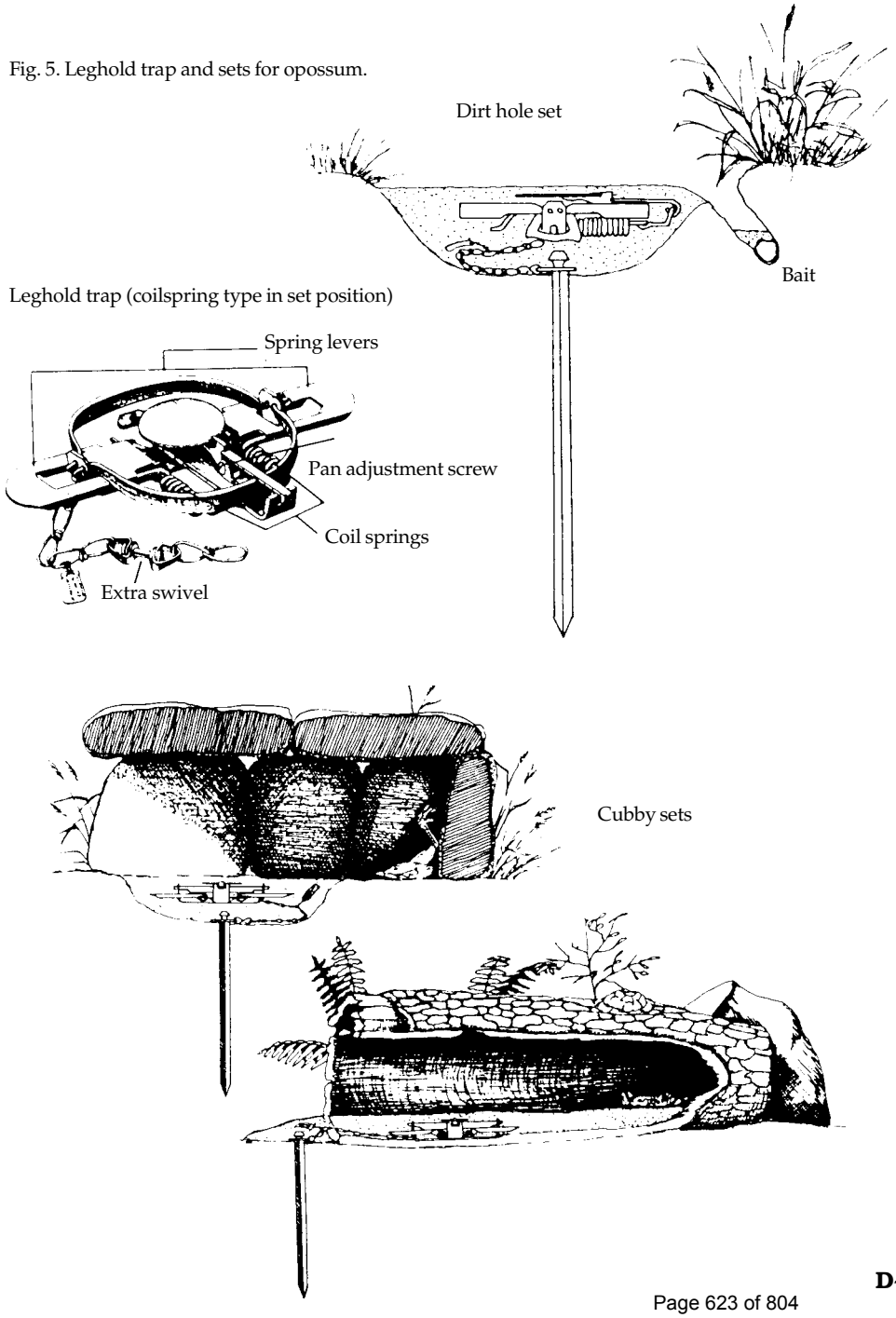


Fig. 4. Cage trap (set position).

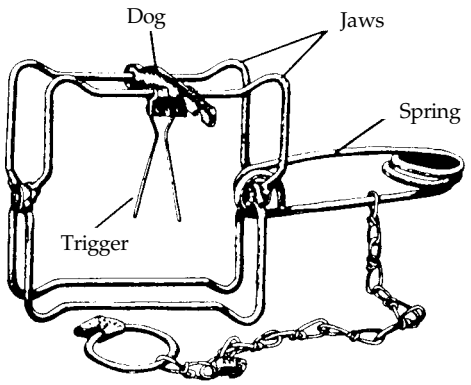
Fig. 5. Leghold trap and sets for opossum.



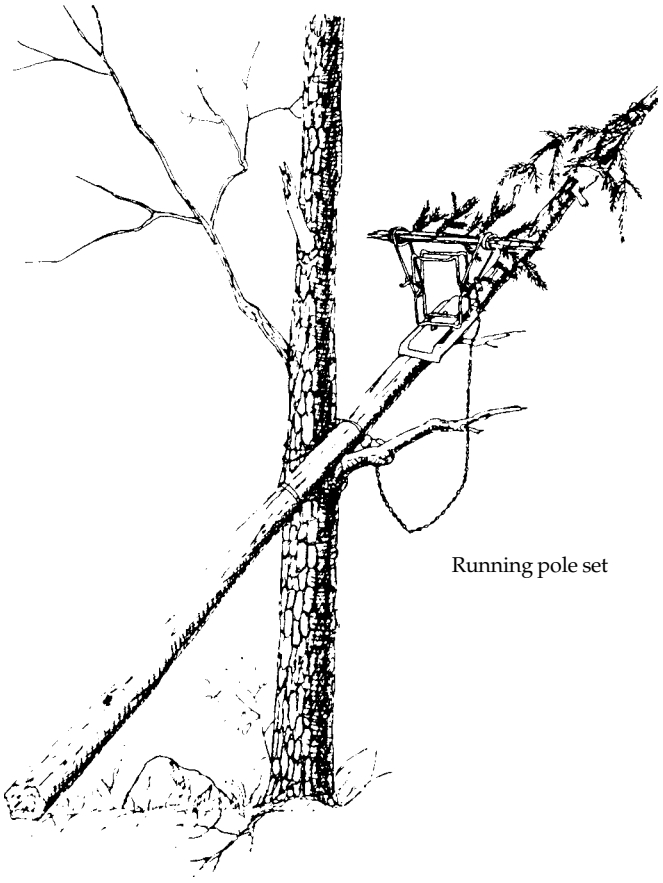
that it will place its foot on the trap. Place bait such as cheese, or slightly spoiled meat, fish, or fruit in the dirt hole or cubby to attract the animal. Using fruit instead of meat will reduce the chance of catching cats, dogs, or skunks.

A medium-sized body-gripping (kill type) trap will catch and kill opossums. Place bait behind the trap in such a way that the animal must pass through the trap to get it. Body-gripping traps kill the captured animal quickly. To reduce chances of catching pets, set the trap above ground on a running pole (Fig. 6).

Fig. 6. Body-gripping trap and running pole set.



Body-gripping trap (set position)



Running pole set

Shooting

A rifle of almost any caliber or a shotgun loaded with No. 6 shot or larger will effectively kill opossums. Use a light to look for opossums after dark. If an opossum has not been alarmed, it will usually pause in the light long enough to allow an easy shot. Once alarmed, opossums do not run rapidly. They will usually climb a nearby tree where they can be located with a light. Chase running opossums on foot or with a dog. If you lose track, run to the last place where you saw the animal. Stop and listen for the sound of claws on bark to locate the tree the animal is climbing.

Sometimes opossums can be approached quietly and killed by a strong blow with a club, but they can be surprisingly hard to kill in this manner. They can be taken alive by firmly grasping the end of the tail. If the animal begins to "climb its tail" to reach your hand, lower the animal until it touches the ground. This will distract the opossum and cause it to try to escape by crawling. Opossums can carry rabies, so wear heavy gloves and be wary of bites.

Euthanize unwanted animals humanely with carbon dioxide gas, or release them several miles from the point of capture.

Economics of Damage and Control

No data are available; however, it is usually worthwhile to remove a particular animal that is causing damage.

Acknowledgments

Much of the information on habitat, food habits, and general biology comes from J. J. McManus (1974) and A. L. Gardner (1982). The manuscript was read and improved by Jim Byford and Robert Timm.

Figures 1, 2a, 2c, and 3 from Schwartz and Schwartz (1981).

Figure 2b by Jill Sack Johnson.

Figures 4, 5, and 6 by Michael D. Stickney, from the New York Department of Environmental Conservation publication "Trapping Furbearers, Student Manual" (1980), by R. Howard, L. Berchielli, C. Parsons, and M. Brown. The figures are copyrighted and are used with permission.

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Cottontail Rabbit

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COTTONTAIL RABBITS

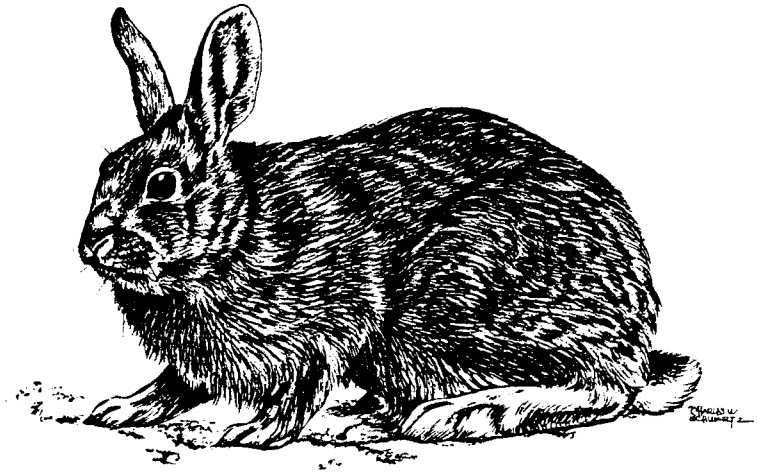


Fig. 1. Eastern cottontail rabbit, *Sylvilagus floridanus*

Damage Prevention and Control Methods*

Exclusion

Low fences are very effective around gardens or shrubs.

Hardware cloth cylinders will protect fruit trees and ornamental plants.

Habitat Modification

Removal of brush piles, debris, dumps, and other cover makes an area less suitable for rabbits.

Frightening

Several methods are available but none are reliable.

Repellents

A wide variety of commercial formulations is available; most are taste repellents based on the fungicide thiram. Home-remedy types may provide some relief.

Toxicants

None are registered.

Trapping

Commercial live traps or homemade box traps are effective, particularly during winter in northern states.

Shooting

Sport hunting and/or routine shooting of problem individuals are very effective methods.

Other Methods

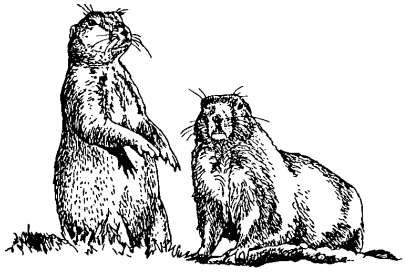
Many "gimmick" solutions are available but unreliable. For example, sections of garden hose to simulate snakes, water-filled jugs to create frightening, distorted reflections.

**Most methods apply to all rabbit and hare species.*

Introduction

Rabbits mean different things to different people. For hunters, the cottontail rabbit is an abundant, sporting, and tasty game animal. However, vegetable and flower gardeners, farmers, and homeowners who are suffering damage may have very little to say in favor of cottontails. They can do considerable damage to flowers, vegetables, trees, and shrubs any time of the year and in places ranging from suburban yards to rural fields and tree plantations. Control is often necessary to reduce damage, but complete extermination is not necessary, desirable, or even possible.

Rabbits usually can be accepted as interesting additions to the backyard or rural landscape if control techniques are applied correctly. Under some unusual circumstances, control of damage may be difficult.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

Damage control methods include removal by live trapping or hunting, exclusion, and chemical repellents. In general, no toxicants or fumigants are registered for rabbit control; however, state regulations may vary. Frightening devices may provide a sense of security for the property owner, but they rarely diminish rabbit damage.

Identification

There are 13 species of cottontail rabbits (genus *Sylvilagus*), nine of which are found in various sections of North America north of Mexico. All nine are similar in general appearance and behavior, but differ in size, range, and habitat. Such differences result in a wide variation of damage problems, or lack of problems. The pygmy rabbit (*S. idahoensis*), found in the Pacific Northwest, weighs only 1 pound (0.4 kg), while the swamp rabbit (*S. aquaticus*), found in the southeastern states as far north as southern Illinois, may weigh up to 5 pounds (2.3 kg). Most species prefer open, brushy, or cultivated areas but some frequent marshes, swamps, or deserts. The swamp rabbit and the marsh rabbit (*S. palustris*) are strong swimmers. The eastern cottontail (*S. floridanus*) is the most abundant and widespread species. For the purposes of the discussion here about damage control and biology, the eastern cottontail (Fig. 1) will be considered representative of the genus. Cottontail rabbits must be distinguished from jackrabbits and other hares, which are generally larger in size and have longer ears. Jackrabbits are discussed in another chapter of this book.

The eastern cottontail rabbit is approximately 15 to 19 inches (37 to 48 cm) in length and weighs 2 to 4 pounds (0.9 to 1.8 kg). Males and females are basically the same size and color. Cottontails appear gray or brownish gray in the field. Closer examination reveals a grizzled blend of white, gray, brown, and black guard hairs over a soft grayish or brownish underfur, with a characteristic rusty brown spot on the nape of the neck. Rabbits molt twice each year, but remain the same general color. They have large ears, though smaller than those of jackrabbits, and the hind feet are much larger than the forefeet. The tail is short and white on the undersurface, and its similarity to a cotton ball resulted in the rabbit's common name.

Range

The eastern cottontail's range includes the entire United States east of the Rocky Mountains and introductions further west. It extends from southern New England along the Canadian border west to eastern Montana and south into Mexico and South America (Fig. 2). The most common species of the western United States include the desert cottontail (*S. auduboni*, Fig. 3), and mountain cottontail (*S. muttalli, Fig. 4*). Refer to a field guide or suggested readings if other species of the genus *Sylvilagus* are of interest.

Habitat

Cottontails do not distribute themselves evenly across the landscape. They tend to concentrate in favorable habitat such as brushy fence rows or field edges, gullies filled with debris, brush piles, or landscaped backyards where food and cover are suitable. They are rarely found in dense forests or open grasslands, but fallow crop fields, such as those in the Conservation Reserve Program, may provide suitable habitat.

Cottontails generally spend their entire lives in an area of 10 acres or less. Occasionally they may move a mile or so from summer range to winter cover or to a new food supply. Lack of food or cover is usually the motivation for a rabbit to relocate. In suburban areas, rabbits are numerous and mobile enough to fill any "empty" habitat created when other rabbits are removed. Population density varies with habitat quality, but one rabbit per acre is a reasonable average.

Contrary to popular belief, cottontails do not dig their own burrows, as the European rabbit does. Cottontails use natural cavities or burrows excavated by woodchucks or other animals.

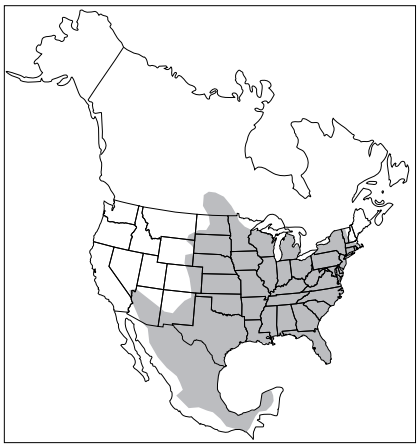


Fig. 2. Range of the eastern cottontail in North America.

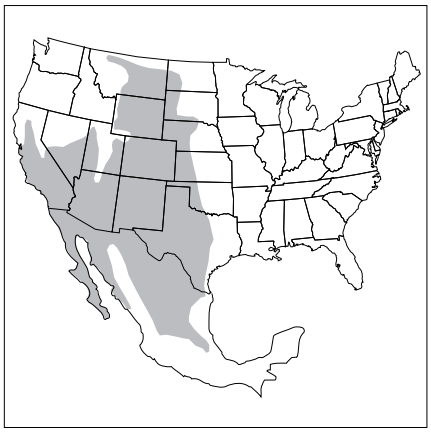


Fig. 3. Range of the desert cottontail in North America.

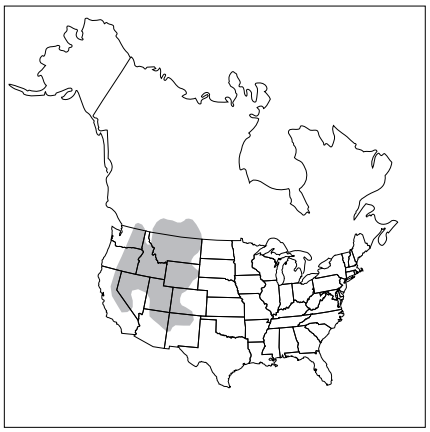


Fig. 4. Range of the mountain cottontail in North America.

Underground dens are used primarily in extremely cold or wet weather and to escape pursuit. Brush piles and other areas of cover are often adequate alternatives to burrows.

In spring and fall, rabbits use a grass or weed shelter called a "form." The form is a nestlike cavity on the surface of the ground, usually made in dense cover. It gives the rabbit some protection from weather, but is largely used for concealment. In summer, lush green growth provides both food and shelter, so there is little need for a form.

General Biology and Reproduction

Rabbits live only 12 to 15 months, and probably only one rabbit in 100 lives to see its third fall, yet they make the most of the time available to them. Cottontails can raise as many as 6 litters in a year. Typically, there are 2 to 3 litters per year in northern parts of the cottontail range and up to 5 to 6 in southern areas. In the north (Wisconsin), first litters are born as early as late March or April. In the south (Texas), litters may be born year-round. Litter size also varies with latitude; rabbits produce 5 to 6 young per litter in the north, 2 to 3 in the south. The rabbit's gestation period is only 28 or 29 days, and a female is usually bred again within a few hours of giving birth. Rabbits give birth in a shallow nest depression in the ground. Young cottontails are born nearly furless with their eyes closed. Their eyes open in 7 to 8 days, and they leave the nest in 2 to 3 weeks.

Under good conditions, each pair of rabbits could produce approximately 18 young during the breeding season. Fortunately, this potential is rarely reached. Weather, disease, predators, encounters with cars and hunters, and other mortality factors combine to keep a lid on the rabbit population.

Because of the cottontail's reproductive potential, no lethal control is effective for more than a limited period. Control measures are most effective when used against the breeding population during the winter. Habitat modification and exclusion techniques provide long-term, nonlethal control.

Food Habits, Damage, and Damage Identification

The appetite of a rabbit can cause problems every season of the year. Rabbits eat flowers and vegetables in spring and summer. In fall and winter, they damage and kill valuable woody plants.

Rabbits will devour a wide variety of flowers. The one most commonly damaged is the tulip; they especially like the first shoots that appear in early spring.

The proverbial carrot certainly is not the only vegetable that cottontails eat. Anyone who has had a row of peas, beans, or beets pruned to ground level knows how rabbits like these plants. Only a few crops—corn, squash, cucumbers, tomatoes, potatoes, and some peppers—seem to be immune from rabbit problems.

Equally annoying, and much more serious, is the damage rabbits do to woody plants by gnawing bark or clipping off branches, stems, and buds. In winter in northern states, when the ground is covered with snow for long periods, rabbits often severely damage expensive home landscape plants, orchards, forest plantations, and park trees and shrubs. Some young plants are clipped off at snow height, and large trees and shrubs may be completely girdled. When the latter happens, only sprouting from beneath the damage or a delicate bridge graft around the damage will save the plant.

A rabbit's tastes in food can vary considerably by region and season. In general, cottontails seem to prefer plants of the rose family. Apple trees, black and red raspberries, and blackberries are the most frequently damaged food-producing woody plants, although cherry, plum, and nut trees are also damaged.

Among shade and ornamental trees, the hardest hit are mountain ash, basswood, red maple, sugar maple, honey locust, ironwood, red and white oak, and willow. Sumac, rose, Japanese barberry, dogwood, and some woody members of the pea family are among the shrubs damaged.

Evergreens seem to be more susceptible to rabbit damage in some areas than in others. Young trees may be clipped off, and older trees may be deformed or killed.

The character of the bark on woody plants also influences rabbit browsing. Most young trees have smooth, thin bark with green food material just beneath it. Such bark provides an easy-to-get food source for rabbits. The thick, rough bark of older trees often discourages gnawing. Even on the same plant, rabbits avoid the rough bark but girdle the young sprouts that have smooth bark.

Rabbit damage can be identified by the characteristic appearance of gnawing on older woody growth and the clean-cut, angled clipping of young stems. Distinctive round droppings in the immediate area are a good sign of their presence too.

Rabbit damage rarely reaches economic significance in commercial fields or plantations, but there are exceptions. For example, marsh rabbits have been implicated in sugarcane damage in Florida. Growers should always be alert to the potential problems caused by locally high rabbit populations.

Legal Status

In most states, rabbits are classified as game animals and are protected as such at all times except during the legal hunting season. Some state regulations may grant exceptions to property owners, allowing them to trap or shoot rabbits outside the normal hunting season on their own property.

Damage Prevention and Control Methods

Exclusion

One of the best ways to protect a backyard garden or berry patch is to put up a fence. It does not have to be tall or especially sturdy. A fence of 2-foot (60-cm) chicken wire with the bottom tight

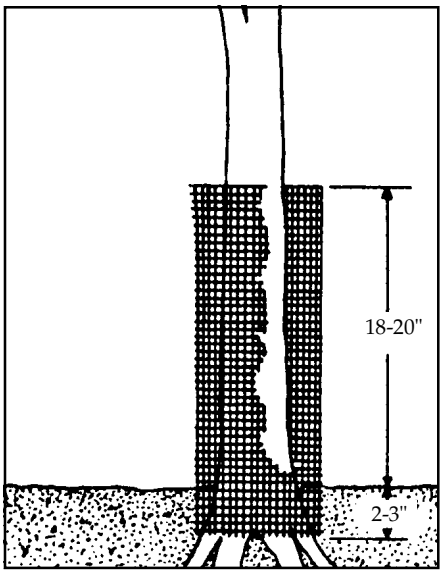


Fig. 5. A cylinder of hardware cloth or other wire mesh can protect trees from rabbit damage.

to the ground or buried a few inches is sufficient. Be sure the mesh is 1 inch (2.5 cm) or smaller so that young rabbits will not be able to go through it. A more substantial fence of welded wire, chain link, or hog wire will keep rabbits, pets, and children out of the garden and can be used to trellis vine crops. The lower 1 1/2 to 2 feet (45 to 60 cm) should be covered with small mesh wire. A fence may seem costly, but with proper care it will last many years and provide relief from the constant aggravation of rabbit damage. Inexpensive chicken wire can be replaced every few years.

Cylinders of 1/4-inch (0.6-cm) wire hardware cloth will protect valuable young orchard trees or landscape plants (Fig. 5). The cylinders should extend higher than a rabbit's reach while standing on the expected snow depth, and stand 1 to 2 inches (2.5 to 5 cm) out from the tree trunk. Larger mesh sizes, 1/2- to 3/4-inch (1.2- to 1.8-cm), can be used to reduce cost, but be sure the cylinder stands far enough away from the tree trunk that rabbits cannot eat through the holes. Commercial tree guards or tree wrap are another alternative. Several types of paper wrap are available, but they are designed for protection from sun or other damage. Check with your local garden center for advice. When rabbits are abundant and food is in short supply, only hardware cloth will guarantee protection. Small mesh (1/4-inch [0.6-cm]) hardware cloth also protects against mouse damage.

A dome or cage of chicken wire secured over a small flower bed will allow vulnerable plants such as tulips to get a good start before they are left unprotected.

Habitat Modification

One form of natural control is manipulation of the rabbits' habitat. Although frequently overlooked, removing brush piles, weed patches, dumps, stone piles, and other debris where rabbits live and hide can be an excellent way to manage rabbits. It is especially effective in suburban areas where fewer suitable habitats are likely to be available. Vegetation control along ditch banks or fence rows will eliminate rabbit habitat in agricultural settings but is likely to have detrimental effects on other species such as pheasants. Always weigh the consequences before carrying out any form of habitat management.

Repellents

Several chemical repellents discourage rabbit browsing. Always follow exactly the directions for application on the container. Remember that some repellents are poisonous and require safe storage and use. For best results, use repellents and other damage control methods at the first sign of damage.

Most repellents can be applied, like paint, with a brush or sprayer. Many commercially available repellents contain the fungicide thiram and can be purchased in a ready-to-use form (see **Supplies and Materials**).

Some formerly recommended repellents are no longer available. Most repellents are not designed to be used on plants or plant parts destined for human consumption. Most rabbit repellents are contact or taste repellents that render the treated plant parts distasteful. Mothballs are an example of an area or odor repellent that repels by creating a noxious odor around the plants to be protected. Taste repellents protect only the parts of the plant they contact; new growth that emerges after application is not protected. Heavy rains may necessitate reapplication of some repellents.

Mothballs or dried blood meal sometimes keeps rabbits from damaging small flower beds or garden plots. Place these substances among the plants. Blood meal does not weather well, however.

Taste repellents are usually more effective than odor repellents. The degree of efficacy, however, is highly variable, depending on the behavior and number of rabbits, and alternative foods available. When rabbits are abundant and hungry, use other control techniques along with chemical repellents.

Toxicants

There are no toxicants or fumigants registered for use against rabbits. Poisoning rabbits is not recommended. Since state pesticide registrations vary, check with your local Cooperative Extension Service or USDA-APHIS-ADC office for information on repellents or other new products available for use in your area.

Trapping

Trapping is the best way to remove rabbits in cities, parks, and suburban areas. The first step is to get a well-built and well-designed live trap. Several excellent styles of commercial live traps are available from garden centers, hardware stores, and seed catalogs. Most commercial traps are wire and last indefinitely with proper care. Average cost is about $20 to $30. Live traps can often be rented from animal control offices or pest control companies.

An effective wooden box trap (Fig. 6) can be made. This type of trap has proven itself in the field and has been used in rabbit research by biologists. For best results, follow the plan to the letter because each detail has been carefully worked out.

Place traps where you know rabbits feed or rest. Keep traps near cover so

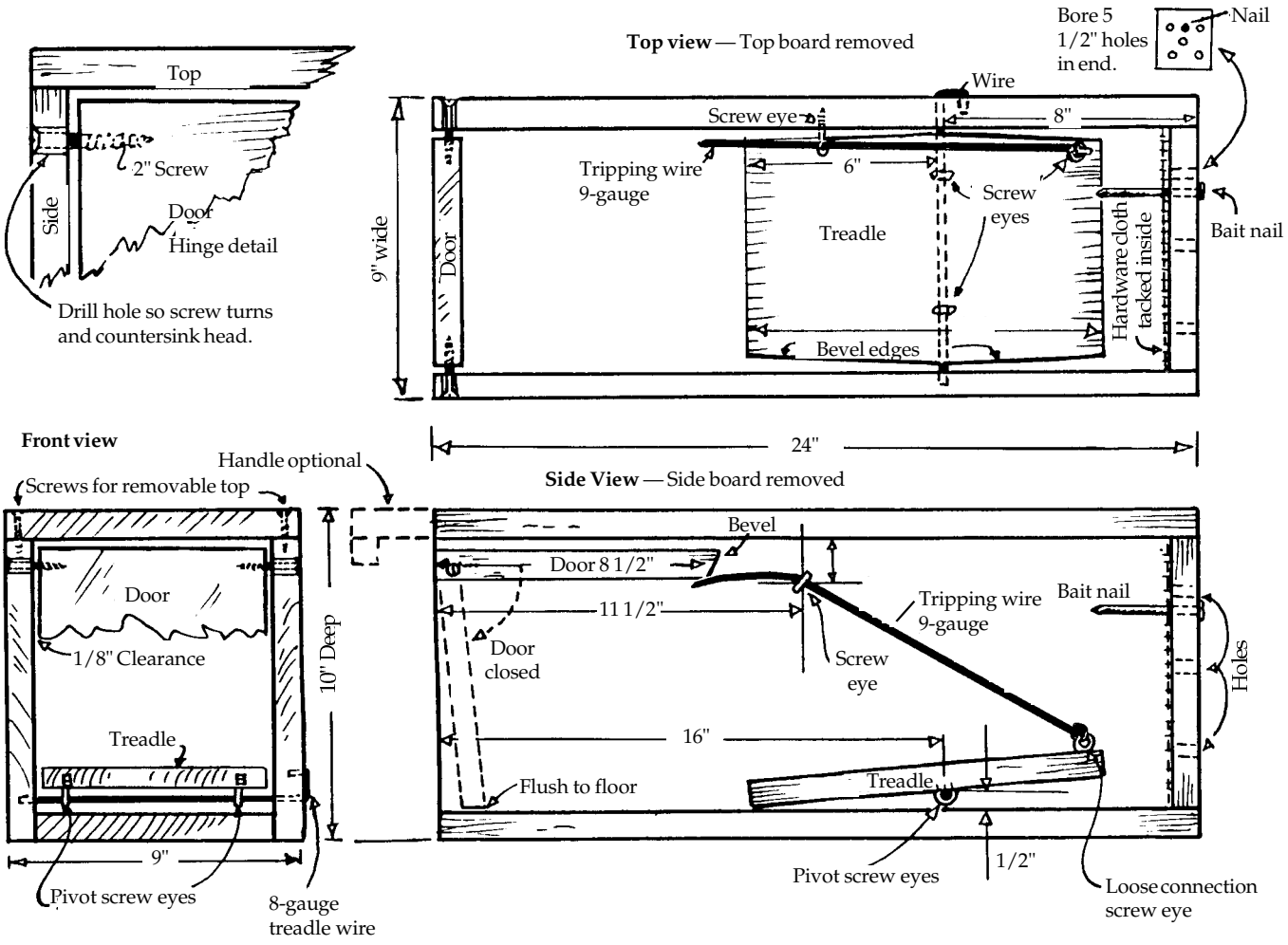


Fig. 6. Plans for the Tom Butzen wooden box trap for rabbits.

that rabbits won't have to cross large open areas to get to them. In winter, face traps away from prevailing winds to keep snow and dry leaves from plugging the entrance or interfering with the door. Check traps daily to replenish bait or remove the catch—daily checks are essential for effective control and for humane treatment of the animals. Move traps if they fail to make a catch within a week.

Finding bait is not a problem, even in winter, because cob corn (dry ear corn) or dried apples make very good bait. Impale the bait on the nail or simply position it at the rear of the trap (commercial traps may not have a nail). When using cob corn, use half a cob and push the nail into the pith of the cob; this keeps the cob off the floor and visible from the open door. Dried leafy alfalfa and clover are also good cold-weather baits.

Apples, carrots, cabbage, and other fresh green vegetables are good baits in warmer weather or climates. These soft baits become mushy and ineffective once frozen. A good summer bait for garden traps is a cabbage leaf rolled tightly and held together by a toothpick. For best results, use baits that are similar to what the target rabbits are feeding on.

A commercial wire trap can be made more effective (especially in winter) by covering it with canvas or some other dark material. Be sure the cover does not interfere with the trap's mechanism.

Release rabbits in rural areas several miles from where they have been trapped if local regulations allow relocation. Do not release them where they may create a problem for someone else.

Shooting

Shooting is a quick, easy, and effective method of control, but make sure that local firearms laws allow it and that it is done safely. In some states, the owner or occupant of a parcel of land may hunt rabbits all year on that land, except for a short time before the firearm deer season. Consult your state wildlife agency for regulations. You must be persistent if shooting is the only technique you rely on. Removing rabbits in one year never guarantees that the rabbit population will be low the next year (this is also true for trapping).

Other Methods

Encouraging the rabbit's natural enemies—or at least not interfering with them—may aid in reducing rabbit damage. Hawks, owls, foxes,

mink, weasels, and snakes all help the farmer, gardener, homeowner, and forester control rabbits. These animals should never be needlessly destroyed. In fact, it is against the law to kill hawks and owls; foxes, mink, and weasels are protected during certain seasons as valuable furbearers. Even the family cat can be a very effective predator on young nestling rabbits, but cats are likely to kill other wildlife as well.

Many people have a favorite rabbit remedy. A piece of rubber hose on the ground may look enough like a snake to scare rabbits away. Another remedy calls for placing large, clear glass jars of water in a garden. Supposedly, rabbits are terrified by their distorted reflections. Most home remedies, unfortunately, are not very effective. Inflatable owls and snakes, eyespot balloons, and other commercial products are readily available in garden centers and through mail order catalogues. Feeding rabbits during the winter in much the same way as feeding wild birds might divert their attention from trees and shrubs and thus reduce damage in some areas. There is always the risk that this tactic can backfire by drawing in greater numbers of rabbits or increasing the survival of those present.

Acknowledgments

I thank R. A. McCabe for reviewing this manuscript and providing the trap design.

Figure 1 from Schwartz and Schwartz (1981).

Figures 2 and 3 adapted from Burt and Grossenheider (1976) by Dave Thornhill, University of Nebraska-Lincoln.

Figures 4 and 5 courtesy of the Department of Agricultural Journalism, University of Wisconsin-Madison.

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Raccoon

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RACCOONS

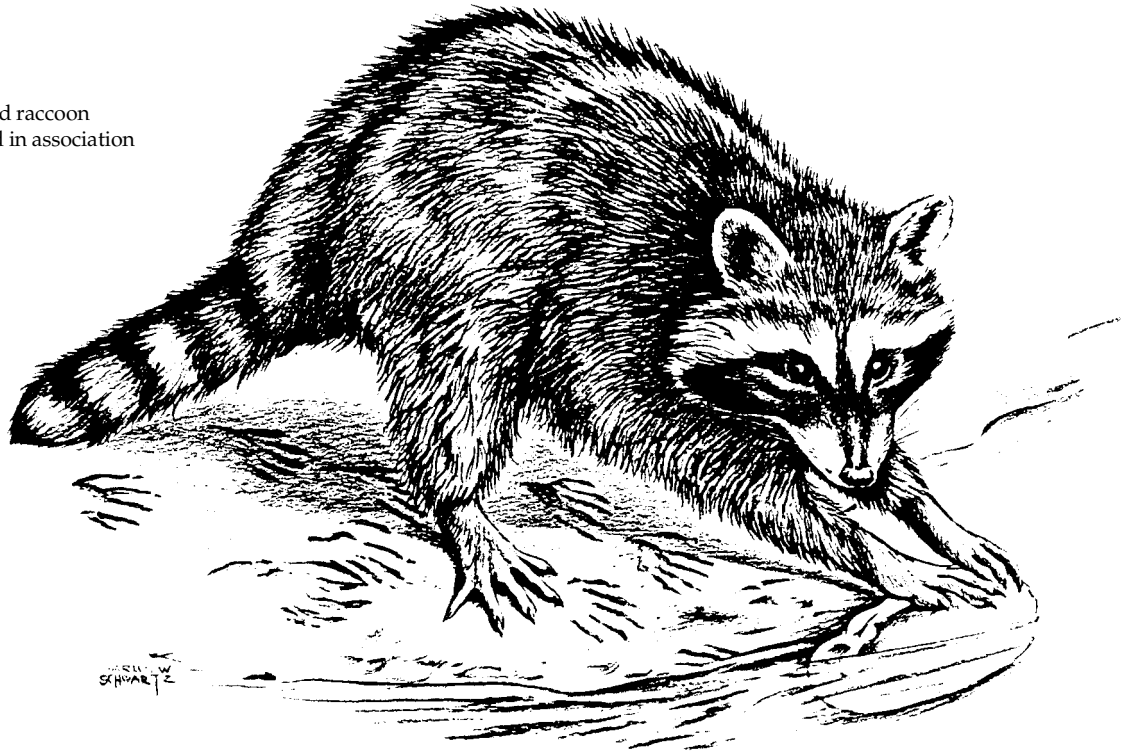


Fig. 1. The distinctively marked raccoon (*Procyon lotor*) is usually found in association with water.

Damage Prevention and Control Methods

Exclusion

Usually the best method for coping with almost all types of raccoon damage.

Habitat Modification

Remove obvious sources of food or shelter around the premises; usually not practical as a sole method of controlling damage.

Frightening

Several methods may be effective, but only for a short time.

Repellents, Toxicants, and Fumigants

None are registered.

Trapping

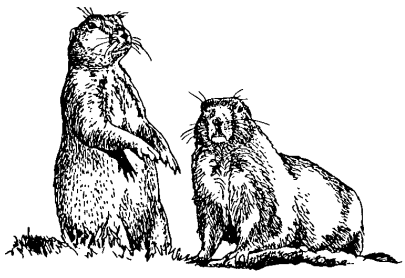
Cage traps, body-gripping, and foothold traps are very effective, especially in conjunction with exclusion and/or habitat modification.

Shooting

Can be very effective, particularly if trained hounds are used to tree the raccoons. Local regulations may apply.

Identification

The raccoon (*Procyon lotor*), also called "coon," is a stocky mammal about 2 to 3 feet (61 to 91 cm) long, weighing 10 to 30 pounds (4.5 to 13.5 kg) (rarely 40 to 50 pounds [18 to 22.5 kg]). It is distinctively marked, with a prominent black "mask" over the eyes and a heavily furred, ringed tail (Fig. 1). The animal is a grizzled salt-and-pepper gray and black above, although some individuals are strongly washed with yellow. Raccoons from the prairie areas of the western Great Plains are paler in color than those from eastern portions of the region.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

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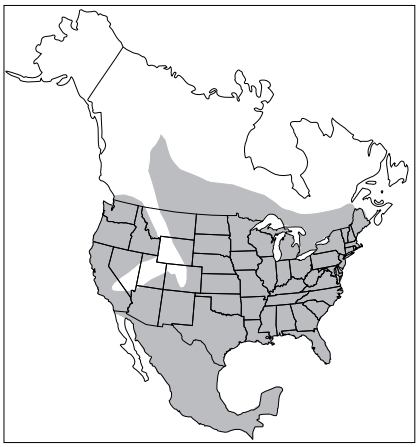

Fig. 2. Distribution of the raccoon in North America.

Range

The raccoon is found throughout the United States, with the exception of the higher elevations of mountainous regions and some areas of the arid Southwest (Fig. 2). Raccoons are more common in the wooded eastern portions of the United States than in the more arid western plains.

Habitat

Raccoons prefer hardwood forest areas near water. Although commonly found in association with water and trees, raccoons occur in many areas of the western United States around farmsteads and livestock watering areas, far from naturally occurring bodies of permanent water. Raccoons den in hollow trees, ground burrows, brush piles, muskrat houses, barns and abandoned buildings, dense clumps of cattail, haystacks, or rock crevices.

General Biology, Reproduction, and Behavior

Raccoons are omnivorous, eating both plant and animal foods. Plant foods include all types of fruits, berries, nuts, acorns, corn, and other types of grain. Animal foods are crayfish, clams, fish, frogs, snails, insects, turtles and their eggs, mice, rabbits, muskrats, and the eggs and young of ground-nesting birds and waterfowl. Contrary to popular myth, raccoons do not always wash their food before eating, although they frequently play with their food in water.

Raccoons breed mainly in February or March, but matings may occur from December through June, depending on latitude. The gestation period is about 63 days. Most litters are born in April or May but some late-breeding females may not give birth until June, July, or August. Only 1 litter of young is raised per year. Average litter size is 3 to 5. The young first open their eyes at about 3 weeks of age. Young raccoons are weaned sometime between 2 and 4 months of age.

Raccoons are nocturnal. Adult males occupy areas of about 3 to 20 square miles (8 to 52 km^2), compared to about 1 to 6 square miles (3 to 16 km^2) for females. Adult males tend to be territorial and their ranges overlap very little. Raccoons do not truly hibernate, but they do "hole up" in dens and become inactive during severe winter weather. In the southern United States they may be inactive for only a day or two at a time, whereas in the north this period of inactivity may extend for weeks or months. In northern areas, raccoons may lose up to half their fall body weight during winter as they utilize stored body fat.

Raccoon populations consist of a high proportion of young animals, with one-half to three-fourths of fall populations normally composed of animals less than 1 year in age. Raccoons may live as long as 12 years in the wild, but such animals are extremely rare. Usually less than half of the females will breed the year after their birth, whereas most adult females normally breed every year.

Family groups of raccoons usually remain together for the first year and the young will often den for the winter with the adult female. The family gradually separates during the following spring and the young become independent.

Damage and Damage Identification

Raccoons may cause damage or nuisance problems in a variety of ways, and their distinctive tracks (Fig. 3) often provide evidence of their involvement in damage situations.

Raccoons occasionally kill poultry and leave distinctive signs. The heads of adult birds are usually bitten off and left some distance from the body. The crop and breast may be torn and chewed, the entrails sometimes eaten, and bits of flesh left near water. Young poultry in pens or cages may be killed or injured by raccoons reaching through the wire and attempting to pull the birds back through the mesh. Legs or feet of the young birds may be missing. Eggs may be removed completely from nests or eaten on the spot with only the heavily cracked shell remaining. The lines of fracture will normally be along the long axis of the egg, and the nest materials are often disturbed. Raccoons can also destroy bird nests in artificial nesting structures such as bluebird and wood duck nest boxes.

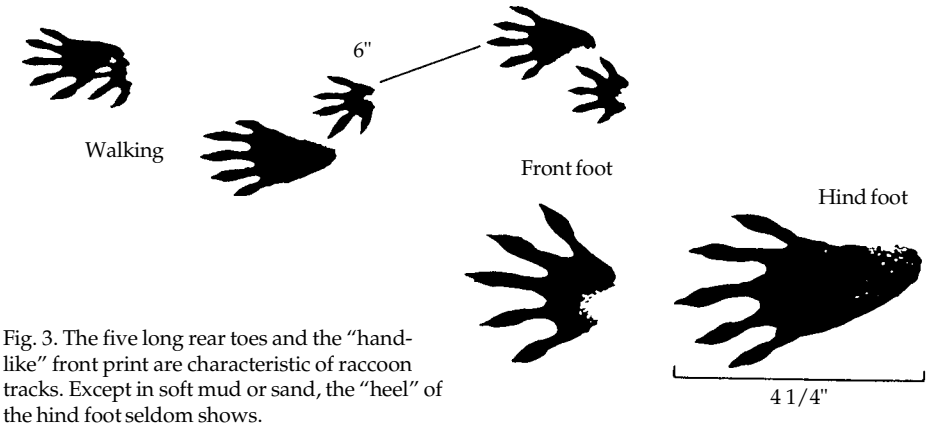

Fig. 3. The five long rear toes and the "hand-like" front print are characteristic of raccoon tracks. Except in soft mud or sand, the "heel" of the hind foot seldom shows.

Raccoons can cause considerable damage to garden or truck crops, particularly sweet corn. Raccoon damage to sweet corn is characterized by many partially eaten ears with the husks pulled back. Stalks may also be broken as raccoons climb to get at the ears. Raccoons damage watermelons by digging a small hole in the melon and then raking out the contents with a front paw.

Raccoons cause damage or nuisance problems around houses and outbuildings when they seek to gain entrance to attics or chimneys or when they raid garbage in search of food. In many urban or suburban areas, raccoons are learning that uncapped chimneys make very adequate substitutes for more traditional hollow trees for use as denning sites, particularly in spring. In extreme cases, raccoons may tear off shingles or facia boards in order to gain access to an attic or wall space.

Raccoons also can be a considerable nuisance when they roll up freshly laid sod in search of earthworms and grubs. They may return repeatedly and roll up extensive areas of sod on successive nights. This behavior is particularly common in mid- to late summer as young raccoons are learning to forage for themselves, and during periods of dry weather when other food sources may be less available.

The incidence of reported rabies in raccoons and other wildlife has increased dramatically over the past 30 years. Raccoons have recently been identified as the major wildlife host of rabies in the United States, primarily due to increased prevalence in the eastern United States.

Legal Status

Raccoons are protected furbearers in most states, with seasons established for running, hunting, or trapping. Most states, however, have provisions for landowners to control furbearers that are damaging their property. Check with your state wildlife agency before using any lethal controls.

Fig. 4. Electric fencing can be very effective at excluding raccoons from sweet corn or other crops. Two wires are recommended, but one wire 6 inches above the ground may be sufficient. Electric fence chargers are available at farm supply dealers. The fence can be activated at dusk and turned off after daybreak.

Damage Prevention and Control Methods

Exclusion

Exclusion, if feasible, is usually the best method of coping with raccoon damage.

Poultry damage generally can be prevented by excluding the raccoons with tightly covered doors and windows on buildings or mesh-wire fences with an overhang surrounding poultry yards. Raccoons are excellent climbers and are capable of gaining access by climbing conventional fences or by using overhanging limbs to bypass the fence. A "hot wire" from an electric fence charger at the top of the fence will greatly increase the effectiveness of a fence for excluding raccoons.

Damage to sweet corn or watermelons can most effectively be stopped by excluding raccoons with a single or double hot-wire arrangement (Fig. 4). The fence should be turned on in the evening before dusk, and turned off after daybreak. Electric fences should be used with care and appropriate caution signs installed. Wrapping filament tape around ripening ears of corn (Fig. 5) or placing plastic bags over the ears is an effective method of reducing raccoon damage to sweet corn. In general, tape or fencing is more effective than bagging. When using tape, it is important to apply the type with glass-yarn filaments embedded within so that the

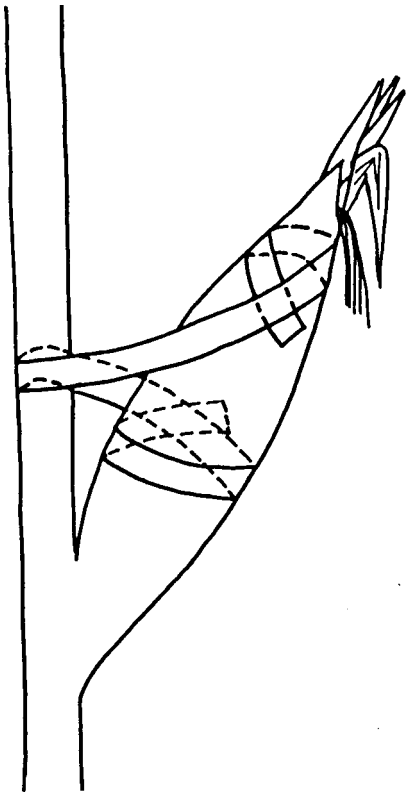

Fig. 5. Wrapping a ripening ear of sweet corn with reinforced filament tape as shown can reduce raccoon damage by 70% to 80%. It is important that each loop of the tape be wrapped over itself so that it forms a closed loop that cannot be ripped open by the raccoon.

raccoons cannot tear through the tape. Taping is more labor-intensive than fencing, but may be more practical and acceptable for small backyard gardens.

Store garbage in metal or tough plastic containers with tight-fitting lids to discourage raccoons from raiding garbage cans. If lids do not fit tightly, it may be necessary to wire, weight, or clamp them down to prevent raccoons from lifting the lid to get at garbage. Secure cans to a rack or tie them to a support to prevent raccoons from tipping them over.

Prevent raccoon access to chimneys by securely fastening a commercial cap of sheet metal and heavy screen over the top of the chimney (Fig. 6). Raccoon access to rooftops can be limited by removing overhanging branches and by wrapping and nailing sheets of slick metal at least 3 feet (90 cm) square around corners of buildings. This prevents raccoons from being able to get a toehold for climbing (Fig. 7). While this method may be practical for outbuildings, it is unsightly and generally unacceptable for homes. It is more practical to cover chimneys or other areas attracting raccoons to the rooftop or to remove the offending individual animals than to completely exclude them from the roof.

Homeowners attempting to exclude or remove raccoons in the spring and summer should be aware of the possibility that young may also be present. Do not complete exclusion procedures until you are certain that all raccoons have been removed from or have left the exclusion area. Raccoons frequently will use uncapped chimneys as natal den sites, raising the young on the smoke shelf or the top of the fireplace box until weaning. Homeowners with the patience to wait out several weeks of scratching, rustling, and chirring sounds will normally be rewarded by the mother raccoon moving the young from the chimney at the time she begins to wean them. Homeowners with less patience can often contact a pest removal or chimney sweep service to physically remove the raccoons. In either case, raccoon exclusion procedures should be completed immediately after the animals have left or been removed.

Habitat Modification

There are no practical means of modifying habitat to reduce raccoon depredations, other than removing any obvious sources of food or shelter which may be attracting the raccoons to the premises. Raccoons forage over wide areas, and anything other than local habitat modification to reduce raccoon numbers is not a desirable technique for reducing damage.

Raccoons sometimes will roll up freshly laid sod in search of worms or grubs. If sodded areas are not extensive, it may be possible to pin the rolls

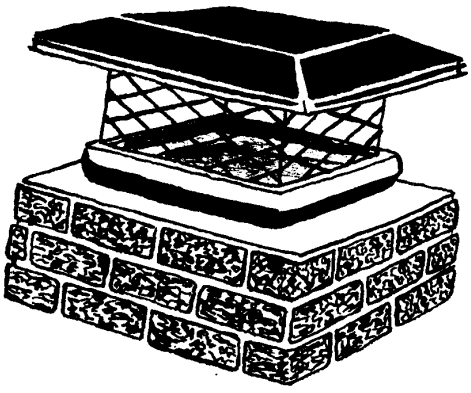

Fig. 6. A cap or exclusion device will keep raccoons and other animals out of chimneys. These are available commercially and should be made of heavy material. Tightly clamp or fasten them to chimneys to prevent raccoons from pulling or tearing them off.

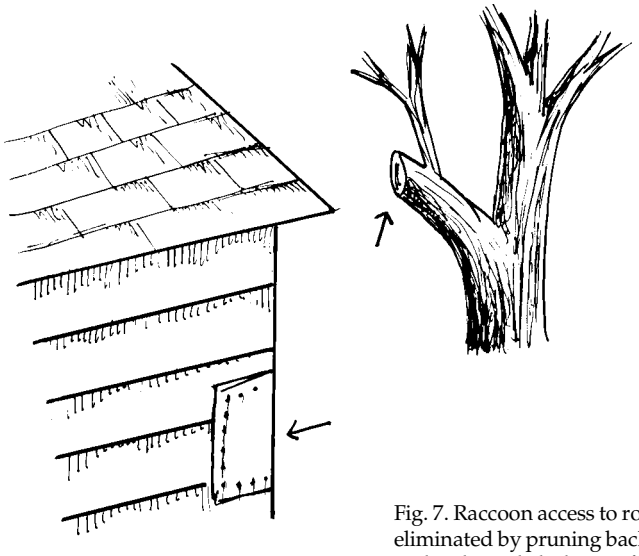

Fig. 7. Raccoon access to rooftops can be eliminated by pruning back overhanging limbs and tacking slick sheets of metal at least 3 feet square around corners of buildings.

down with long wire pins, wooden stakes, or nylon netting until the grass can take root, especially if the damage is restricted to only a portion of the yard, such as a shaded area where the grass is slower to take root. In more rural areas, use of electric fences may be effective (see section on exclusion). Because the sod-turning behavior is most prevalent in mid- to late summer when family groups of raccoons are learning to forage, homeowners may be able to avoid problems by having the sod installed in spring or early summer. In most cases, however, removal of the problem raccoons is usually necessary.

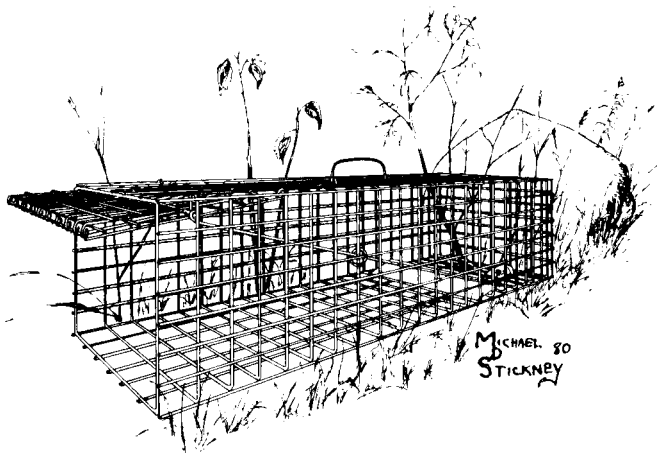

Fig. 8. A cage-type live trap, although bulky and expensive, is often the best choice for removing raccoons near houses or buildings where there is a likelihood of capturing dogs or cats.

Frightening

Although several techniques have been used to frighten away raccoons, particularly in sweet corn patches, none has been proven to be effective over a long period of time. These techniques have included the use of lights, radios, dogs, scarecrows, plastic or cloth streamers, aluminum pie pans, tin can lids, and plastic windmills. All of these may have some temporary effectiveness in deterring raccoons, but none will provide adequate long-term protection in most situations.

Repellents, Toxicants, and Fumigants

There are no repellents, toxicants, or fumigants currently registered for raccoon control.

Trapping

Raccoons are relatively easy to catch in traps, but it takes a sturdy trap to hold one. For homeowners with pets, a live or cage-type trap (Fig. 8) is usually the preferable alternative to a leghold trap. Traps should be at least 10 x 12 x 32 inches (25.4 x 30.5 x 81.3 cm) and well-constructed with heavy materials. They can be baited with canned fish-flavored cat food, sardines, fish, or chicken. Place a pile of bait behind the treadle and scatter a few small bits of bait outside the opening of the trap and just inside the entrance. Traps with a single door should be placed with the back against a wall, tree, or other object. The back portion of the trap should be tightly screened with one-half inch (1.3 cm) or smaller mesh wire to prevent raccoons from reaching through the wire to pull out the bait.

Conibear®-type body-gripping traps are effective for raccoons and can be used in natural or artificial cubbies or boxes. Because these traps do not allow for selective release of nontarget catches, they should not be used in areas where risk of nontarget capture is high. Box or leghold traps should be used in those situations instead. It is possible, however, to use body-gripping traps in boxes or on leaning poles so that they are inaccessible to dogs (Figs. 9 and 10). Check local state laws for restrictions regarding use of Conibear®-type traps out of water.

Raccoons also can be captured in foothold traps. Use a No. 1 or No. 1 1/2 coilspring or stoploss trap fastened to a drag such as a tree limb 6 to 8 feet (1.8 to 2.4 m) long. For water sets, use a drowning wire that leads to deep water. The D-P trap and Egg trap are new foot-holding devices that are highly selective, dog-proof, and show promise for reducing trap-related injury. They are available from trapping supply outlets.

The "pocket set" is very effective for raccoons, and is made along the water's edge where at least a slight bank is present (Fig. 11). Dig a hole

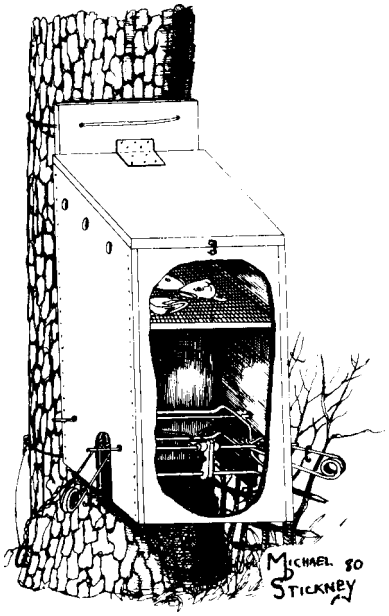

Fig. 9. A "raccoon box" is suspended 6 inches above the ground and is equipped with a Conibear®-type trap. Suspended at this level, this set is dog-proof.

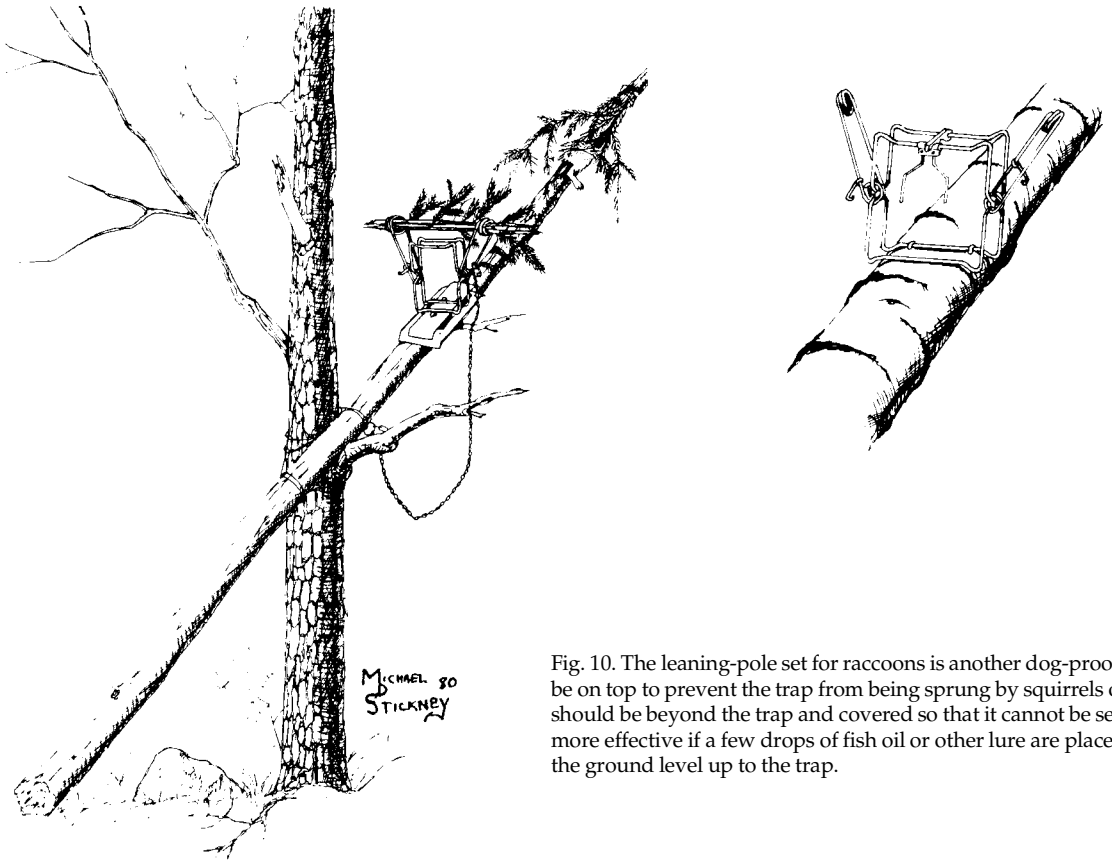

Fig. 10. The leaning-pole set for raccoons is another dog-proof set. The trigger should be on top to prevent the trap from being sprung by squirrels or chipmunks. Bait should be beyond the trap and covered so that it cannot be seen by birds. The set is more effective if a few drops of fish oil or other lure are placed along the pole from the ground level up to the trap.

3 to 6 inches (7.6 to 15.2 cm) in diameter horizontally back into the bank at least 10 to 12 inches (25.4 to 30.5 cm). The bottom 2 inches (5.1 cm) of the hole should be below the water level. Place a bait or lure (fish, frog, anise oil, honey) in the back of the hole, above the water level. Set the trap (a No. 1 or 1 1/2 coilspring, doublejaw or stoploss is recommended) below the water level in front of or just inside the opening. The trap should be tied to a movable drag or attached with a one-way slide to a drowning wire leading to deep water.

Dirt-hole sets (Fig. 12) are effective for raccoons. Place a bait or lure in a small hole and conceal the trap under a light covering of soil in front of the hole. A No. 1 or 1 1/2 coilspring trap is recommended for this set. It is important to use a small piece of clean cloth, light plastic, or a wad of dry grass to

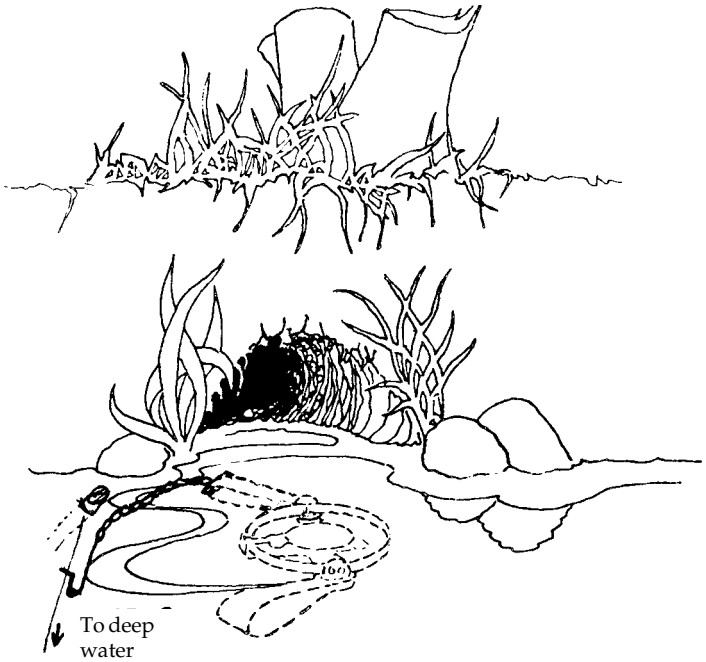

Fig. 11. The pocket set is very effective for raccoons and mink. Place a bait in the back of the hole above the water level and attach the trap to a one-way slide on a drowning wire leading to deep water, or to a movable drag such as a large rock or a section of tree limb 5 to 6 feet long and 3 to 5 inches in diameter.

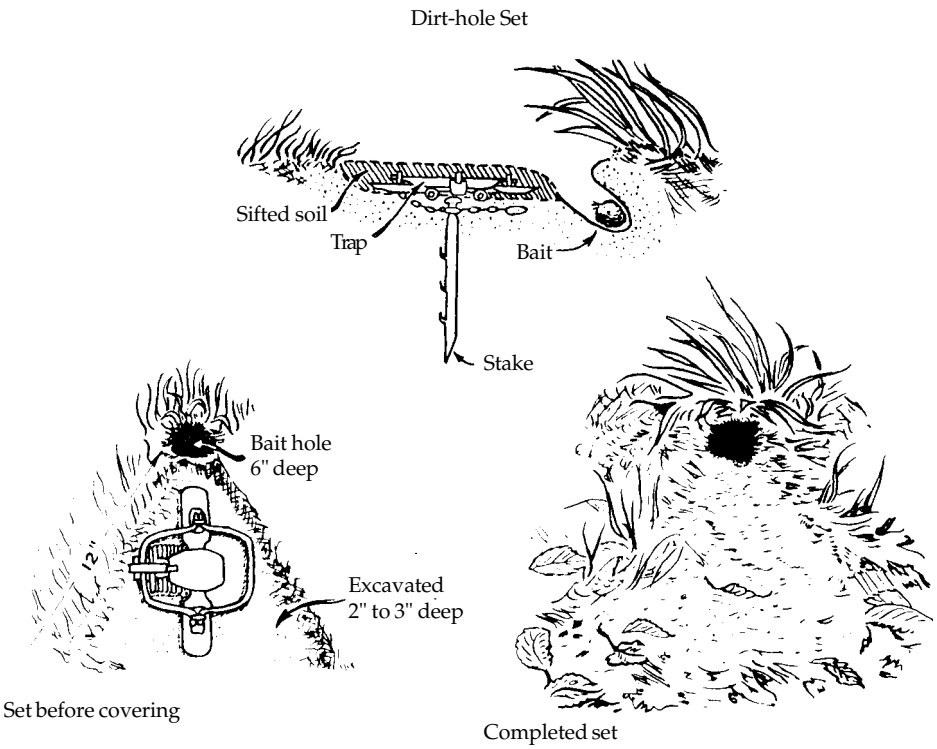

Fig. 12. The dirt-hole set is effective for all species of terrestrial furbearers, including raccoons. The bait is placed in the hole and should be lightly covered with soil so that it is not visible.

prevent soil from getting under the round pan of the trap and keeping it from going down. If this precaution is not taken, the trap may not go off.

Shooting

Raccoons are seldom seen during the day because of their nocturnal habits. Shooting raccoons can be effective at night with proper lighting. Trained dogs can be used to tree the raccoons first. A .22-caliber rifle will effectively kill treed raccoons.

Many states have restrictions on the use of artificial light to spot and shoot raccoons at night, and shooting is prohibited in most towns and cities. It is advisable to check with state and local authorities before using any lethal controls for raccoons.

Economics of Damage and Control

Statistics are unavailable on the amount of economic damage caused by raccoons, but the damage may be offset by their positive economic and aesthetic values. In 1982 to 1983, raccoons were by far the most valuable furbearer to hunters and trappers in the United States; an estimated 4.8 million raccoons worth $88 million were harvested. Raccoons also provide recreation for hunters, trappers, and people who enjoy watching them. Although raccoon damage and nuisance problems can be locally severe, widespread raccoon control programs are not justifiable, except perhaps to prevent the spread of raccoon rabies. From a cost-benefit and ecological standpoint, prevention practices and specific control of problem individuals or localized populations are the most desirable alternatives.

Acknowledgments

Although information for this section came from a variety of sources, I am particularly indebted to Eric Fritzell of the University of Missouri, who provided a great deal of recently published and unpublished information on raccoons in the central United States. Information on damage identification was adapted from Dolbeer et al. 1994.

Figures 1 through 3 from Schwartz and Schwartz (1981).

Figures 4, 6, and 7 by Jill Sack Johnson.

Figure 5 from Conover (1987).

Figures 8, 9, and 10 by Michael D. Stickney, from the New York Department of Environmental Conservation publication *Trapping Furbearers, Student Manual* (1980), by R. Howard, L. Berchielli, G. Parsons, and M. Brown. The figures are copyrighted and are used with permission.

Figure 11 by J. Tom Parker, from *Trapping Furbearers: Managing and Using a Renewable Natural Resource*, a Cornell University publication by R. Howard and J. Kelly (1976). Used with permission.

Figure 12 adapted from *Controlling Problem Red Fox* by F. R. Henderson (1973), Cooperative Extension Service, Kansas State University, Manhattan.

For Additional Information

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Tree Squirrels

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TREE SQUIRRELS

Fig. 1. Fox squirrel, *Sciurus niger*

Damage Prevention and Control Methods

Exclusion

Install sheet metal bands on isolated trees to prevent damage to developing nuts.

Close external openings to buildings to stop damage to building interiors.

Place an 18-inch (46-cm) section of 4-inch (10-cm) diameter plastic pipe or a one-way door over openings to allow squirrels to leave and prevent them from returning.

Plastic tubes on wires may prevent access to buildings.

Cultural Methods

Remove selected trees or their branches to prevent access to structures.

Repellents

Naphthalene (moth balls), Ro-pel, capsaicin, and polybutenes are registered for controlling tree squirrels.

Toxicants

None are registered.

Fumigants

None are registered.

Trapping

Leghold traps.

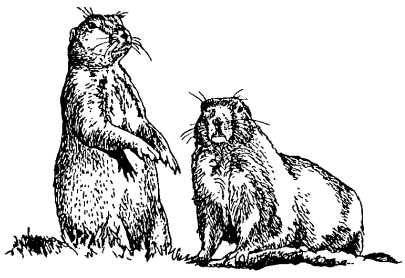
Box and cage traps.

Rat snap traps.

Box choker traps.

Shooting

Effective where firearms are permitted. Use a shotgun with No. 6 shot or a .22-caliber rifle.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

Identification

In this chapter tree squirrels are divided into three groups: large tree squirrels, pine squirrels, and flying squirrels. Large tree squirrels include fox (*Sciurus niger*), eastern gray (*Sciurus carolinensis*), western gray (*Sciurus griseus*), and tassel-eared (*Sciurus aberti*) squirrels.

Fox squirrels (Fig. 1) measure 18 to 27 inches (46 to 69 cm) from nose to tip of tail. They weigh about 1 3/4 pounds (787 g) to 2 1/4 pounds (1,012 g). Color varies greatly, from all black in Florida to silver gray with a white belly in Maryland. Georgia fox squirrels usually have a black face. Ohio and Michigan fox squirrels are grizzled gray-brown above with an orange underside. Sometimes several color variations occur in a single population.

Eastern gray squirrels are also variable in color. Some have a distinct reddish cast to their gray coat. Black ones are common in some northern parts of their range. Eastern gray squirrels measure 16 to 20 inches (41 to 51 cm). They weigh from 1 1/4 pounds (567 g) to 1 3/4 pounds (794 g).

The western gray squirrel is gray above with sharply distinct white underparts. Size is similar to that of the eastern gray squirrel.

Tassel-eared squirrels are similar in size to gray squirrels and have several color phases. The most common is gray above with a broad reddish band down the back. Black tufted ears are their most distinguishing characteristic (the tufts are larger in winter, about 1 inch [2.5 cm]).

There are two species of pine squirrels: the red squirrel (*Tamiasciurus hudsonicus*) and Douglas pine squirrel (*Tamiasciurus douglasii*). Pine squirrels are 10 to 15 inches (25 to 38 cm) in total length and weigh 1/3 to 2/3 pounds (151 to 303 g). Red squirrels are red-brown above with white underparts. Douglas squirrels are gray-brown above with yellowish underparts. Both species have small ear tufts and often have a black stripe separating the dark upper color from the light belly.

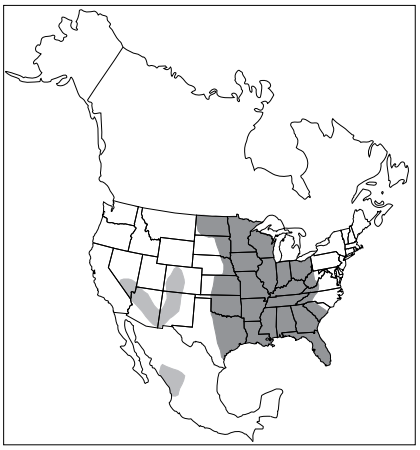


Fig. 2. Range of the fox squirrel (dark) and tassel-eared squirrel (light) in North America.

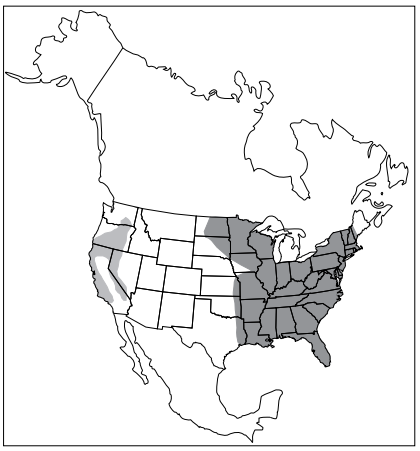


Fig. 3. Range of the eastern gray squirrel (dark) and western gray squirrel (light) in North America.

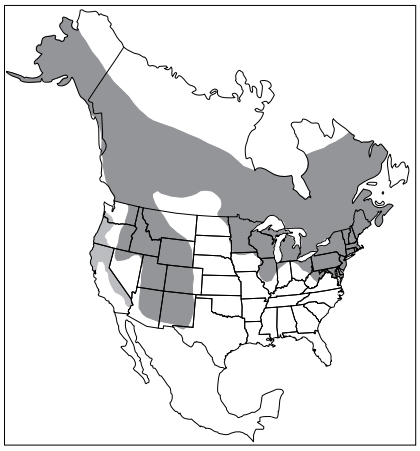


Fig. 4. Range of the red squirrel (dark) and Douglas squirrel (light) in North America.

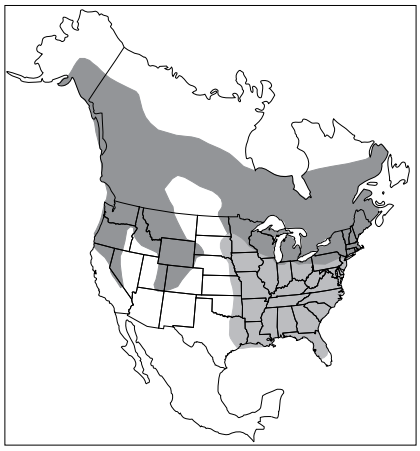


Fig. 5. Range of the northern flying squirrel (dark) and southern flying squirrel (light) in North America.

Two species of flying squirrels occur in North America. The southern flying squirrel (*Glaucomys volans*) is 8 to 10 inches (20 to 25 cm) long. The northern flying squirrel (*Glaucomys sabrinus*) averages 2 inches (5 cm) longer. It can be difficult to distinguish between the two; both may be various shades of gray or brown above and lighter below. A sharp line of demarcation separates the darker upper color from the lighter belly. The most distinctive characteristics of flying squirrels are the broad webs of skin connecting the fore and hind legs at the wrists, and the distinctly flattened tail.

Range

Fox squirrels occur in much of the eastern and central United States, as well as in several locations in the West, where they have been introduced (Fig. 2).

Eastern gray squirrels have a similar range to that of fox squirrels but do not occur in many western areas of the fox squirrel's range. They have been introduced in several locations in the West (Fig. 3).

Western gray squirrels are confined to west coast states and a small portion of western Nevada (Fig. 3).

Pine squirrels occur across northern North America south into the Appalachians and Rockies, and on the west coast.

Red squirrels are often associated with coniferous forests. The Douglas squirrel is restricted to the west coast from southwestern British Columbia south through the Sierras to northern Baja California (Fig. 4).

The tassel-eared squirrel is restricted to Ponderosa pine forests in the Southwest, usually at altitudes above 5,000 feet (1,500 m). It occurs in portions of Wyoming, Colorado, New Mexico, Arizona, and Utah (Fig. 2).

The northern flying squirrel occurs across northern North America. Its range extends south into the Appalachians and Rockies. The southern flying squirrel occurs in the central and eastern United States (Fig. 5).

Habitat

Fox squirrels and gray squirrels inhabit the same kinds of forests, both hardwood and coniferous, over much of their range. Gray squirrels are more abundant where a high percentage of land is forested. In areas with 10% forest cover, fox and gray squirrel populations may be equal. Fox squirrels prefer oak-hickory habitat over much of their range, especially in the West. In Georgia and Florida, fox squirrels seem to prefer pine timber. The western gray squirrel prefers mixed hardwoods and conifers and dry open hardwoods. Tassel-eared squirrels are strongly associated with Ponderosa pine. Pine squirrels prefer coniferous forests but also occur in mixed conifer and hardwood forests, or sometimes in hardwood habitats.

Food Habits

Fox and gray squirrels have similar food habits. They will eat a great variety of native foods and adapt quickly to unusual food sources. Typically, they feed on mast (wild tree fruits and nuts) in fall and early winter. Acorns, hickory nuts, walnuts, and osage orange fruits are favorite fall foods. Nuts are often cached for later use. In late winter and early spring they prefer tree buds. In summer they eat fruits, berries, and succulent plant materials. Fungi, corn, and cultivated fruits are taken when available. During population peaks, when food is scarce, these squirrels may chew bark from a variety of trees. They will also eat insects and other animal matter.

Pine squirrels are often heavily dependent on coniferous forests for cones and buds but will also eat a variety of other foods common to gray and fox squirrel diets. Douglas squirrels depend largely on Ponderosa pine for food. Flying squirrels' food habits are generally similar to those of other squirrels. However, they are the most carnivorous of all tree squirrels. They eat bird eggs and nestlings, insects, and other animal matter when available. Flying squirrels often occupy bird houses, especially bluebird houses.

General Biology, Reproduction, and Behavior

Fox and gray squirrels breed when they are 1 year old. They breed in mid-December or early January and again in June. Young squirrels may breed only once in their first year. The gestation period is 42 to 45 days.

During the breeding season, noisy mating chases take place when one or more males pursue a female through the trees.

They nest in tree cavities, human-made squirrel boxes, or in leaf nests. Leaf nests are constructed with a frame of sticks filled with dry leaves and lined with leaves, strips of bark, corn husks, or other materials. Survival of young in cavities is higher than in leaf nests. Cavities are the preferred nest sites.

About 3 young comprise a litter. At birth they are hairless, blind, and their ears are closed. Newborns weigh about 1/2 ounce (14 g) at birth and 3 to 4 ounces (84 to 112 g) at 5 weeks. Young begin to explore outside the nest about the time they are weaned at 10 to 12 weeks. At weaning they are about half of their adult weight.

Home range size depends on the season and availability of food. It may vary from 1 to 100 acres (0.4 to 40 ha). Squirrels move within their range according to availability of food. They often seek mast-bearing forests in fall and favor tender buds in elm and maple forests in the spring.

During fall, squirrels may travel 50 miles (80 km) or more in search of better habitat. Squirrel populations periodically rise and fall. During periods of high populations, squirrels—especially gray squirrels—may go on mass emigrations. At such times many animals die.

Fox and gray squirrels are vulnerable to numerous parasites and diseases. Ticks, mange mites, fleas, and internal parasites are common. Squirrel hunters often notice bot fly larvae (called "wolves" or "warbles") protruding from the skin. These fly larvae do not impair the quality of the meat for eating.

Squirrels are a food source for hawks, owls, snakes, and several mammalian predators. Predation seems to have little effect on squirrel populations.

Typically about half the squirrels in a population die each year. In the wild, squirrels over 4 years old are rare, while in captivity individuals may live 10 years or more.

The biology of other North American squirrels has much in common with that of fox and gray squirrels, although most other species have one breeding season per year. Flying squirrels are unique in that they are active at night. All other species are active during the day.

Damage

Squirrels may occasionally damage forest trees by chewing bark from branches and trunks. Pine squirrels damage Ponderosa pine, jack pine, and paper birch. In the Southeast, fox squirrels damage loblolly and other pines.

These species and others may eat cones and nip twigs to the extent that they interfere with natural reseeding of important forest trees. This is a particular problem in Ponderosa pine forests where pine squirrels may remove 60% to 80% of the cones in poor to fair seed years. In forest seed orchards, such squirrel damage interferes with commercial seed production.

In nut orchards, squirrels can severely curtail production by eating nuts prematurely and by carrying off mature nuts. In New England fruit orchards, pine squirrels may eat ovaries of cherry blossoms and destroy ripe pears. Pine, gray, and fox squirrels may chew bark of various orchard trees.

In residential areas, squirrels sometimes travel powerlines and short out transformers. They gnaw on wires, enter buildings, and build nests in attics. They frequently chew holes through pipelines used in maple syrup production.

Squirrels occasionally damage lawns by burying or searching for and digging up nuts. They will chew bark and clip twigs on ornamental trees or shrubbery planted in yards. Often squirrels take food at feeders intended for birds. Sometimes they chew to enlarge openings of bird houses and then enter to eat nestling songbirds. Flying squirrels are small enough to enter most bird houses and are especially likely to eat nesting birds.

In gardens, squirrels may eat planted seeds, mature fruits, or grains such as corn.

Legal Status

Fox and gray squirrels are usually classified as game animals in states where they occur. The tassel-eared squirrel is normally a protected species. Check with local or state authorities to determine legal status of squirrels in your area.

Damage Prevention and Control Methods

Exclusion

Prevent squirrels from climbing isolated trees and power poles by encircling them with a 2-foot-wide (61-cm) collar of metal 6 feet (1.8 m) off the ground. Attach metal using encircling wires held together with springs to allow for tree growth.

Prevent squirrels from traveling on wires by installing 2-foot (61-cm) sections of lightweight 2- to 3-inch diameter (5.1- to 7.6-cm) plastic pipe. Slit the pipe lengthwise, spread it open, and place it over the wire. The pipe will rotate on the wire and cause traveling squirrels to tumble.

Close openings to attics and other parts of buildings but make sure not to lock squirrels inside. They may cause a great deal of damage in their efforts to chew out. Place traps inside as a precaution after openings are closed. A squirrel excluder can be improvised by mounting an 18-inch (46-cm) section of 4-inch (10-cm) plastic pipe over an opening. The pipe should point down at a 45º angle. A one-way door can also be used over an opening to let squirrels out and prevent them from returning.

Close openings to buildings with heavy 1/2-inch (1.3-cm) wire mesh or make other suitable repairs.

Custom-designed wire mesh fences topped with electrified wires may effectively keep out squirrels out of gardens or small orchards.

Habitat Modification

Trim limbs and trees to 6 to 8 feet (1.8 to 2.4 m) away from buildings to prevent squirrels from jumping onto roofs.

In backyards where squirrels are causing problems at bird feeders, consider providing an alternative food source. Wire or nail an ear of corn to a tree or wooden fence post away from where the squirrels are causing problems.

In high-value crop situations, it may pay to remove woods or other trees near orchards to block the "squirrel highway."

Repellents

Naphthalene (moth balls) may temporarily discourage squirrels from entering attics and other enclosed spaces. Use of naphthalene in attics of occupied buildings is not recommended, however, because it can cause severe distress to people. Supplement this method with lights. A cat in the attic may discourage squirrels.

Ro-pel is a taste repellent that can be applied to seeds, bulbs, and flowers; trees and shrubs; poles and fences; siding and outdoor furniture. Capsaicin is also a taste repellent, registered for use on maple sap collecting equipment.

Polybutenes are sticky materials that can be applied to buildings, railings, downspouts, and other areas to keep squirrels from climbing. They can be messy. A preapplication of masking tape is recommended.

Toxicants

None are registered.

Fumigants

None are registered.

Trapping

A variety of traps will catch squirrels, including No. 0 or No. 1 leghold traps, the "Better Squirrel and Rat Trap," box traps, and cage traps. Regular rat-sized snap traps will catch flying squirrels and small pine squirrels. Glue traps for rats will catch small squirrels.

Since squirrels are classified as game species in most states, trapping permits may be required from your local state wildlife agency or municipal Animal Control office. Wire cage traps and box traps can be used to capture squirrels alive. Tie trap doors open for 2 to 3 days to get squirrels accustomed to feeding in the traps. Then set the traps and check them twice daily. Inform your neighbors of your trapping activities. Translocation of tree squirrels is a questionable practice because of the stress placed on transported and resident squirrels and concerns regarding the transmission of diseases.

Good baits are slices of orange and apple, walnuts or pecans removed from the shell, and peanut butter. Other foods familiar to the squirrel may also work well, such as corn or sunflower seeds.

Shooting

Where firearms are permitted, shooting is effective. A shotgun with No. 6 shot or a .22-caliber rifle is suitable. Check with your state wildlife agency for regulations pertaining to the species in your area.

Other Methods

Often several control methods used simultaneously are more successful than a single method. For example, to remove a squirrel from an attic, watch squirrels to determine where they enter. Then use repellents and lights to drive them out. After squirrels appear to have left the building, use appropriate exclusion methods to keep them out. One or more baited traps will catch squirrels that are accidentally closed in. This last step is very important because locked-in squirrels may cause damage when they try to chew their way out.

Squirrel damage in yards, gardens, forests, and orchards is often very difficult to control. During population highs, new squirrels arrive quickly to replace those shot or trapped.

Economics of Damage and Control

Squirrels cause economic losses to homeowners, nut growers, and forest managers. The extent of these losses is not well known.

Squirrels caused 177 power outages in Lincoln, Nebraska, in 1980, which was 24% of all outages. Estimated annual costs were $23,364 for repairs, public relations, and lost revenue. In Omaha, in 1985, squirrels caused 332 outages costing at least $47,144. After squirrel guards were installed over pole-mounted transformers in Lincoln in 1985, annual costs were reduced 78% to $5,148.

Acknowledgments

References by Boggess (1980) and Flyger and Gates (1982a,b) were particularly useful in preparing this publication. The manuscript was read and improved by the comments of Elizabeth McGhee.

Figure 1 from Schwartz and Schwartz (1981).

Figures 2 through 4 adapted from Flyger and Gates (1982a,b) by Jill Sack Johnson.

Figure 5 adapted from Burt and Grossenheider (1976) by David Thornhill.

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Great Trinity Forest Management Plan

Wildlife Management

Prevention and Control of Wildlife Damage:

Feral Pig

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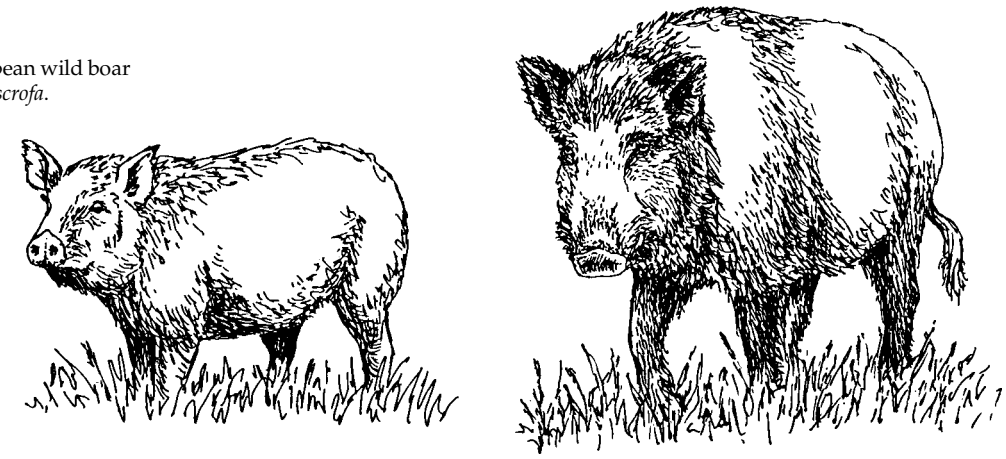
WILD PIGS

Fig. 1. Feral hog (left) and European wild boar (right). Both are the species *Sus scrofa*.



Damage Prevention and Control Methods

Exclusion

Heavy-mesh wire fences and electric fences may be effective, especially around gardens and other small areas.

Frightening

No methods are effective.

Repellents

None are registered.

Toxicants

None are registered.

Trapping

Stationary corral trap.

Portable drop gate trap.

Leg snare.

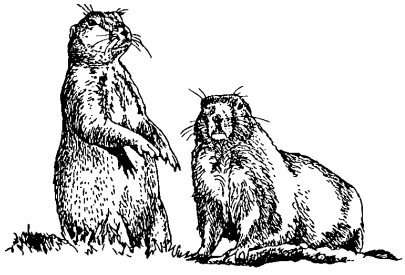
Shooting

Sport hunting, especially with dogs, can reduce pig populations in local areas.

Identification

Wild pigs (*Sus scrofa*, Fig. 1) include both feral hogs (domestic swine that have escaped captivity) and wild boar, native to Eurasia but introduced to North America to interbreed with feral hogs. Like domestic hogs, they may be any color. Their size and conformation depend on the breed, degree of hybridization with wild boar, and level of nutrition during their growing period.

Wild boar have longer legs and larger heads with longer snouts than feral



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

hogs. The color of young boar is generally reddish brown with black longitudinal "watermelon" stripes. As the young develop, the stripes begin to disappear and the red changes to brown and finally to black. Both the male feral hog and wild boar have continuously growing tusks. Wild boar and feral hogs hybridize freely; therefore, the term *wild pig* is appropriate as a generic term for these animals.

Range

Christopher Columbus first introduced members of the family Suidae into North America in 1493 in the West Indies (Towne and Wentworth 1950). The first documented introduction to the United States was in Florida by de Soto in 1593. More introductions followed in Georgia and the Carolinas, which established free-ranging populations in the Southeast. Free-ranging practices continued until they became illegal in the mid-twentieth century. Populations of unclaimed hogs increased and spread throughout the Southeast. Domestic hogs were released in California in 1769 and free-ranging practices there also resulted in a feral hog population. European wild boar were released at Hooper Bald, North Carolina, in 1912, and from there introduced to California in 1925.

Wild pigs are found throughout the southeastern United States from Texas east to Florida and north to Virginia; and in California, Hawaii, Puerto Rico, and the Virgin Islands. The local introduction of these animals for hunting purposes occurred in North Carolina, Tennessee, Texas, Louisiana, and California. The National Park Service reports feral hogs in 13 National Park Service areas. They occur in many state parks as well (Mayer and Brisbin 1991). Feral hogs are also found in Hawaii, Australia, New Zealand, and several other South Pacific Islands.

Habitat

A variety of habitats, from tidal marshes to mountain ranges, are suitable for wild pigs. They prefer cover of dense brush or marsh vegetation. They are generally restricted to areas below snowline and above freezing temperatures during the winter. Wild pigs frequent livestock-producing areas. They prefer mast-producing hardwood forests but will frequent conifer forests as well. In remote areas or where human activities are minimal, they may use open range or pastures, particularly at night. During periods of hot weather, wild pigs spend a good deal of time wallowing in ponds, springs, or streams, usually in or adjacent to cover.

Food Habits

Types of food vary greatly depending on the location and time of year. Wild pigs will eat anything from grain to carrion. They may feed on underground vegetation during periods of wet weather or in areas near streams and underground springs. Acorns or other mast, when available, make up a good portion of their diet. Wild pigs gather in oak forests when acorns fall, and their movements will generally not be as great during this period. In the winters of poor mast years, wild pigs greatly increase their range and consume greater quantities of underground plant material, herbaceous plants, and invertebrates (Singer 1981). Stomach analyses indicate that wild hogs ingest flesh from vertebrates, but the extent to which animals are taken as prey or carrion is not known. Wild pigs are capable of preying on lambs (Pavlov et al. 1981), as well as goat kids, calves, and exotic game.

General Biology, Reproduction, and Behavior

Wild pigs are intelligent animals and readily adapt to changing conditions. They may modify their response to humans fairly rapidly if it benefits their survival. Wild boar have a greater capacity to invade colder and more mountainous terrain than do other wild pigs. Feral hogs feed during daylight hours or at night, but if hunting pressure becomes too great during the day, they will remain in heavy cover at that time and feed at night. In periods of hot weather, wild pigs remain in the shade in wallows during the day and feed at night.

The wild pig is the most prolific large wild mammal in North America. Given adequate nutrition, a wild pig population can double in just 4 months. Feral hogs may begin to breed before 6 months of age, if they have a high-quality diet. Sows can produce 2 litters per year and young may be born at any time of the year. Wild boar usually do not breed until 18 months of age and commonly have only 1 litter per year unless forage conditions are excellent. Like domestic animals, the litter size depends upon the sow's age, nutritional intake, and the time of year. Litter sizes of feral hogs in northern California average 5 to 6 per sow (Barrett 1978). Wild boar usually have litter sizes of 4 to 5 but may have as many as 13 (Pine and Gerdes 1973).

Damage and Damage Identification

Wild pigs can cause a variety of damage. The most common complaint is rooting (sometimes called grubbing), resulting in the destruction of crops and pastures. Damage to farm ponds and watering holes for livestock is another common problem. Predation on domestic stock and wildlife has been a lesser problem in North America.

Damage to crops and rangeland by wild pigs is easily identified. Rooting in wet or irrigated soil is generally quite visible, but can vary from an area of several hundred square feet (m^2) or more to only a few small spots where the ground has been turned over. Rooting destroys pasture, crops, and native plants, and can cause soil erosion. Wallows are easily seen around ponds and streams. Tracks of adult hogs resemble those made by a 200-pound (90-kg) calf. Where ground is soft, dewclaws will show on adult hog tracks (Fig. 2).

Wild pig depredation on certain forest tree seedlings has been a concern of

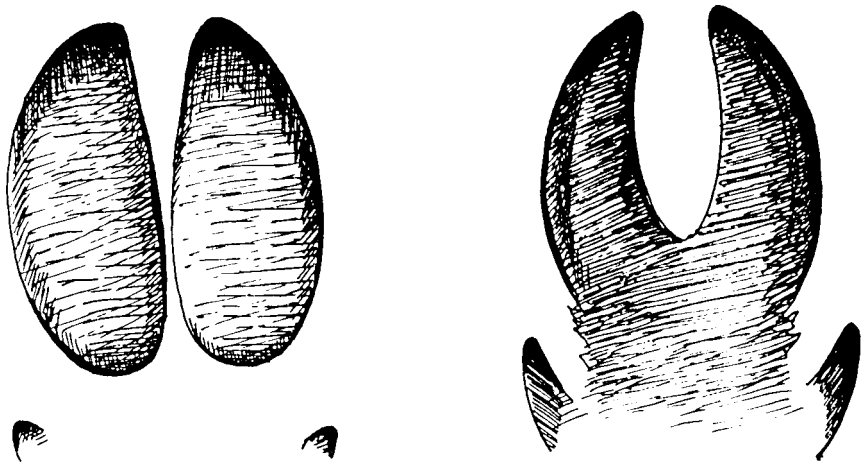


Fig. 2. Tracks of the feral hog (left) and European wild boar (right).

foresters in the South and West. Wild pigs have destroyed fragile plant communities in Great Smoky Mountains National Park and other preserves. They have been known to damage fences when going into gardens and can do considerable damage to a lawn or golf course in a single night.

In California, wild pigs have entered turkey pens, damaging feeders, eating the turkey feed, and allowing birds to escape through damaged fences. Wild pigs in New South Wales, Australia, reportedly killed and ate lambs on lambing grounds. Producers in Texas and California reported to USDA-APHIS-ADC that 1,473 sheep, goats, and exotic game animals were killed by wild pigs in 1991. Predation usually occurs on lambing or calving grounds, and some hogs become highly efficient predators. Depredation to calves and lambs can be difficult to identify because these small animals may be killed and completely consumed, leaving little or no evidence to determine whether they were killed or died of other causes and then were eaten. Determining predation by wild hogs is possible if carcasses are not entirely eaten, because feral hogs follow a characteristic feeding pattern on lambs (Pavlov and Hone 1982). Photographs and additional information on wild pig predation may be found in the booklet by Wade and Bowns (1982).

Always be aware of the potential for disease transmission when feral hogs are associated with domestic livestock. Cholera, swine brucellosis, trichinosis, bovine tuberculosis, foot and mouth disease, African swine fever, and pseudorabies are all diseases that may be transmitted to livestock (Wood and Barrett 1979). Bovine tuberculosis was transmitted to beef cattle by wild hogs on the Hearst Ranch in California in 1965. Pork that was infected with hog cholera brought into Kosrae Island in the East Carolinas resulted in the decimation of all domestic and feral hogs on the island.

Legal Status

Wild pigs are game mammals in California, Texas, Tennessee, North Carolina, Puerto Rico, Hawaii, and Florida (Wood and Barrett 1979, Mayer and Brisbin 1991). In California, a depredation permit is required from the Department of Fish and Game to conduct a control program or to take depredating animals. Contact your state wildlife agency to determine if a permit is required.

Damage Prevention and Control Methods

Exclusion

Fencing is generally not practical except in small areas around yards and gardens. Heavy wire and posts must be used, but if hogs are persistent, exclusion is almost impossible. Electric fencing on the outside of the mesh may be of some help, but it is difficult to maintain over large areas. Electric fencing has been used effectively in New South Wales, Australia. See the **Deer** chapter for details on electric fencing.

Frightening

No methods are effective.

Repellents

None are registered.

Toxicants

There are no toxicants currently registered for controlling wild pigs in the United States.

Trapping

Cage Traps. Trapping, especially where pig densities are high, is probably the most effective control method. Traps may not be effective, however, during fall and winter when acorns or other preferred natural foods are available. Hogs seem to prefer acorns over grain and other baits. Leg snares and hunting may be more productive control methods during fall and winter. Stationary corral-type traps and box traps have been used with success. The corral or stationary trap is permanent and should be constructed in locations where large populations of hogs are evident and where more than one hog can be trapped at a time (Fig. 3). Build the trap out of steel fence posts and 2 x 4-inch (5.1 x 10.2-cm) welded 12-gauge wire fencing. A gate frame can be made from 2 x 4-inch (5.1 x 10.2-cm) boards. Make doors from 3/4-inch (1.9-cm) plywood and mount them so that they open inward and close automatically with screen door springs. Heavier material may be used for the gate and frame in areas where exceptionally large hogs are to be trapped. Also, more steel fence posts may be needed to reinforce the wire fencing. The wire fencing should be put on the ground as well as at the top of the trap to prevent hogs from going under the sides or over the top. Fasten the sides to the top and bottom. One or two small hogs can be left inside the trap with adequate food and water to act as decoys.

2" x 4" x 24' wood
36" x 48" x 3/4" plywood
36' x 2" x 4" mesh welded wire
4 6" strap hinges
2 12" screen door springs
8 6" steel fence posts
4 lbs. 16-penny nails
1 lb. 12-penny nails
2 lbs. 1 1/2" staples
1 100' 12-gauge wire

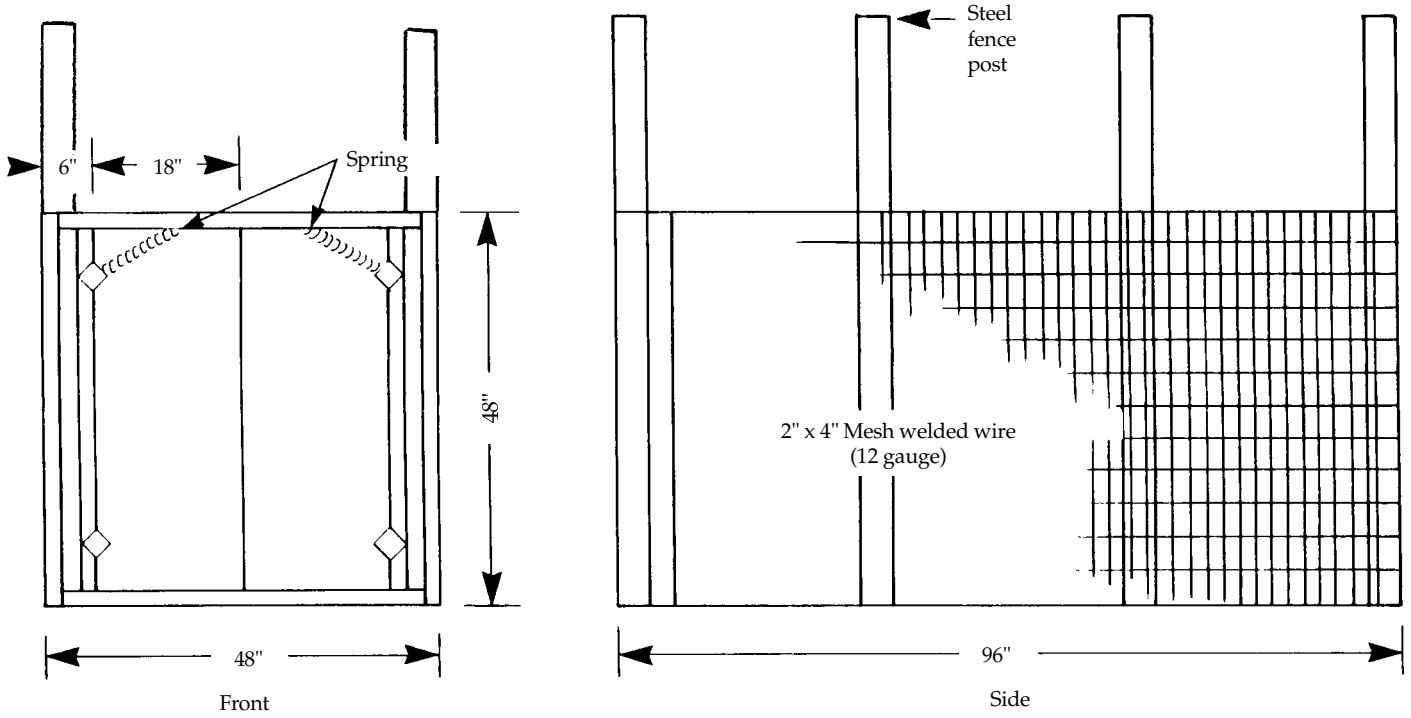


Fig. 3. Stationary hog trap.

A portable trap with a drop gate has been used very effectively and can be moved from one area to another (Fig. 4). It is especially effective where hogs occur intermittently. Build the trap out of 2 x 4-inch (5.1 x 10.2-cm) welded 12-gauge wire over a 2 x 4-inch (5.1 x 10.2-cm) wooden frame using a 3/4-inch (1.9-cm) plywood drop gate. Place loose barbed wire fencing around the outside of the trap to prevent livestock from entering and to protect both the traps and bait material. When traps are not in use make sure trap doors are locked shut to prevent the possibility of trapping livestock.

There are a number of different styles of live or cage traps. The two described here have been used effectively in California. As many as 14 hogs have been trapped during a night in one trap. It is important that the material used in the construction of these traps be strong and heavy enough to prevent escapes. Corral-type traps have captured up to 104 hogs in a single night and may have to be reinforced with extra fence posts and heavier fencing material.

Persistence and dedication are required if a feral hog control program is to be successful. Traps must be checked daily to be reset and to replace bait when needed. Many times control measures fail because operators fail to check their traps or provide bait in adequate amounts. Trapping hogs that are feeding on acorns may be difficult because they seem to prefer acorns to grain or other baits.

Traps should be checked from a distance when possible. If several large hogs are in a trap, the presence of a person or vehicle will frighten them and escapes can occur even out of well-built traps. A well-placed shot to the head from a large-caliber rifle will kill the hog instantly without greatly alarming other hogs in the trap. Shoot the largest hog first, if possible. When a trapping program is being conducted, all hunting in the area should cease, especially the use of dogs, as this may pressure the pigs to move to another area.

A prebaiting program should be conducted before a trapping program is initiated. Grains such as barley, corn, or oats make good attractants, as do vegetables or fruits, if a supply is available. If bait is accepted by hogs, replace it daily. Make sure enough bait is out to induce hogs to return the next day; if no feed is available, they may move on to other feeding areas. A place where hogs have gathered in the

8	2" x 4" x 6'
4	2" x 4" x 3'
6	2" x 4" x 2'
1	3/4" x 24" x 36" plywood
2	3' x 6' welded-wire fencing (12-gauge)
2	2' x 6' welded-wire fencing (12-gauge)
1	2' x 3' welded-wire fencing (12-gauge)
2	3" strap hinges
1	12" x 20" plywood
2	8' cable or nylon
2	1" x 1" steel pin
	16-penny nails

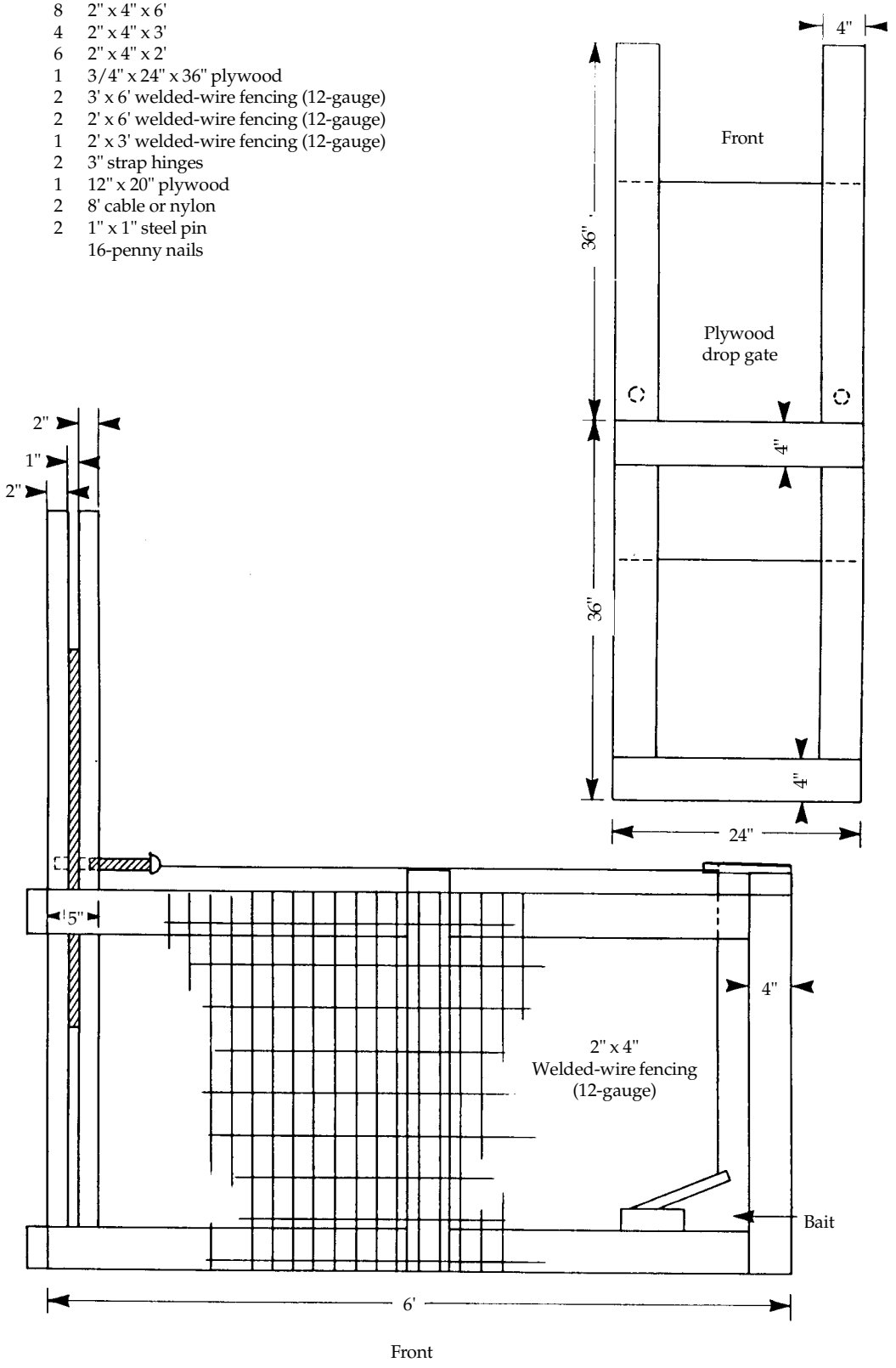


Fig. 4. Portable hog trap with drop gate

past and seem to frequent often, is probably a good place to build a corral-type trap. If only one or two hogs are attracted to the prebait, a portable trap should be installed.

If a swing gate corral trap is prebaited, prop the doors open so that hogs can move in and out. When it appears that the number of hogs that are accepting the bait has peaked, position the doors so that they will close after hogs enter the trap.

Steel Traps. Steel leghold traps are not recommended for pigs.

Leg Snares. Leg snares can be used with success where terrain prohibits the use of cage traps. Snares are not recommended if livestock, deer, or other nontarget animals are in the area. An ideal location for leg snares is at a fence where hogs are entering pens or on trails that hogs are traveling. Fasten the snare to a heavy drag, such as an oak limb, 6 to 12 feet (1.8 to 3.6 m) in length, or longer if large hogs are in the area. Make sure the size of the cable is heavy enough to hold a large hog.

Shooting

Sport hunting is used in certain areas to reduce wild pig densities and can be a source of revenue for ranchers. Success is highly dependent on local situations and terrain. Hunting is not recommended if there is a serious depredation or disease problem. Unsuccessful hunting will make wild pigs keep to cover and change their feeding habits. The use of dogs can increase hunter success. Good dogs chase pigs from cover where they can be shot by hunters.

Economics of Damage and Control

In most areas it is unlikely that wild pigs can be exterminated. It is theoretically possible, but the cost to do so is usually prohibitive. Landowners must generally accept the fact that they will always have some wild pigs and should therefore plan for a long-term control program.

Feral hog damage can be extensive and costly if not controlled. Control for disease suppression is extremely expensive because many hogs need to be eliminated. Crop depredations may cease after one or two hogs are shot or trapped, or intermittent hunting pressure is put on them. They simply move to new areas. If depredations are heavy enough to require a reduction in the overall population then a program can be very costly, depending on the size of the area involved.

Acknowledgments

Figures 1 and 2 by Emily Oseas Routman.

Figures 3 and 4 by Marilyn Murtos, US Bureau of Reclamation, Sacramento, California.

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Feral Hogs in Texas

Feral Hogs in Texas

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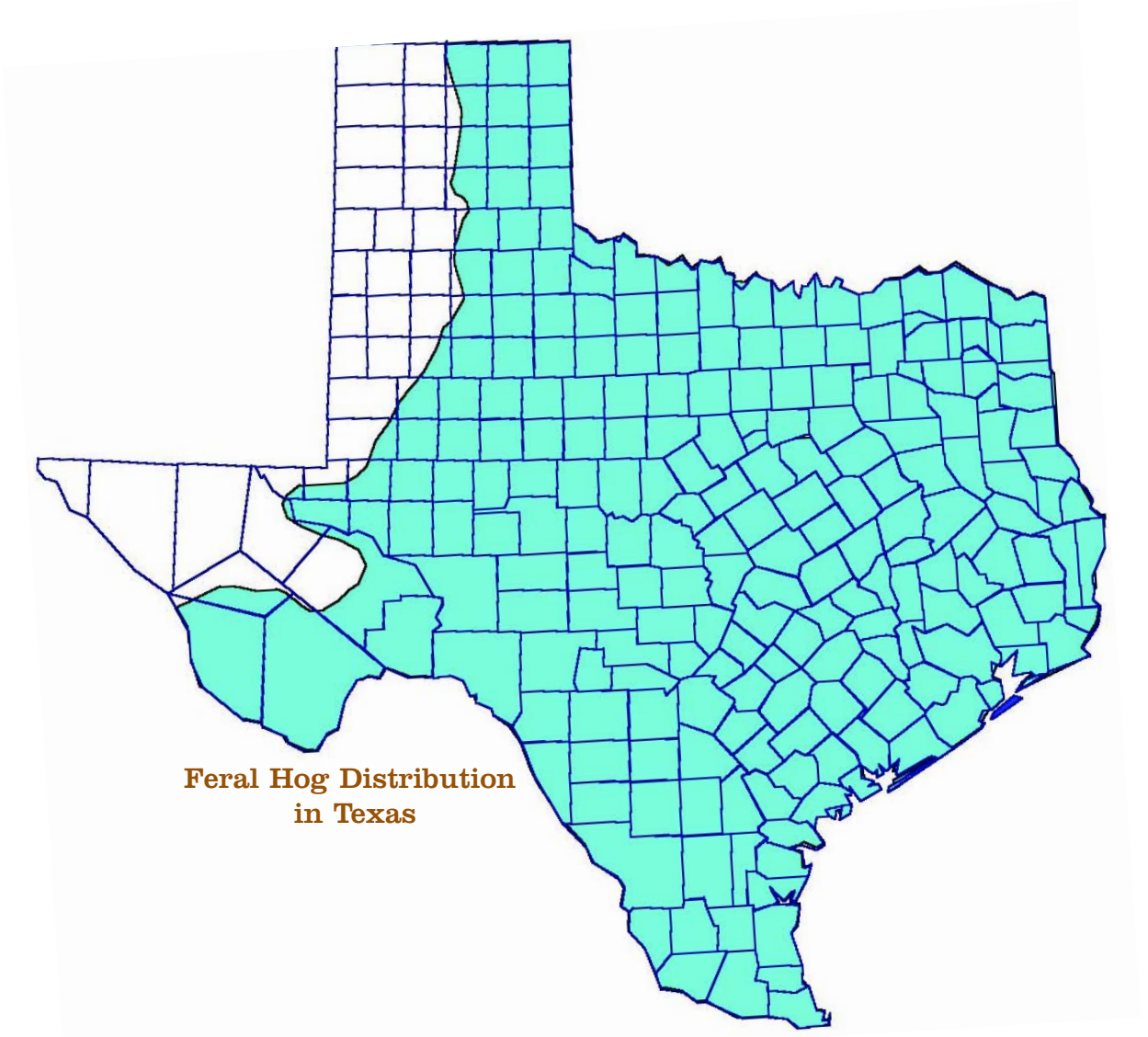
Contents

Introduction

Texas is home to an estimated 2 million feral hogs (*Sus scrofa*), about 50 percent of all the feral hogs in the U.S. From the panhandle to the Gulf coast, from the arid southwest to the eastern pineywoods, feral hogs may be found in nearly every Texas county.

The population and range of feral hogs have expanded dramatically because they are extremely adaptable animals with a high reproductive rate. Relocation by hunters, disease control in domestic animals, the management of rangelands, and habitat improvements made for livestock and wildlife also have helped feral hogs. Hogs are prized by hunters but despised by landowners who suffer from their damage.



Feral Hog Distribution in Texas

History

Hogs are an Old World species that has existed since before the Ice Age. Evidence indicates that early man hunted and ate feral swine and that these animals continued to thrive throughout the Stone Age in Europe and Asia. Hogs may have been domesticated about 7000 B.C. Explorers such as De Soto, Cortes and LaSalle brought them to the New World. They have been in Texas since the 1680s and were important livestock to the early settlers, who usually allowed their animals to roam free. When confronted by war and economic hard times, settlers often had to abandon their homesteads on short notice, leaving their animals to fend for themselves. Thus, many free-ranging domesticated hogs became feral over time.

Feral hogs have adapted to every region of the state and can be found in forests, swamps, brushy lands and deserts.

Identification

The three strains of wild hogs in Texas are the Eurasian, the feral (escaped or released domestic hogs), and hybrids of these two. Few, if any, pure Eurasian hogs remain. Coat color, pattern and bristle length can help identify the strain of feral hog.

The term “feral hogs” applies collectively to Eurasian wild boars (i.e., Russian boars), domesticated hogs that have become feral, and hybrids of these two. Feral hogs also have been called European wild hogs, wild boars, razorbacks, pineywoods rooters, woods hogs and other more "colorful" names. All these names refer to the same species of swine. However, it is important to note that the hog-like collared peccary, or javelina (*Tayassu tajacu*), a native species of the southwestern U.S., belongs to a different family and is not a feral hog.

Eurasian Wild Boars

Eurasian wild boars have longer legs, larger heads, longer snouts, and a larger head-to-body ratio than other feral hogs. They have shorter, straighter tails than feral hogs or hybrids. The coat usually consists of light brown to black bristles with cream to tan tips. The back of the head and part of the rostrum are covered with brown to black bristles with white tips. The underside is lighter in color (cream to smoky gray) and the legs, ears and tail are darker than the rest of the coat–usually dark brown or black bristles with no light-colored tips. Bristles of the pure Eurasian hog are the longest and thickest of all types and usually have multiple splits at the tips. Eurasians have no neck wattles or syndactylous (joined or webbed) digits, as have been found in the other types of wild swine.

The javalina, a native of the southwestern U.S., is often confused with the feral hog, although they are not closely related.

Texas ranchers and sportsmen released Eurasian wild boars for hunting in the 1930s. Many of these animals escaped and began breeding with feral hogs that were already free ranging. This led to the decline of the pure Eurasian strain; there are now few, if any, in Texas.

Feral Hogs

Feral hogs are domestic hogs that have escaped or been released into the wild. With each generation the animals' domestic characteristics diminish as they develop the traits necessary to survive in the wild.

Their original breed and their nutrition during development determine the size and color of feral hogs. Coat color and pattern are highly variable. Solid black is the predominate color, but hogs also may be brown, red, white, spotted, belted (black or brownish red with a white band across the shoulders and forelimbs) or have rare blue or gray roan patterns. Bristles of feral hogs are shorter than those of Eurasian boars and hybrids. Bristles are less thick than those of Eurasians but thicker than those of hybrids. Bristles are a solid color and split at the tips. The underfur and bristles are the same color Feral hogs may have neck wattles and syndactylous (webbed) digits.

Hybrids

Hybrid hogs are crosses between Eurasian boars and feral hogs and have characteristics of both. Coat color and pattern can resemble that of Eurasian boars, feral hogs, or any combination of the two. Bristles are shorter than in Eurasians but longer than in feral hogs, and not as thick as either of the other two. The bristles have split tips. The underfur varies from black to a whitish or smoky gray and may be a different color than the bristles. Hybrids may have neck wattles and syndactylous digits.

Biology and Ecology

Feral hogs are so adaptable to different environments, so adept at survival, and have such a high reproductive rate, that their population has exploded. This has made them significant pests in much of Texas.

Feral hog boars weigh an average of 130 pounds; sows average 110 pounds. However, much larger hogs have been documented. This hog weighed 465 pounds.

Characteristics

Overall, feral swine are smaller, leaner, and more muscular than their domestic counterparts. Average boar and sow weights are about 130 pounds and 110 pounds, respectively, although the largest adults may weigh more than 400 pounds and be more than 3 feet tall and 5 feet long. Males have larger heads and tusks than females. Compared to domestic swine, feral hogs have more well-developed shoulders, longer and larger snouts and tusks, smaller and mostly pricked ears, longer and coarser hair, and straighter tails (with a bushy tip).

Some feral hogs develop a mane or crest of hair on their necks and backs that can be raised when they are angered. This is the reason for the nickname "razorback." Juveniles of all types of wild swine may have striped patterns that disappear as the hogs mature. Longitudinal striping is rarely seen in domestic hogs.

Feral hogs have rounded body contours, short legs, and cloven-hoofs with four toes, two of which have been modified into large dewclaws. Males develop thick areas of tough skin, cartilage and scar tissue on their shoulders. This area, called the shield, develops continually as the hog ages and fights and may be up to 2 inches thick.

Juveniles of all types of wild swine may have stripes that disappear as they mature.

Feral hogs have poor eyesight but excellent hearing and sense of smell. Their flattened snouts allow them to root in the soil (left photo). Male feral hogs have four canine teeth, called tusks, that grow continually. They are used for defense and to establish dominance. If the upper tusk is damaged or deformed, the corresponding lower tusk may continue to grow in a complete circle (right photo).

Feral hogs have poor eyesight but excellent senses of hearing and smell. Their specially developed snouts are flattened and strengthened by a plate of cartilage, which allows them to root in all types of soil.

Hogs have 44 teeth; the molars have low crowns with simple cusps. The permanent teeth are in place by the time a hog is 22 months old. Males of all three types of wild swine have four continually growing tusks (canine teeth) that they use for defense and to establish dominance for breeding. Tusks project from the sides of the mouth, can be extremely sharp, and may grow 5 inches before they are broken off or worn down from use. The upper tusks (sometimes called witters or grinders) function as whetstones to the lower tusks, keeping them sharp. If an upper tusk is damaged or deformed, the corresponding lower tusk can continue to grow in a complete circle and re-enter the lower jaw.

Female feral hogs may have as many as 10 to 13 piglets per litter. With adequate nutrition, a feral hog population can double in 4 months.

Reproduction

Feral hogs are the most prolific large, wild mammal in North America. With adequate nutrition, a feral hog population can double in 4 months. Breeding occurs throughout the year when conditions are favorable, and seasonally when food supply and nutrient quality vary. Females begin breeding at about 8 to 10 months old, or as young as 6 months if food is abundant. Under favorable conditions, sows can produce two litters every 12 to 15 months, with an average of four to eight piglets per litter and a sex ratio of 1:1. Younger sows tend to have smaller litters, while an older sow may have as many as 10 to 13 piglets. Piglets are weaned in 2 to 3 months. Drought and food shortages can delay breeding and reduce the number of piglets born, but feral hog populations recover quickly when conditions improve.

Habitat

Feral hogs have adapted well to a wide range of ecosystems in Texas. They prefer moist bottomland and are commonly found in riparian areas near rivers, creeks, streams, lakes, ponds, marshes, bogs, swamps and sloughs. They also prefer dense vegetation that conceals them and protects them from temperature extremes. Only poor habitat and extremely arid conditions seem to limit their distribution. Hogs usually concentrate where food is plentiful. They may rest during the day in dense, shady areas and move at night to more open areas for food and water.

Feral hogs can be found in many different habitats, but prefer moist bottomland and riparian areas.

Feral hogs usually travel in family groups, or sounders, made up of two or more sows and their young. Boars are normally solitary, joining a group only to breed.

Behavior

Feral hogs are mostly social animals and tend to travel in family groups. A basic group, called a sounder, consists of one or more sows and their young. Weaned pigs remain with their mother until another litter is due or until they have mated. Other groups may consist of young females, bachelor males, or other combinations. Adult boars older than 18 months are almost always solitary animals that rejoin groups only to mate or to feed on a particular food source. Farrowing sows will temporarily separate themselves from a group. Group sizes vary considerably by region and season. Groups normally consist of two to 20 individuals, but as many as 40 or 50 animals may come together during dry seasons or drought.

Home range is largely influenced by the abundance of food. Feral hogs (particularly boars) may travel as much as 15 miles in search of adequate food and/or water. Hogs in areas where food is scarce have larger home ranges than those where food is adequate. Therefore, fall and winter ranges are generally larger than spring and summer ranges. Home ranges vary from 0.4 to more than 19 square miles, but normally are 0.5 to 3 square miles. Unlike territorial animals, feral hogs do not travel throughout their entire range in short periods of time, but rather traverse the area randomly throughout the season. Boars have larger daily, seasonal and overall home ranges than sows. Sows with newborn young will stay in a very small area during the piglets' first couple of weeks of life.

Feral hogs are usually nocturnal. They may be active for a while during early morning or late afternoon, but only when temperatures are conducive and when seeking suitable shelter and wallowing areas. They seldom move around at mid-day unless disturbed. Major disturbances can cause feral hogs to permanently shift their home range several miles away. Infrequent or minor disturbances will cause hogs to move only a short distance, and they will return once the disturbance has passed.

Feral hogs are opportunistic omnivores; they eat almost anything and everything they find.

Food

Feral hogs require high energy foods with lots of protein, so their diet is largely determined by the nutrient levels of the foods available at a given time and will vary seasonally and regionally. They may become semi-nomadic to locate an abundant source of suitable food.

Feral hogs are opportunistic omnivores, eating almost anything and everything they find. They prefer succulent green vegetation (they do not digest cellulose well) along with a variety of animal material, fruit and grain. In the spring they eat grasses, forbs, roots and tubers. In the summer and fall they eat mostly soft and hard mast such as prickly pear cactus, mesquite, guajillo, huisache, grapes, plums, acorns and persimmons. Rhizomes, bulbs and tubers are also important food items during the fall. Winter diets consist mainly of grasses, forbs and agricultural grains such as corn, milo, wheat, oats, rice and soybeans. They also eat peanuts, pumpkins, watermelons, potatoes, cantaloupes and orchard fruit. Shelled corn put out as supplemental feed for wildlife attracts feral hogs and can be a major part of their diet. They readily consume carrion and animal matter, including arthropods (especially beetles), amphibians, reptiles, eggs, birds, small mammals, and the young of wild mammals and livestock. Large feral hogs also may cannibalize pigs and shoats.

Mortality

When conditions are good, feral hogs live an average of 4 to 5 years. Some live as long as 8 years. Mortality among juveniles, particularly during the first 3 months of life, is extremely high, but tapers off slightly throughout the first year. Juveniles may die from accidental suffocation by sows, starvation, parasites, disease, accidental death, hunting and predation. Adults are sometimes killed by coyotes, bobcats, mountain lions, large raptors and feral dogs.

Hogs root in the ground to find food. They can damage suburban yards and golf courses as well as agricultural land.

Signs

The presence of feral hogs is usually fairly easy to determine. In addition to sighting them, one may find tracks, trails, crawls, rooting, wallows, rubs and scat (droppings).

Hogs root or dig in the ground to find food. Rooted areas can be extensive and cover several acres. If the soil is soft, rooted areas can be as much as 3 feet deep. Feral hogs are persistent and will methodically root an area until the food is depleted.

During warm weather feral hogs wallow in moist areas to coat themselves with mud. This helps them stay cool and protects them from insects and the sun.

Rubs on trees, logs, posts, poles and rocks indicate the presence of feral hogs.

Tracks can be difficult to identify because they are similar to those of deer, sheep and goats. Hog tracks are wider than they are long and shorter than a deer track of the same width. A distinguishing characteristic is the appearance of rounded or blunt toes in hogs as opposed to more pointed toes in deer. Both deer and hog tracks may show dewclaw marks in soft ground. Contrary to popular belief, dewclaws do not determine an animal's sex or age. However, the relative size of a track can indicate an animal's sex or age.

During the warmer months, feral hogs create wallows in moist areas. These muddy depressions help the hogs keep cool and coat them with mud that protects them from the sun and from insects. In hot weather hogs will lie in wallows during the day.

Feral hogs consistently use the same trails and crawls, often traveling underneath and through fences when roaming from site to site. Coarse hair found hanging on fence wires is a sign of hogs. Marks from rubbing or tusking on trees or logs along trails also indicate the presence of feral hogs. Rubs are often found near wallows. Rubbing is done to scratch the skin and remove dried mud, hair and parasites. Trees, fallen logs, fence posts, rocks and power poles are commonly used for rubbing. Hogs seem to have a real affinity for rubbing on power poles treated with creosote. Any such poles within a hog's home range will usually have visible rubs.

Where there are feral hogs, scat can usually be found. Scat deteriorates quickly and can be highly variable in appearance, which makes identification difficult. Generally, feral hog scat has the same shape and consistency of dog droppings. Examining scat can reveal what the hog has been eating, which is useful when considering whether or not to control hogs.

Damage and Disease

Feral hogs cause various kinds of agricultural and environmental damage, mostly by rooting, wallowing and depredation. They also compete with wildlife and livestock for habitat, harbor endemic and exotic diseases, and transmit parasites to domestic livestock and humans. As their populations continue to expand across the state, their damage will increase as well.

Agricultural Damage

Hogs will feed on almost any agricultural crop they find, especially crops adjacent to riparian areas. They eat seeds, seedlings, mature crops, hay, turf and gardens. Their rooting and trampling also damages crops. The financial losses to agricultural producers can be staggering.

Feral swine compete with livestock by rooting up and eating vegetation intended for livestock feed. Rooting creates troughs or mounds that can damage farm equipment and injure livestock. Rooting can also affect the plant composition of a pasture by promoting the growth of undesirable plants where hogs have destroyed desirable forage grasses. Once pastures are degraded in this way, landowners must spend considerable money and time restoring them to pre-swine conditions. Swine wallowing can severely muddy ponds and streams and cause algae blooms, oxygen depletion, bank erosion and soured water. This is particularly true when drought conditions concentrate large numbers of hogs around a few water sources.

Feral hogs consume supplemental food and damage feeders and food plots intended for livestock and wildlife. When hogs frequent these sites other animals often avoid them.

Fence damage–torn netting, holes, and weakened wires and posts–can allow livestock to wander, give access to predators, and result in costly repairs. Hogs are so persistent and strong that they can breach all but the most expensive and sturdy fence.

Crops such as sorghum, rice, wheat, corn, soybeans, potatoes, watermelon, cantaloupe, pecans and peanuts are often damaged by feral hogs.

Hogs not only eat crops, but also root them.

Extensive rooting can destroy native plants and pastureland, which can cause soil erosion.

Environmental Damage

Measuring the environmental impact of feral hogs can be difficult. Most important is the destruction of the habitat of native wildlife and the predation of wildlife. Feral hogs compete for food with many other animals, including white-tailed deer, javelina, turkey, bobcat, and various small mammals. Swine often deplete specific food sources on which other species depend for survival. Extensive rooting of soils, forest litter and grasslands can cause serious erosion of riparian areas, which leads to siltation, lower water quality, and sometimes fish kills. Rooting may also disrupt native plants and change the plant and animal community.

Predation

Predation of livestock and wildlife by feral hogs can be a serious problem in some areas. When the opportunity presents itself, hogs prey upon kids, lambs, calves, deer, fawns, ground-nesting birds, and a variety of other animals. Some hogs become highly efficient predators. They generally prey upon young animals but will kill injured or weak adults. Feral hogs are often attracted to birthing grounds, where they feed on afterbirth and fetal tissue. In certain areas, feral hogs may cause significant losses to endangered or threatened wildlife species.

Hog predation can be hard to detect because hogs often eat the entire animal, leaving little or no evidence. Tracks, scat and other hog signs that confirm the presence of hogs are usually needed to confirm predation. However, hogs are both predators and scavengers, so even the presence of hogs at a kill site isn't proof that hogs made the kill. Hogs

Feral hogs prey on livestock and wildlife, and can seriously threaten endangered species.

may not be suspected when predation occurs, but they may be responsible more often than is thought.

Diseases and Parasites

Feral hogs are susceptible to a variety of infectious and parasitic diseases. The more hog populations increase and expand, the greater the chances that they may transmit disease to other wildlife, to livestock and to humans. External parasites that infest feral hogs include fleas, hog lice and ticks. Internal parasites include roundworms, liver flukes, kidneyworms, lungworms, stomach worms and whipworms. Hog diseases that could have severe repercussions for agribusiness include swine brucellosis, pseudorabies, leptospirosis, tuberculosis, tularemia, trichinosis, plague and anthrax. Exotic or foreign diseases of concern include foot and mouth disease, African swine fever, hog cholera and swine vesicular disease.

Swine brucellosis is a bacterial disease of animals and humans. It causes abortions in sows and can cause infertility in boars. It is a threat to the swine industry. It is transmitted through reproductive discharges (semen and afterbirth) and, once infected, a hog is a carrier for life. Brucellosis is contagious to humans; chronic symptoms range from severe flu to arthritis and meningitis. Humans can be treated with antibiotics, but there is no cure for livestock.

Pseudorabies, a viral disease, attacks the central nervous system and can be fatal to cattle, horses, goats, sheep, dogs, cats, raccoons, skunks, opossums and small rodents. It is not related to rabies and it does not infect humans. Pseudorabies is a special concern to swine producers because it causes abortions and stillbirths. Once infected, hogs are lifetime carriers and periodically shed the virus through their noses and mouths. Livestock can be infected by direct contact with infected animals, consuming contaminated feed or water, or contacting contaminated equipment. Vaccinating livestock, particularly swine, may help to curb the spread of the virus.

Anthrax is a soil-borne disease that occurs irregularly in Texas, usually where the daily minimum temperature is at least 60 degrees F, where wet periods are followed by long dry periods, and where soils are alkaline or neutral. All mammals, especially ruminants, are susceptible to anthrax. Feral hogs may come into contact with the bacteria while feeding or by interacting with infected animals. Humans can contract the disease from contaminated soil or animals. Vaccines are available for both humans and livestock.

Foot and mouth disease is a foreign animal disease of great concern because it is highly contagious, spreads rapidly, can cause serious economic losses, and can constrain international trade in livestock products. It is a viral disease of ungulates (mainly cloven-hoofed ruminants, including swine) and some rodents. It does not affect humans, but humans can spread the virus. There is no known cure. Symptoms include fever and blister-like lesions on the tongue, teats, lips, inside of the mouth, and between the hooves. Many infected animals recover, but are permanently debilitated. The virus can be spread by contact with infected animals and with contaminated feed, water or equipment.

Livestock should be vaccinated appropriately, especially if they may have contact with feral hogs. Anyone who handles a feral hog should wear rubber gloves, particularly if there is contact with blood or reproductive organs. Feral hog meat should be thoroughly cooked before it is eaten.

Control Methods

Once feral hogs have become established in an area it is nearly impossible to remove all of them. However, with an integrated approach one can control the size of the population and keep hog damage at an acceptable level.

Hogs can be controlled with exclusion, snares, live traps, shooting and aerial hunting. There are no toxicants, repellents, fertility agents or biological control agents registered for use against feral hogs in the U.S. Such products have had limited success in other countries, but the cost of developing and registering them for use in the U.S. has been prohibitive.

In Texas, feral hogs are considered free-ranging exotic animals and may be taken at any time of the year by any legal means. Contact the Texas Parks and Wildlife Department for more information about the legal status of feral hogs. The Texas Animal Health Commission regulates the trapping and moving of feral hogs to help prevent the spread of infectious diseases.

Exclusion

Modifying habitat, changing animal husbandry practices, and building fences are a few of the ways feral hogs can be excluded from an area. However, these methods may be cost prohibitive, especially over large acreages. Fencing small areas may be helpful. Mesh wire fencing used in combination with electric fencing is most successful at excluding hogs. Chain link fencing also can be used if a sufficient portion is buried underground. Unfortunately, fencing seldom controls hogs permanently. They eventually find their way through most fences, regardless of the design. Also, fences have to be maintained, which increases the cost.

Snares can be used to capture hogs as they travel along trails or under fences.

Snares

Snares are excellent tools for managing feral hogs. They can be placed on fences where hogs are crossing or along hog trails. A snare consists of a flexible wire cable loop, a sliding lock device, and a heavy swivel. The cable should be either 3/32 or 1/8 inch in diameter and up to 48 inches long.

Most cage traps are constructed of stock panels or heavy, welded wire with a steel pipe or angle iron frame.

Neck snares restrain hogs with a 12- to 18-inch-diameter loop that is securely attached, via the swivel, to a fence or other firm object, or to a drag. An extension cable at least 3 feet long may be needed to reach posts, trees or other stable structures. The snare loop should be suspended above the ground with wire clips or small gauge metal wire. Leg snares also can be used along hog trails. Leg snares, which are placed on the ground, have smaller loops and are activated when an animal triggers the mechanical throwing arm.

Snares have several pros and cons. They are relatively inexpensive, require minimum equipment for installation, and need little maintenance. However, they will catch a variety of animals (including deer), not just hogs. They need to be located where the chance of catching nontarget animals is minimized.

Cage Traps

Cage traps are often used with feral hogs and have several advantages. They interfere little with normal hog behavior, can be either permanent or portable fixtures, can catch several hogs at once depending upon the size and design of the trap, and allow the trapper to release any nontarget animals that are caught. Captured hogs can be slaughtered or sent to market. Trapped hogs should not be relocated without checking with the Texas Animal Health Commission for the latest restrictions on relocation. Releasing feral hogs is not recommended because they are destructive and may transmit disease.

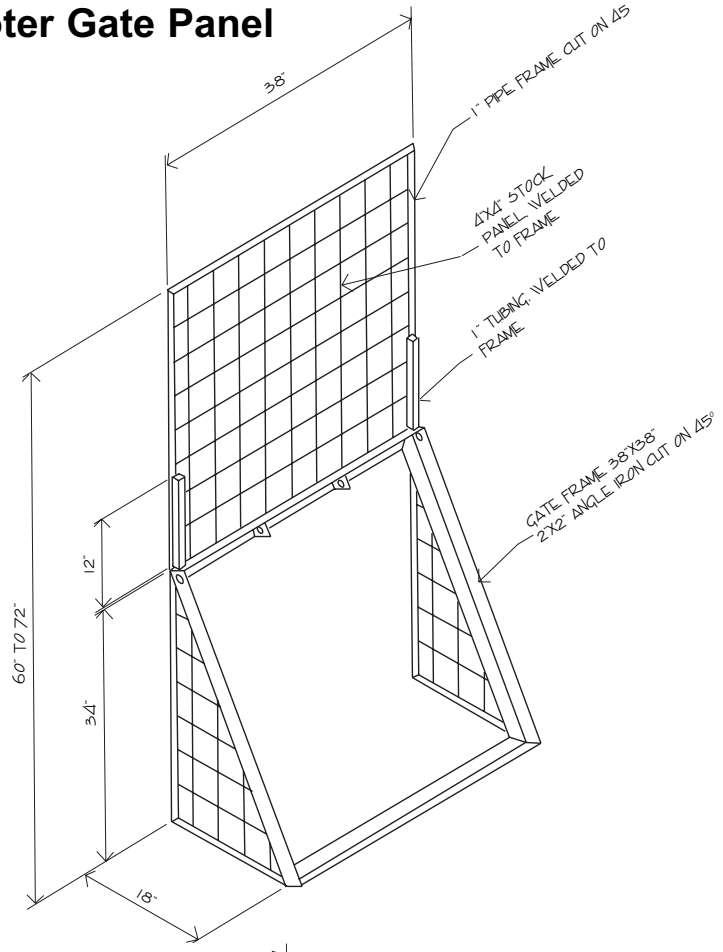
Cage traps for feral hogs come in a variety of designs and shapes. Most are constructed of stock panels with a steel pipe or angle iron frame. The primary differences between trap designs are size, portability, door configuration, flooring or roofing. Any trap needs two key elements to function properly–a reliable door and stout enough materials to hold trapped hogs. Door

There are many kinds of cage traps. The main differences are in size, portability and door configuration. Door designs include drop/slide gates, rooter/lifter gates, and spring/swing gates.

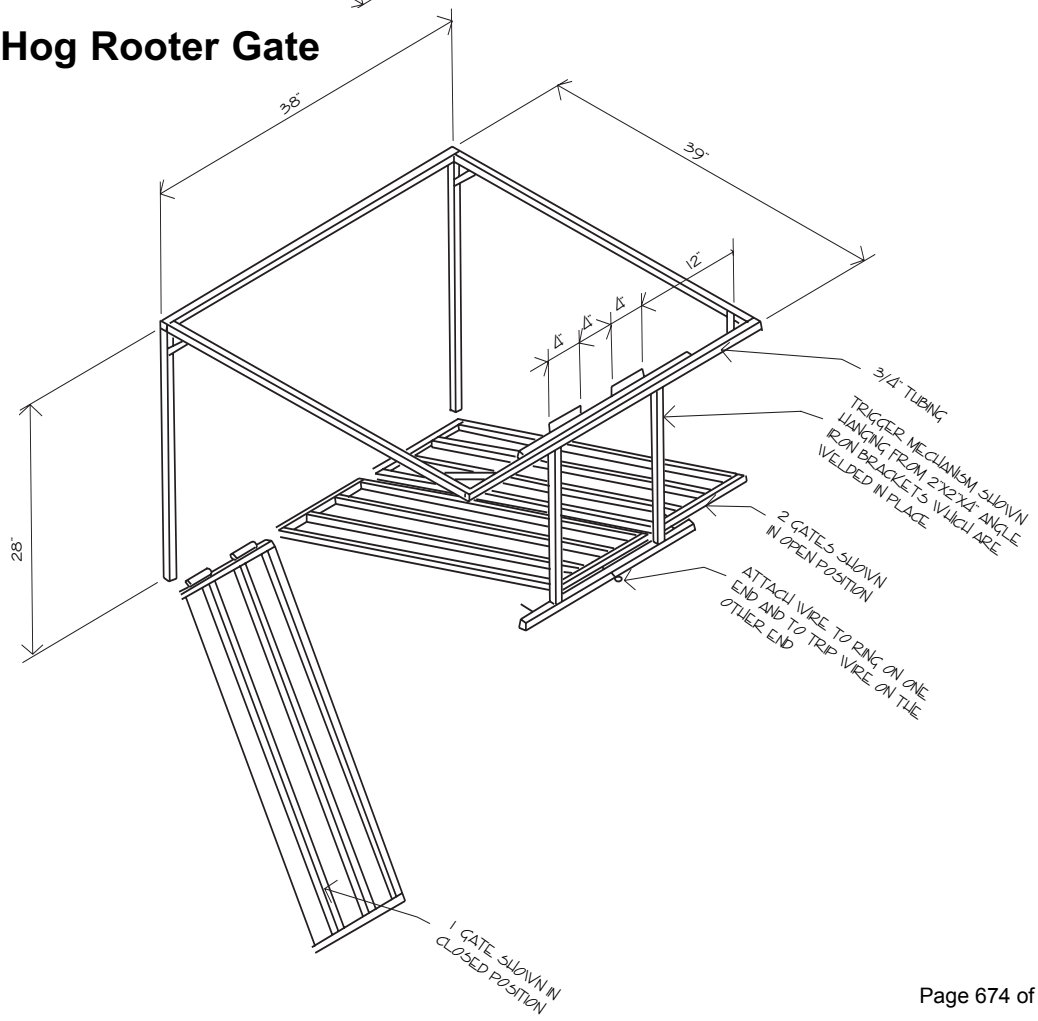
designs include drop gate/slide door, rooter/lifter gates and spring/swing gates. Drop gates use a trip wire to trigger the door. Rooter or lifter gates require that the hog use its nose to lift or root open the door. Spring or swing gates use a screen-door type spring to close the door after hogs push it open. Doors or gates can be hinged from the top or the side of the trap. Some trap designs just use paneling fashioned as a funnel or door into the trap. Doors should open in only one direction so hogs can get in, but not out. Floors and/or roofs can be used on traps to ensure that hogs do not dig underneath, jump out, climb over, or otherwise escape. The most popular styles of cage traps are corral traps, panel traps, box traps and portable traps.

This circular trap has overlapping panels that funnel the hogs into the trap but don't allow them to exit.

Kerrville Hog Rooter Gate Panel



Kerrville Hog Rooter Gate



Feral hogs can be hunted year-round in Texas. Many hunters use dogs trained to track hogs.

A successful trapping program requires that traps be placed in areas where feral hogs are active and that they be pre-baited for several days to get hogs used to entering the traps. This is accomplished by wiring the door or gate open until hogs are no longer wary of the trap. Hogs can be baited with fermented corn or grain, whole corn, livestock pellets or cubes, vegetables, fruit or carrion. Once hogs are entering the trap without fear, the trap door can be set to capture them. Traps should be checked daily and from a distance when possible. Unnecessary activity around the trap site may cause hogs to avoid it. Be careful when approaching traps that contain hogs as they will become excited. With multi-catch traps, a decoy animal can be left in the trap to help entice other hogs to enter. Decoy animals should be fed and watered daily. Trapping should continue until the desired number of feral hogs has been captured or until no further hog activity occurs at the trap site. Trapping is most successful during cooler months.

Shooting

Hogs can be shot when the opportunity arises, but this usually will not reduce the population to a great extent. Ground shooting might be effective if it is intensive and if the hog population is small. Current Texas law does not require a landowner or landowner's agent or lessee to have a hunting license if feral hogs are damaging the landowner's property. Feral hog hunting has become popular in Texas and generates income for many landowners. Feral hog hunting can take place year-round, but most hunters take feral hogs incidental to deer hunting.

Hunting techniques for feral hog are essentially the same as those for white-tailed deer. Stand hunting or still hunting can be conducted in baited areas or in areas with abundant fresh hog sign. As feral hogs are attracted to supplemental feeding sites and deer feeders, these can be prime areas for

hunting feral hogs. However, feral hogs are very intelligent and can be a challenging foe. Intensive hunting may cause feral hogs to shift their home range or become more nocturnal. When this happens, hogs can be hunted at night using a spotlight with a red filter. Contact the local game warden for permission first, because there are laws regarding the use of a spotlight.

Trained dogs can be used to locate individual hogs or small groups of hogs. In fact, using dogs to trail and bay hogs is a hunting method that has been around for many years. Success will depend on the experience of the dogs and the hunter. Most hunters use tracking dogs to find and bay hogs, while relying on catch dogs to hold hogs once bayed. This method should be used only by skilled hunters with well-trained dogs. Tragically, the major disadvantage to this technique is that dogs are often injured or killed by hogs.

Aerial Hunting

With proper permits and licenses, aerial hunting is a legal method of controlling feral hogs in Texas. Most aerial hunting is done with helicopters. There must be an experienced pilot and a capable gunner. Aerial hunting can stop a damage problem quickly and is very highly selective because only targeted animals are killed. Aerial hunting also can be used in areas that are inaccessible to other management methods. Depending on the amount of damage hogs are causing, the benefits of an aerial hunt can far outweigh the costs (which can be $300 or more per hour flown). Like all other control methods, aerial hunting does have limitations. Rough terrain, poor weather, heavy cover, high cost, and the inherent hazards of low-level flight are all factors to consider.

Summary

Feral hogs are well established in Texas, and because of their adaptability, reproductive capability, and skill at survival, they are here to stay. The value of feral hogs is a matter of opinion. Landowners suffering from feral hog damage may be very eager to get rid of them. Hunters look forward to having them show up on their hunting grounds. Entrepreneurs enjoy the economic returns from feral hog hunting fees and the sale of captured hogs. Biologists have ecological concerns as feral swine interact with and harm native wildlife species. Whatever one's opinion may be, the management of feral hogs should be part of any property management plan.

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*Extension publications are available from *http://tcebookstore.org*

Look For Me

iN a FieLd Near you!

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the Unite States Department of Agriculture. Chester P. Fehlis, Deputy Director, Texas Cooperative Extension, The Texas A&M University System.

1M, New

Great Trinity Forest Management Plan

Wildlife Management

Texas Researchers Developing 'Pill' for Wild Hogs

Texas Researchers Developing 'Pill' for Wild Hogs

Texas A&M researchers working on contraception to thin herds of destructive wild hogs

By MICHAEL GRACZYK

The Associated Press

GILMER, Texas

Broad areas of grazing land at Pete Gipson's farm have plow-like scars. But it wasn't an out-of-control mechanical device that left disjointed ruts and holes.

Gipson and other ranchers and farmers in the South are tormented by herds of voracious feral hogs. The beasts, up to 3 feet tall and 400 pounds, devour feed intended for livestock and tear up pastures in their incessant search for food.

The hogs show little respect for such barriers as barbed wire fences, which merely serve as backscratchers for their hairy, leathery hides.

"They got in that yard a couple weeks ago and cultivated it," said Gipson, 67, as his pickup truck bounced across a once-smooth pasture at his 300-acre Red Cap Farms. "I smoothed it out and I'll be damned if they didn't come back the next night and cultivate it again."

In Texas, the wild pig population — now topping 2 million — is exploding thanks to high reproductive rates and few natural predators.

The Texas AgriLife Extension Service estimates the hogs cause $50 million in damage each year.

A solution to the pig problem might come from a lab at Texas A&M University, where a team of researchers is testing an oral contraceptive for the hogs and other pests. It may even become applicable for pets like cats and dogs.

The contraceptive, called a phosphodiesterase 3 inhibitor and in development for about a year and a half, is now in a capsule form and has been fed to captive pigs at the university's research facility. It prevents the females' eggs from maturing.

"It does appear to be effective," said Duane Kraemer, a professor of veterinary physiology and pharmacology who heads the research team.

"The animals can continue to cycle and breed. Their behaviors are the same, except they don't get pregnant."

Still, Kraemer cautions, the "development of an oral contraceptive for an animal that people eat and is to be released into the environment is a complex issue, no question about it."

The hogs are descendants of animals introduced more than 300 years ago by Spanish explorers, domestic hogs that have escaped over the years and survivors of Russian boars brought to Texas in the 1930s as exotic hunting game.

After generations of crossbreeding in the wild, the hogs have evolved into fierce survivors that typically travel in herds known as sounds.

The hogs have keen senses of smell and hearing and sharp, continuously growing tusks — two on top and two on the bottom — all the makings of imposing physical specimens.

Gipson said his son-in-law recently was inspecting some land on foot when he was confronted by several of the animals, which leave the shelter of creek bottoms to do their foraging after dark. Outweighed and outnumbered, his son-in-law climbed a tree to safety until they left, Gipson said.

"You might shoot one, but you'd have the rest of them on you," he said.

There is no closed season on hunting the pigs, and in Texas all you need is a regular hunting license. But it might take more than a shotgun to bring down a big hog.

"Just cleans the dirt off them," said Jake Williams, Gipson's farmhand.

Earlier this month, the Texas Department of Agriculture announced it had awarded the extension service $1 million to provide technical help to landowners under siege from the beasts.

"They eat most anything," Kraemer said. "One of the reasons there's concern is they eat eggs of birds that nest in the ground, little deer if they can catch them, sheep and goats. And, of course, they dig for grubs and worms and roots and in the process of doing so, they tear up crops, pastures and make such a mess you can hardly drive on these pastures. It's just terrible."

He estimates it could be three to five years before the birth-control pill for pigs is readily available. The next step in the research is to test the contraceptive outside the lab.

Among hurdles yet to be overcome are how to ensure that the drug is administered only to wild hogs and won't cause any environmental damage.

"It's got to be effective, it's got to be specific, it's got to be acceptable to meat consumed by humans," Kraemer said. "And it's got to be environmentally safe."

Great Trinity Forest Management Plan

Wildlife Management

Controlling Brown-headed Cowbirds

How Do I Trap Cowbirds?

~~Trap Location:~~ Trap placement is critical to maximize cowbird capture and to minimize non-target birds caught.

- What makes a good trapping site? The ideal site meets as many of the following points as possible:
  - Where cattle or other livestock graze.
  - In open pasture, away from brush.
  - Readily accessible to vehicles, even after heavy rain.
  - Water and some perching snag (dead tree) nearby.
  - Low grass.

~~Trap Operation~~: Operate traps between March 1 and June 20.

- Erect trap on level site with no gap between frame and ground. Use shovel to fill gaps.
- Place a 1-gallon poultry waterer on level ground.
- Scatter cleaned milo (about half of a 1-pound coffee can) in the trap. Be sure to avoid grain in waterer.
- Do not feed milo during rain. The birds don't like soggy grain.
- Traps work best if 10-15 live cowbirds are present to act as decoys. If starting a trap without decoys, be patient. If cowbirds are in the area, they'll find and enter the trap.
- From 1 March to 31 May traps should be checked at least every other day; from 1 to 20 June, check traps daily.
- Use large minnow dip net or trout net to catch birds in trap. **Immediately release** non-target (not cowbirds) species.
- Always remove any dead or injured birds.

~~Killing Cowbirds:~~ Whichever method is used to kill cowbirds, it must be humane, fast, and certain.

- The recommended method is cervical dislocation, separating the vertebra. Hold bird by neck, using thumb and forefinger. Using other hand, take head and pull with a twisting motion. You should be able to feel the vertebra separating. When the vertebra is separated, and the head flops over, the bird is dead.
- While not required, information on numbers of cowbirds caught and killed and other species caught, can provide valuable data to state biologists. Such data, as well as any banded birds (numbered metal and/or colored plastic bands on lower legs) may be reported to a Game Warden or any wildlife official.

~~Predation:~~ Any mammal, bird, or reptile that eats birds will be attracted to the traps in search of an easy meal.

- Recommend using a reptile snare or other tool to remove snakes.
- If a predator, such as a raccoon, digs in under the trap, move trap away from brush/woods and place trap on rocky or other hard surface.
- As with everything else, fire ants are a real problem. A good, commercial ant bait, scattered around and outside of the trap can be effective. Do not use poisons in the trap.
- Keep vegetation in and immediately around the trap low, 2" or less. You'll catch more cowbirds and see any snakes, which have entered the trap to feast on birds.
- Hawks and owls will often swoop down on birds in the traps. This may explain dead or crippled birds in the traps. Humanely dispose injured birds.

~~Non-Target Birds:~~ What is a non-target bird? Any bird caught that is not a cowbird.

- Other birds will enter the traps in search of food (the milo), for company, or just plain curiosity.
- Common non-target birds include mockingbirds, cardinals, various sparrows, grackles, blackbirds, and loggerhead shrikes (often called butcher birds).
- A good bird guidebook will help identify any captured birds.
- Again, **immediately release** non-target birds.

~~Taking Traps Out of Operation:~~ Traps should not be in operation after 20 June.

- Remove all cowbirds, releasing any banded birds and disposing others.
- Birds, including non-target species, tend to enter traps. Place boards over entry slots or secure door in open position.

Ackowledgements

This publication was made possible by the cooperative efforts of Texas Parks and Wildlife, U. S. Army Fort Hood Military Installation, and The Nature Conservancy of Texas. Texas Parks and Wildlife and the U.S. Fish and Wildlife Service, under Section 6 of the Endangered Species Act, provided funds for the production of this booklet. John Cornelius, Environmental Division at Fort Hood, developed the cowbird trap design. Gil Eckrich, The Nature Conservancy of Texas, developed the trapping methodology. Mike Krueger and Linda Campbell of Texas Parks and Wildlife provided technical guidance and overall coordination. We gratefully acknowledge the Information Services Section of Texas Parks and Wildlife for design and layout of this publication. Mark Goering, Michael Sanchez, and Jon Horne at Fort Hood assisted with graphic development. We would also like to thank members of the Central Texas Cattlemen's Association for their support.

What is a Brown-headed Cowbird?

The brown-headed cowbird is a brood parasite that lays its eggs in the nests of more than 225 other species of birds. A "host" that has had its nest parasitized will usually raise cowbird young at the expense of its own eggs or young. Bird species that build open-cup nests in shrubs, such as the Federally Endangered black-capped vireo (BCV) of central Texas, are most vulnerable to being parasitized. Research on the Ft. Hood Military Reservation and the Kerr Wildlife Management Area has documented parasitism rates that exceed 80% of all BCV nests. Cowbird parasitism occurs in a variety of habitat types, but cowbirds tend to select woodland edges and brushy habitats for reproduction more so than large, unbroken woodlands.

Prior to European settlement, the historic range of the cowbird was restricted to the open short-grass prairies of the central United States. Cowbirds followed roving herds of buffalos in search of insects that were flushed by the grazing animals, and with the migration, deposited eggs in the nests of other songbirds and moved along with the herd. Human-altered landscapes resulting from practices such as woodland fragmentation, the widespread introduction of cattle (suitable but non-migratory alternative to buffalo), and agricultural practices that provide food sources during the winter (waste grain, feedlots) have contributed to dramatic increases in the cowbird population as well as the expansion of its range into all of the lower 48 states, southern Canada and northern Mexico. Range expansion has resulted in increased exposure to new, vulnerable host species, ultimately contributing to increased cowbird reproductive success, and increased impact on songbird populations.

Controlling Cowbirds

The most effective way to control cowbird numbers and their impacts on other species is to control the features of the environment on which they thrive. In woodland areas, maintain large tracts of woodland with minimal edge to interior ratios, and minimize openings in woodlands. On rangelands, prevent overgrazing by livestock that produces a short-grass feeding environment and minimize winter food sources. These practices have to be conducted at the landscape level to have a significant impact on cowbirds, which can travel 5-30 miles.

In addition, the trapping (and occasionally supplemental shooting) of cowbirds has proven to reduce cowbird parasitism rates in localized areas. Parasitism rates of the BCV on Ft. Hood and the Kerr WMA have been reduced to less than 20% with intensive trapping to reduce cowbird numbers during the breeding season.

As per Parks and Wildlife Code, Section 64.002 (b), brown-headed cowbirds are included among the small group of eight non-protected bird species that "may be killed at any time and their nests or eggs may be destroyed." HOWEVER, as is the case with many wildlife species when trapping is used as a population control method, there is always the possibility, albeit unintentional, that some non-target, protected species of birds will be captured in cowbird traps. It is prohibited to "catch, kill, injure, pursue, or possess, dead or alive" the vast majority of other bird species that are protected.

For those persons wishing to participate in cowbird trapping, the USFWS has provided TPW the authority under a pilot program to provide training to landowners and their agents. The training will focus on trap placement, humane disposal and careful removal of non-target species. Following this training, persons are "covered" under TPW's permit and requested to participate in a voluntary reporting process.

PWD BR W7000-0514 (6/99)

TEXAS PARKS AND WILDLIFE

CONTROLLING Brown-headed Cowbirds

This publication is designed to minimize the capture of protected, non-target species through proper trap design and placement, and to minimize injury and mortality of captured non-targets with proper trap monitoring.

4200 Smith School Road, Austin, Texas 78744

CONSTRUCTION TIPS

- Use treated lumber throughout. Added initial cost is compensated by longer field life and reduced maintenance.
- Don't rip lumber until you are ready to start construction. Ripped lumber will bow and twist if allowed to sit for several days.
- Use a shelf bracket on diagonal corners to square each panel before attaching gussets. To cut gussets, lay out sheet of plywood in 12" squares, then draw diagonals across the square. A sheet of plywood will make 64 gussets.
- Gussets go on one side of panel, hailscreen attaches to the other side. For side and top panels, wire will end up being on the inside of the panel. This prevents birds from roosting on framework next to wire where they are prone to predation. ***Exception:** End panels are constructed the same way, but during final trap assembly, the wire goes on the outside, because the drop entrance attaches to horizontal members for structural stability.
- This pattern is designed to use 48" wide hailscreen to maximize efficiency. Internal cross members are placed to allow for slight overlap. Wide hailscreen will probably not be readily available in stock, but any building supply can order it. Use of narrower hailscreen requires repositioning of tack strips, and results in higher lumber use.
- To maximize shop efficiency: cut gussets; rip lumber; pre-cut lengths; cut out slot assembly; assemble side, top, and end panels; attach hailscreen; final assembly. When building multiple units, performing similar actions for several traps at the same time will allow you to develop an assembly line process that cuts construction time per unit.
- Slot width of 1.25 inches in slot assembly is **critical.** Wider slots will increase non-target captures, including small raptors which will feed on your decoy birds. Escapes by females may also increase with wider slots.
- Side panels attach to the outside of end panels. Nothing else will fit if you attach ends outside.
- During final assembly, assemble in this order: end, side, side, top, top, dropping slot assembly (3 pieces), then finish with the other end.

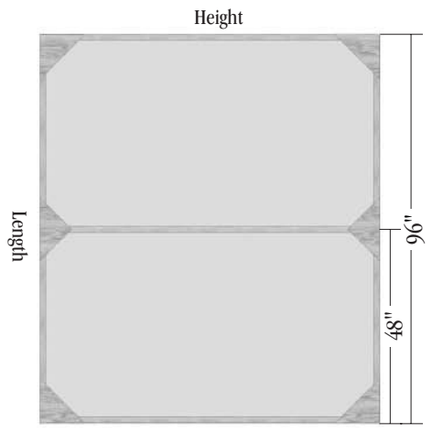
Recommended Tools For Construction

Shop assembly of panels

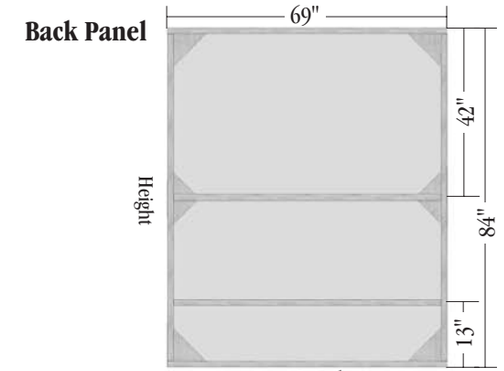
Table saw - for ripping 2x2
Chop saw - for cutting boards to length
Electric hand saw - for cutting out gussets and slot assembly
Retractable rule - for measuring dimensions
Electric or cordless drill/driver - for driving screws
Pneumatic or electric nibbler - for cutting hail screen
Pneumatic stapler - for attaching gussets and wire
Pneumatic nailer - for assembly of panels
(optional but helpful - Panels can be assembled with 3" deck screws if nailer is not available)

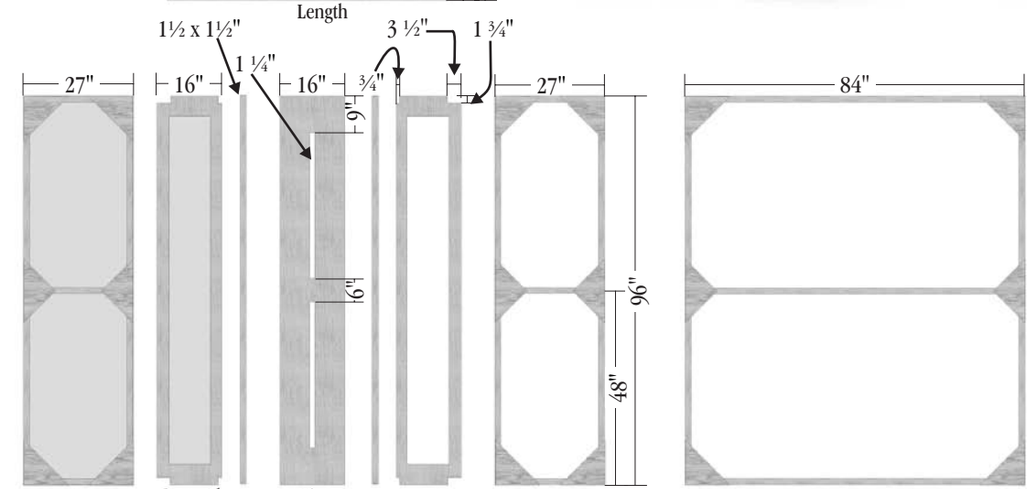
Field Assembly

Cordless drill/driver - for driving screws
Bar of soap - to lubricate screw threads
Hand stapler - to secure wire to ends of drop entrance
Step ladder - for attaching top panels



Left Side Panel *(same as right panel)*

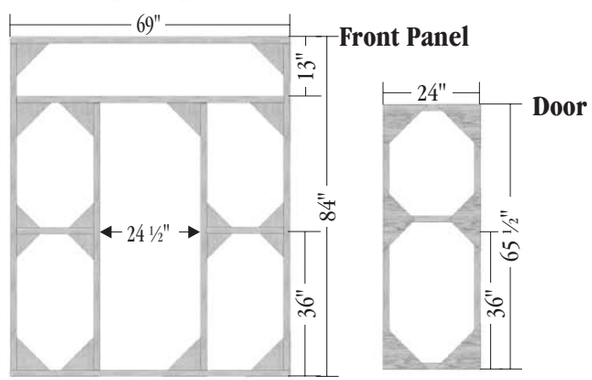




Right Side Panel

Top Panel/Slot Assembly

End View of Top Panel/Slot Assembly



Front Panel

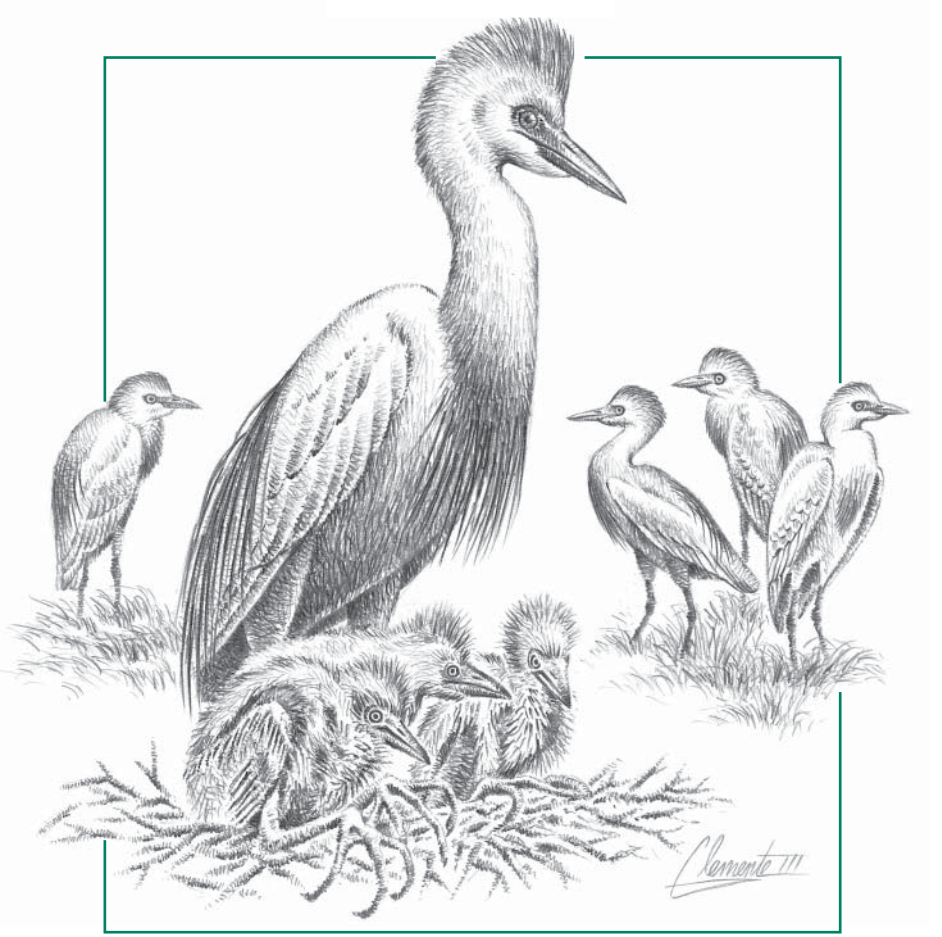
Door

Materials List for 6x8 Portable Cowbird Trap

Number	Description	Comments
16	2x4x8 (treated)	Rip 2x4 into 2x2
2	Sheets ½" CDX plywood (treated)	1 sheet is for slot assembly, 1 sheet is to cut up for gussets
64 linear feet	½" mesh hailscreen	Bought in 100 ft. rolls
1 pair	Tight pin hinges (3")	Door hinges
1	Screen doorhandle	Outside of door
1	Galvenized hasp (4½")	Use with padlock for security
1	Screen door latch	Used on inside of door
14	10"x12" shelf brackets	Used to square panels (2 per panel)
125 (approx)	1" drywall screws	Field assembly of slot assembly, attaching shelf brackets to panels
50 (approx)	3" galvenized deck screws	Field assembly (panel to panel)
300 (approx)	1½" pneumatic staples	Used to attach gussets
600 (approx)	1" pneumatic staples	Used to attach screen to panels
300 (approx)	½" staples	Used to attach screen to slot assembly

TEXAS PARKS AND WILDLIFE

NUISANCE HERONRIES IN TEXAS



CHARACTERISTICS AND MANAGEMENT

by Ray C. Telfair II, Bruce C. Thompson, and Linda Tschirhart

– Second Edition –

NUISANCE HERONRIES
IN TEXAS:

CHARACTERISTICS AND MANAGEMENT
– Second Edition –

by

Ray C. Telfair II[1], Bruce C. Thompson[2], and Linda Tschirhart[3]

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[3] Texas Wildlife Damage Management Service, Bryan, TX.

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The content and format of the first edition of this management information booklet were substantially improved by suggestions from a variety of professionals who had been involved with nuisance heron issues and were working toward resolution of these conflicts consistent with conservation needs of the species. Special thanks are extended to Dr. Milo Shult (Texas Agricultural Extension Service), Dr. Keith Clark (Texas Department of Health), Donald Hawthorne (Texas Wildlife Damage Management Service), Douglas Hall and Jeff Haskins (U.S. Fish and Wildlife Service), and Stanley Brooks, William Brownlee, George Litton, and Dr. Brent Ortego (Texas Parks and Wildlife).

Cliff Shackelford (Ornithologist, Wildlife Diversity Program, Texas Parks and Wildlife) suggested the need for a new edition since 13 years have elapsed after the first edition was published. Thus, Linda Tschirhart (Biologist, Texas Wildlife Damage Management Service) was invited to add her expertise as a co-author of the new edition.

Financial support for compilation and publication of this information booklet concerning Texas birds was provided by the Federal Aid in Wildlife Restoration Act under Project W-103-R, Nongame Wildlife Investigations, of Texas Parks and Wildlife. The Act is popularly known as the Pittman-Robertson, or P-R Act, after its Congressional sponsors, and provides for a manufacturers' excise tax on sporting arms, handguns, ammunition, and certain items of archery equipment. The collected tax monies are apportioned to the states and territories on a formula basis by the U.S. Fish and Wildlife Service for the conservation of wild birds and mammals.

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Nuisance Heronries in Texas:
Characteristics and Management

by Ray C. Telfair II, Bruce C. Thompson, and Linda Tschirhart

Introduction

Long-legged waterbirds known as herons and egrets are important components of the breeding bird life found in numerous wetlands and woodlands in the eastern half of Texas. These species are part of the natural predator-prey cycle in these habitats and they provide much appreciated scenery to many who routinely enjoy viewing wildlife. The graceful flight, brilliant breeding plumages, and diverse feeding habits of the various species are the subject of much study and artistry, and justify our efforts to maintain populations for future appreciation despite dwindling habitat. However, this beauty and concern for population well-being cannot completely overshadow other management needs in certain circumstances where these birds strongly conflict with human needs.

Heronries (nesting areas of herons, egrets, and other associated colonial nesting waterbirds) can be offensive, and thus unpopular, when they are located near human habitation. Some heronries are considered nuisances when located adjacent to residential areas and airports because of noise, odor, concern about possible health hazards (broken eggs, decomposing birds, associated parasitic insects, and diseases such as psittacosisornithosis, histoplasmosis, encephalitis, and arbovirus), and potential danger to aircraft. Also, heronries may produce detrimental effects upon nest and roost-site vegetation primarily because of the accumulation of excrement on the plants and substrata (soil and/or water). Furthermore, newly flighted young may alight in trees bordering driveways and yards situated near the heronry, and their excrement falls upon parked vehicles, yard equipment, lawn furniture, etc.

In Texas, 33 nuisance heronries have developed in several towns and cities within 5 vegetational areas (Fig. 1), primarily the Post Oak Savannah, Blackland Prairies, and Cross Timbers and Grand Prairie. Unfortunately, visitation to these heronries by curious people and the subsequent disruption of nesting activities can make the situation much worse since young birds are frightened, leave their nests prematurely, become displaced, and die from starvation because they will not be fed by their parents which return only to the vicinity of the nest site.

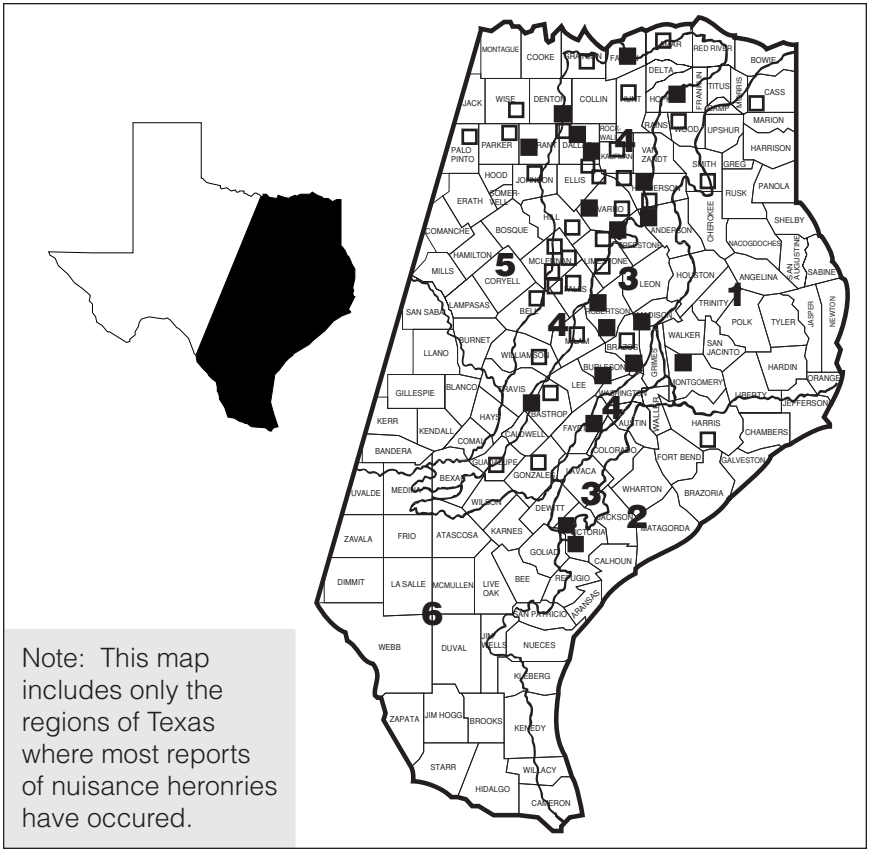

Figure 1. Locations of Texas heronries (■) within regions where some heronries are or have been considered nuisances (□). Vegetational regions are: (1) Pine and Hardwood Timberlands, (2) Gulf Prairies and Marshes, (3) Post Oak Savannah, (4) Blackland Prairies, (5) Cross Timbers and Grand Prairie, and (6) South Texas Plains. Delineation of vegetational regions is based upon Gould et al. (1960), modified by Telfair (1983) and McMahan et al. (1984).

A direct relationship exists between materials deposited in heronries and increased levels of nitrogen and phosphorus in water beneath or in the vicinity of heronries. These nutrients often stimulate production of thick mats of floating and submerged vegetation, particularly algae and duckweed. This rapid eutrophication (nutrient enrichment) concerns many fishermen because the filamentous types of algae entangle and stop propellers of motorboats and prevent retrieval of fishing lures. An example of this situation occurred in the vicinity of the Preserve Island heronry at the Koon Kreek Klub, Henderson Co.

Characteristics of Major Bird Species in Inland Heronries

Most inland heronries in Texas that are or have been considered nuisances contain 3-5 species of herons and egrets as well as Great-tailed Grackles. Characteristics of breeding adults are as follows:

1. **Cattle Egret** (*Bubulcus ibis*) - White with buffy-orange breeding plumes on crest, lower foreneck, and back. The yellow to orange bill and neck are shorter and thicker than in other herons. Legs are yellowish to orange. At rest, whether standing or perched, the Cattle Egret has a "hunched" posture. They fly to and from heronries in small to large flocks often in "V" formation. By the peak of the breeding season in June, they are the most abundant species in heronries; their breeding season may extend from early April to late October.

2. **Little Blue Heron** (*Egretta caerulea*) - Dark slaty-blue body with a maroon-brown head and neck. The bill is bluish with a black tip. Legs are bluish-green. They are the second-most abundant species in most heronries; their breeding season extends from late March to late July.

3. **Snowy Egret** (*Egretta thula*) - White with breeding plumes on crest, lower foreneck, and back. The bill is thin, long, and black with bare yellow skin at the base. Legs are black; feet are bright yellow. Snowy Egrets are longer-necked and slimmer than Cattle Egrets. They are usually the third-most abundant species in heronries; their breeding season extends usually from late March to early August.

4. **Great Egret** (*Ardea alba*) - White, long necked, with long breeding plumes on back extending beyond the tail. The bill is long and yellow. Legs and feet are black. Much larger than Cattle and Snowy Egrets. There may be none to many pairs in a heronry. Their breeding season extends from early March to early August.

5. **Black-crowned Night-Heron** (*Nycticorax nycticorax*) - Black crown with 2-3 long, thin, white plumes; black back, gray wings, and white underparts. Has heavy body, short thick neck, short legs. The bill is thick and black. Legs are yellow. Most heronries contain from none to less than 12 pairs. They are very secretive and are not usually seen flying until dusk. Their breeding season extends from early February to late July.

6. **Great-tailed Grackle** (*Quiscalus mexicanus*) - Male, a large steel-blue blackbird with a very long slender V-shaped tail that widens at the end. Female is paler and browner with a shorter tail. Nests occur in scattered groups throughout the taller trees of some heronries. Their breeding season extends from March to early August.

Legal Status

The bird species typically associated with nuisance heronries are protected under both state and federal laws. All of these species are subject to the Federal Migratory Bird Treaty Act which governs cooperative protective measures between the United States, Canada, Mexico, Japan, and the Soviet Union. Federal regulations pertaining to management of nuisance heronries are specified in Title 50 of the Code of Federal Regulations and are implemented through personnel assigned to the regional U.S. Fish and Wildlife Service Division of Law Enforcement Office. Control activities are exercised only to the extent necessary to resolve demonstrated nuisances or human health and safety hazards.

The birds also are protected by Chapter 64, Texas Parks and Wildlife Code from being killed, possessed, commercialized, or disturbed at breeding sites. Chapter 67 of the Parks and Wildlife Code further provides specific authority for programs necessary for proper species management.

Nuisance conditions – where removal of birds might be considered – are subject to federal permit requirements and procedures. The Texas Wildlife Damage Management Service (TWDMS) is the state agency that can assist the public with the proper procedures to apply for a federal permit. After the breeding season, when the birds have left the nesting area, the nests that remain are still under federal protection. To remove these nests, or to modify nesting habitat, you must first apply for a federal permit. If you believe that you may have a nuisance heronry, or would like to modify a site containing nests, contact TWDMS at (210) 472-5451.

Characteristics of Nuisance Heronries

Most nuisance heronries occur within the breeding range of Cattle Egrets, largely east of the Balcones Escarpment and within or bordering the Post Oak Savannah, Blackland Prairies, and Sulphur, Cypress, and Trinity River tributaries. Breeding distribution and the western inland boundary of the breeding range of the Cattle Egret corresponds with those of the Little Blue Heron and Snowy Egret. Apparently, Cattle Egrets are attracted to inland heronries already established by the latter native species which are, in turn, limited by the distribution and abundance of crayfish upon which they feed. Within or bordering this area there have been 53 heronries, 33 (62%) of which have been considered to constitute nuisance situations.

Most nuisance heronries have occurred in the vegetative areas of Texas that are classified as: (1) woodlands–upland woods with small intermittent streams or ponds within or nearby, but not in water; (2) swamps–shrubs and trees in water, and (3) inland wooded islands–shrubs and trees on islands in inland bodies of water. Predominant vegetation of these areas are: (1) Post Oak Parks/Woods (sandy soils of the Post Oak Savannah and East Cross Timbers); (2) Elm-Hackberry Parks/Woods (within the Blackland Prairies, primarily in Ellis, Navarro, and Limestone counties); and (3) Water Oak-Elm-Hackberry Forest (Sulphur and Trinity rivers and tributaries); (McMahan, Frye, and Brown 1984).

Vegetation of woodland heronries consists of an overstory of 1 to 3 tree species. The most common are sugar hackberry, cedar elm, winged elm, post oak, water oak, willow oak, honey locust, and osage orange (horse apple or bois d'arc). The understory may be absent in some heronries or contain as many as 9 species in others. Common understory species are hawthorn, farkleberry (huckleberry), gum bumelia, red mulberry, plum, sumac, chinaberry, western soapberry, and juniper (eastern red cedar). Except for occasional openings, the canopy tends to be closed (>75%), and nest-site trees are of medium height and diameter, about 20-30 ft (6-9 m) tall and 3-9 in (7.5-23 cm) diameter breast high (DBH).

Vegetation in inland wooded island heronries is usually dense. It is composed of shrubs, saplings, and small trees of several species, primarily post oak, winged elm, green ash, honey locust, water-elm, common buttonbush, chinaberry, and juniper.

The nest-site vegetation in swamp heronries is mostly of 2 species: water-elm and common buttonbush. Red maple, water oak, and Carolina ash are used locally.

Other location characteristics of these heronries include: (1) usually at the periphery of a small town or city (300-100,000, ave. 15,000 population) except islands in reservoirs, (2) in a less affluent section of the community, (3) near a major highway, and (4) within an isolated woods or mott of 0.2-12 acres (0.1-5 ha) usually 2.5-7.5 acres (1-3 ha). Age or life-span of heronry, if left undisturbed-(1-12 years, usually 5 years). Number of nests 130-18,450 (usually about 5,000).

Prevention of Nuisance Heronry Development

The best way to prevent the establishment of a heronry is through public awareness and early detection. If detected early when the birds first move in, they are nervous and can be easily moved with various scaring methods (Booth 1994; Dusi 1977, 1979, 1982, 1983).

Scaring devices such as pyrotechnics (screamers, badgers), cracker shells (shot from a 12-gauge shotgun), rope-firecrackers, and propane cannons all work effectively. To be most effective, combine several of these methods so that the birds do not become accustomed to them. Eye-spot balloons, mylar flagging and streamers, and hawk and owl silhouettes can also be effective when put in the trees of a potential nesting site.

Since a potential nest-site is usually densely vegetated (i.e., with a closed canopy of shrubs and trees 15 to 30 ft (4.6-9.1 m) high and a dense undergrowth of saplings, vines, and herbaceous plants), such a site can be made unattractive by thinning the vegetation to provide spaces between trees and by the removal of undergrowth vegetation. Dramatic changes are not necessary and such modifications of a potential nesting area usually produce longer lasting prevention than other methods.

When trying to prevent a heronry from developing or when trying to move an existing heronry, it is possible that the birds will move to another location that is just as undesirable. An example of this type of situation is in Mexia, Limestone Co., where the heronry has been in at least 8 different locations.

It is not possible to predict that a particular site will become a heronry. However, in towns and cities where heronries have existed, or where there is the possibility for the development of heronries, the community can develop a contingency plan in anticipation of action to be taken should the need arise. Interagency cooperation and neighborhood involvement is vital for successful detection and dispersal of offending birds. In general, early detection of heronry initiation is the best method for eliminating nuisance heronries. We suggest that municipal administrators should consider providing training information on heronry characteristics and initiation to city police, maintenance personnel, and interested volunteers. A comprehensive vigil during the early spring could avert later undesirable circumstances for both people and birds.

Recommendations of Wildlife Biologists

1. Biological control of nuisance heronries (methods to discourage nesting) is more ecologically acceptable than lethal control (which can be controversial as well as illegal) and is founded on the premise that nesting sites are widely available and, thus, are not limiting.

2. Early detection of potential nuisance heronry sites is essential; early vegetation control is advocated; and Texas Parks and Wildlife officials should be contacted when questions arise.

3. Selected vegetation control to move birds from a potential nuisance heronry site does not compromise the Texas Parks and Wildlife Department's responsibility toward wildlife conservation and habitiat preservation.

4. Disturbance of a heronry during the nesting season is disruptive and illegal. It causes premature nest abandonment by the young, and subsequent death of young, especially during hot weather, only contributes to the problem.

5. Tolerance of heronries is advocated where possible because conflicts often involve human encroachment into natural habitats of the birds and large-scale displacement of nesting is not consistent with sound resource management.

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Ash, Carolina	*Fraxinus caroliniana*
Ash, green	*F. pennnsylvanica*
Bumelia, gum	*Bumelia lanuginosa*
Buttonbush, common	*Cephalanthus occidentalis*
Chinaberry	*Melia azedarach*
Elm, cedar	*Ulmus crassifolia*
Elm, winged	*U. alata*
Farkleberry (Huckleberry)	*Vaccinium arboreum*
Hackberry, sugar	*Celtis laevigata*
Hawthorn	*Crataegus spp.*
Juniper (Redcedar, eastern)	*Juniperus virginiana*
Locust, honey	*Gleditsia triacanthos*
Maple, red	*Acer rubrum*
Mulberry, red	*Morus rubra*
Oak, post	*Quercus stellata*
Oak, water	*Q. nigra*
Oak, willow	*Q. phellos*
Osage Orange (Horse Apple, Bois d'Arc)	*Maclura pomifera*
Plum	*Prunus sp.*
Soapberry, western	*Sapindus drummondii*
Sumac	*Rhus sp.*
Water-elm	*Planera aquatica*

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Great Trinity Forest Management Plan

Wildlife Management

Establishing and Maintaining Wildlife Food Sources

UNIVERSITY OF FLORIDA
EXTENSION
Institute of Food and Agricultural Sciences

SS-FOR-12

Establishing and Maintaining Wildlife Food Sources[1]

Chris Demers, Alan Long and Chris Latt[2]

As human populations in the Southeast have grown, so have recreational demands for game and nongame fish and wildlife. Fortunately, southern forests have the potential to be productive wildlife areas, well suited to meet the growing recreational demands. To take advantage of potential economic opportunities, or simply for personal enjoyment, many landowners now include wildlife in their forest management objectives.

Landowners who adopt wildlife management strategies must recognize that each wildlife species requires a specific set of habitat conditions. In other words, animals will frequent your property depending on the condition, type and variety of food and cover that are present. Although proper wildlife management requires both habitat and population considerations, this publication focuses on methods of increasing the abundance and variety of wildlife food sources on, and adjacent to, forestlands. Both "consumptive" uses such as hunting and fishing, and "nonconsumptive" activities (e.g., bird watching, wildlife viewing, photography) will benefit by careful attention to these methods.

Food Sources

Food requirements vary widely among wildlife species and it is beyond the scope of this publication to include all of them. *Mast*—the flowers, seeds and fruits of plants—is probably one of the most important naturally occurring seasonal wildlife food sources on your property. Mast is often separated into two categories: hard mast and soft mast. Hard mast includes hard-shelled seeds such as acorns, hickory nuts, pine seeds and walnuts; soft mast includes flowers, catkins, seeds with a fleshy cover (e.g., berries, cherries) and soft-coated seeds.

Acorns are an especially important source of hard mast in many forests because of their substantial contribution to the total wildlife food base. Many wildlife species rely on these foods to establish fat and energy reserves that help maintain skeletal and muscle mass during seasonal stress periods, when nutritional intake is minimal or body demands are high. However, the contributions of trees and shrubs that produce soft mast may be equally important. Most wildlife species depend on a variety of food types, including the herbaceous parts of many trees and shrubs.

A critical aspect of the food requirements of different animals is the seasonality of flower and fruit production. Fruiting patterns vary among different species and localities, as well as among individual trees of the same species. Using oaks as an example, white oaks produce mature acorns

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during a single growing season. Red oaks flower and bear fruit during one growing season, but the acorns do not mature until fall of the following season. Important wildlife management objectives will be to have a variety of mast-producing species on your property so that wildlife food is available in each season. In addition to variety, the distribution of these trees across your property will also influence wildlife usage. The Forest Stewardship publication, *Making the Most of Your Mast* (SS-FOR-3), provides more detail on this subject.

Although animals will tend to favor mast whenever it is available, herbage and browse (leaves, twigs and buds) provide a second major food source, especially when mast is not available. As with mast, a variety of forage types is better than a single, or few, species. These foods are kept palatable and nutritious through forest management practices such as prescribed burning, timber thinning and harvest.

Openings and Plantings for Wildlife

A variety of wildlife species benefit from open spaces and supplemental plantings. Good examples of these habitat components include managed forest openings, edge plantings, food plots, and fruit and nut plantations.

Forest Openings

Many wildlife species require and/or benefit from open spaces. These areas provide a variety of foods and cover types which may not occur on forested sites—grasses, herbaceous plants, various insects, berries, small mammals, nesting habitat, and sites for territorial displays and watching for predators. Properly planned openings not only provide important wildlife habitat, but also can add to the attractiveness of your property, serve as firebreaks and increase internal access. Openings may be located along roads, right-of-ways and fence lines, on old log decks, as irregular small openings scattered throughout your forest, in strips between different aged plantations and even as old fallow fields. Two rules of thumb when planting pines on your property are:

- When planting areas of five to ten acres, leave openings approximately 66 feet (1 chain) wide between the newly planted area and existing forest.
- For areas of greater than ten acres, leave numerous small openings scattered throughout the new plantation.

Various low cost operations encourage the establishment and maintenance of herb and grass cover in these open areas. Disking or rotovating to break up compact soils, such as on log decks or old fire lines, can be followed by seeding clover or grass if grass cover did not previously exist. Regular mowing will prevent the intrusion of shrubs and trees. Rotational mowing, by which different areas are mowed at different times of the year, will encourage a wider variety of plants and available mast than mowing all open areas at the same time. Periodic disking of established ground covers will similarly enhance species and mast diversity. To avoid the disturbance of ground nesting species such as turkey and quail, and to promote the growth of important wildlife foods such as partridge pea, ragweed, and beggarweed, mowing and disking should be conducted during the winter months (December - February).

Landowners planning to create and maintain forest openings for wildlife are eligible to receive cost-share funding for these operations under the Wildlife Habitat Incentive Program (WHIP). Wildlife plantings also fulfill requirements for enrollment in the Conservation Reserve Program (CRP). Contact your local U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) office for more information about these programs.

Edge Plantings

Other food sources include edge plantings, food plots and fruit/nut plantations. An *edge* is a place where two or more different habitat types come together. Borders between field and forest, or forest stands of different ages or species, are valuable to wildlife because they typically contain a diversity of species from each of the adjacent plant communities. The value of edge areas can be further enhanced by planting shrubs, vines and other herbaceous plants or by managing existing vegetation to benefit wildlife

along the edges of fields, plantations, roads, water bodies or other openings. Besides wildlife foods, these plants can provide shade, nesting areas and hiding cover for many wildlife species and, in some cases, may improve the aesthetics of the property. Additional wildlife food and benefits can be provided by leaving several crop rows along the edges of agricultural fields.

Edge plantings should be at least 20 feet wide and usually contain taller plants than adjacent open areas. Sometimes the only action needed to establish a stand of shrubs, vines, and other wildlife food plants in an edge is to cut existing trees and let succession run its course. If this method fails to produce the plant community you want, it may be necessary to plant. A clever and inexpensive way to seed these areas is to plow the strip, then stretch a wire or cord between poles along its center. Birds resting on the wire will drop seeds to revegetate the strip.

If you want more control over the plant species in your edge area, transplanting from elsewhere on the property is a relatively inexpensive solution. A more costly alternative is to order nursery stock. Wax-myrtle, native hollies, hawthorn, crabapple, dogwood, wild plum, bicolor lespedeza, sumac, persimmon, cherries, blackberries, honeysuckle, greenbriar and blueberries are some of the species suitable for edge plantings. You can allow these to grow into solid thickets, which will provide both food and cover.

If you remove trees to provide sufficient light to the strips, cut the trees with the least wildlife value. Trees such as cherries, oaks, and nut-producers have high food value, and should be retained scattered throughout the edge strip.

Food Plots

Food plots are an effective, albeit relatively expensive, method of providing food sources for game birds, rabbits, raccoons, deer and other species. In this method, fields are planted with grains, corn, millet, legumes, sunflowers and other plants with high nutritional value for wildlife. The size of food plots varies according to landowner preferences and the requirements of the target wildlife species, but usually they are a minimum of 1/2 to 1 acre in size, with a maximum of 3 acres.

Entire food plots can be planted annually, but it is usually better to divide a field into strips, plowing and planting a different strip each year (Fazio, 1987). In fields large enough for five strips, the recommended yearly sequence of working the strips is 1-3-5-2-4. This sequence maximizes the age difference between adjacent strips and enhances habitat diversity. As with any crop, the successful establishment of food plots starts with proper soil sampling and depends on good seedbed preparation followed by proper liming and fertilization. Seed selection is important and should be based on your soil type and the wildlife species or groups of species you are targeting.

The Florida Fish and Wildlife Conservation Commission, the Natural Resources Conservation Service (NRCS), or the Cooperative Extension Service can provide advice on which crops to plant for your target wildlife species, the suitability of your soil for these crops, and their cultural requirements.

Fruit and Nut Plantations

Small fruit and nut plantations are another way to attract wildlife. Fast-maturing species like sawtooth oak, red mulberry, honeylocust, persimmon, black cherry and Chinese chestnut should produce fruit by age 10. Large caliper trees (diameter = 2-4 inches) should be stagger planted approximately 50 feet apart in rows 12 feet apart. Bareroot stock can be planted using a spacing pattern of 8 'x 12'. Once these mast producers bear fruit, watch them for about three years and note which trees produce well and which produce poorly. As thinning becomes necessary, remove the poor-producing trees to provide additional light and space for the best-producing trees and understory plants.

In the case of dioecious species such as red mulberry and persimmon (which produce male and female flowers on different trees) only the female trees bear fruit. To provide growing space for fruit-producing trees, you should remove most of the male trees, leaving only a few to pollinate the female flowers.

In areas where deer or rabbits may excessively browse or girdle newly established seedlings, it may be necessary to use some type of protection device, such as a tree shelter. These devices provide physical protection of seedlings until they become established and can withstand some damage.

Enhancing Wildlife Food Production in Existing Forests

Regular forest management practices can also be utilized to increase diversity, availability and quality of wildlife food. The primary objective of these practices will be to replace older shrub and hardwood cover with younger sprouts and herbaceous vegetation.

Prescribed fire causes many shrubs, grasses and herbaceous plants to resprout from roots with more succulent foliage and more prolific flowering than in the absence of fire. It also recycles nutrients, raises the soil pH and increases germination of seeds that have accumulated in the soil surface. Fire frequency and season will favor different species. For example, a one- to two-year burning schedule keeps the understory open and creates habitat favorable for quail. A three- to five-year burning schedule allows browse and cover plants to develop, thereby favoring deer. A study in the Alabama Piedmont compared populations of breeding songbirds on sites that received hot burns and sites that received cool burns. Cool fires resulted in a greater abundance and variety of birds while hot fires had more ground-feeding and ground-nesting species (Stribling and Barron, 1995).

Thinning dense pine plantations allows extra sunlight to reach the forest floor, which promotes growth of herbaceous plants, grasses, shrubs and vines. Residual pine densities of 50 to 70 ft^2 /ac are a little lower than optimum for timber production, but will favor understory plant development and are a good compromise if wildlife is to be included in forest management objectives. Follow-up treatments with prescribed burning or fertilization will increase ground cover development and the nutritional value of forage and mast.

Forests with a variety of stand ages and/or species mixtures generally support more animals than do forests with little *habitat diversity*. Pines and hardwoods, although not always economically compatible, are a very good combination for creating habitat diversity. Protect hardwood hammocks or clumps, hardwood stands along streams, and productive, mast-producing individual trees. Also, wildlife populations benefit when stands of different ages are available, because each age represents a different stage of plant succession, favoring different plant and animal species. Balancing the age structure of a forest accomplishes two objectives: (1) sustained yield of forest products, and (2) diverse wildlife habitat.

In addition to the availability of wildlife food plants, it is important that landowners consider the availability of *protective cover*. Many things can be considered cover—tall grass, brush piles, thickets, snags, stands of mature timber—depending on the wildlife species in which you are interested. In the ideal situation, plants that provide wildlife food will provide cover as well. Animals often hesitate to stray far from cover; therefore, to obtain the greatest benefit from your wildlife food sources, try to maintain patches of protective cover nearby.

Conclusion

Mast and forage production for wildlife can be increased on your forest property through the judicious use of open areas, edge strips, food plots, prescribed burning, thinning, and stand diversity, singly or in various combinations. The two most important criteria for the success of your efforts will be the diversity and seasonal availability of food sources.

Acknowledgments

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UT Extension
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Growing and Managing Successful Food Plots for Wildlife in the Mid-South

THE UNIVERSITY of TENNESSEE

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Photos by the author except where noted.
Cover photo taken by Charlie Fritts in one of the demonstration fields used to recommend forages for white-tailed deer.
Design by Gary Dagnan

Growing and Managing Successful Food Plots for Wildlife in the Mid-South

Craig A. Harper, ***Associate Professor, Forestry, Wildlife and Fisheries***

Planting food plots is an excellent way to improve available nutrition, increase the carrying capacity and concentrate wildlife on your property. Food plots do not take the place of habitat management in general, but are intended to augment the quantity and quality of food occurring naturally in an area. Whenever habitat improvement is desired, other management practices (e.g., timber management, prescribed burning and discing) should be implemented as well. Food plot plantings should depend upon which wildlife species you want to attract and the seasonal requirements of those species. Not all wildlife species benefit from all food plot plantings. Certain food plot mixtures provide benefit to different wildlife species. For example, doves do not get much benefit from a clover patch planted for white-tailed deer.

INITIAL CONSIDERATIONS

It is important to take the proper steps when preparing wildlife food plots. The process for planting food plots is really no different than farming — with wildlife as the objective. The most important consideration is matching the planting to the appropriate soil type and moisture regime in an area where wildlife will be attracted. Start by identifying locations on the property where the targeted wildlife species are often found. Then look for suitable sites for planting. The best sites are generally flat, where more moisture is retained, nutrient levels are higher and it is easier to operate equipment. Soil moisture is critical. It is very important to plant when adequate soil moisture is present to improve seed germination and establishment. In addition, the best time to plant is just prior to a rain event. When it is dry for an extended period after planting, germination and growth are usually less than desirable. Therefore, planting by a certain date is of little concern unless there is projected rainfall.

Successful plantings result when soils are amended with lime and fertilizer at rates recommended from a soil test. The next step is proper seedbed preparation and seeding depth (see Appendix 1). Drilling or covering seed too deep is a common reason for crop failure. While grains (e.g., corn and milo) can be drilled or disced approximately 1 inch deep, small-seeded species (e.g., clovers and alfalfa) should be covered no more than ¼ inch. Germination of cool-season grains (e.g., oats, wheat and rye) is generally better if the seed are lightly disced-in (especially oats). Establishing mixtures of small grains (and other relatively large seed) and small-seeded species is best accomplished by the following procedures:

It is impossible to know how much lime or fertilizer is required without collecting a soil sample and having it tested. Without question, it is the best $6 – 10 that can be spent on food plots.

1. Prepare seedbed by plowing and/or discing or tilling (lime and fertilizer should be incorporated into soil at this time if you have not done so already).
2. Sow large seed (e.g., oats, winter peas, cowpeas) onto prepared seedbed.
3. Lightly disc seed into plot, covering approximately 1 inch deep.
4. Firm the seedbed with a cultipacker (this is an especially important step for really small seeds, such as ladino clover).
5. Sow small seed (e.g., clovers, alfalfa, etc.).
6. Cultipack seedbed once again to ensure firm seed-to-soil contact and improve germination rate.

A cultipacker is the best implement to firm a seedbed prior to sowing small seed (e.g., ladino white clover) and to establish firm seed-to-soil contact after sowing. The use of a cultipacker leads to more satisfactory results than dragging some object (e.g., a log, chain or section of woven fence) across the field behind a tractor.

When planting legumes, either buy pre-inoculated seed or treat the seed with the appropriate inoculant prior to sowing. Information concerning proper inoculation is detailed in Appendix 3. Proper inoculation helps ensure crop success and can save on fertilizer costs.

Another critical consideration is weed control. Weed pressure varies tremendously in different areas and from site to site. It is advantageous to know the general weed composition in the seedbank (seed occurring naturally in the top few inches of soil). This can determine what should be planted based on the herbicides that can be used to control those weeds. Herbicide recommendations are provided with several of the recommended seed mixtures, under ***Managing Forage Plots*** and in Appendix 4.

Planting success and use of forage plots should be monitored using exclusion cages. These cages allow you to observe how much forage is being consumed by wildlife over time and to estimate the success of your planting, especially if deer are overgrazing a plot as soon as the plants germinate. Exclusion cages (approximately 4 feet in diameter and 4–5 feet tall) can be made of chicken wire wrapped around four stakes driven into the ground.

There are many commercial food plot mixtures available. Some are worth what they cost; some are not. Most commercial blends contain quality seed that can produce quality food plots if planted correctly at the appropriate time on the appropriate site. Most contain some combination of the plants listed in Appendix 1. Be aware, however, that some commercial blends contain odd mixtures. Many commercial blends contain both large seed and small seed – seed that require different seeding depths. Some commercial blends contain plant species suited for moist areas as well as species suited for dry areas. Some contain seed for both warm-season plants and cool-season plants. These mixtures are largely a waste of money because much of the seed is destined to fail, wherever and whenever it is planted. Keep in mind, however, whether you decide to mix your own planting or buy a commercial blend, the planting procedures outlined above are critical to success. Do not be misled by advertisements stating all you have to do is spread the seed on the ground with no preparation necessary. This usually leads to disappointment.

Before planting, consider food plot placement, size, shape and distribution carefully. Although

Exclusion cages should be erected to monitor the success of forage plots. This photo represents an extreme example of deer over-grazing a food plot. If the appropriate herbicides had not been used, this plot would have been covered by weeds. When that happens, most people think their planting efforts failed, when in fact, the culprit might be too many deer and/or not enough forage across the area.

size, shape and distribution may vary somewhat for different wildlife species (as described below), food plots should not be placed where they are visible from public roads. This only advertises your work and increases opportunities for poachers.

Nearly an infinite number of planting combinations could be used in food plot mixtures. The mixtures listed in this publication (rates are per acre) have produced successful food plots in the appropriate soil types and moisture regimes for the wildlife species listed. Although only five species or groups of wildlife are listed, many other species may benefit from food plots (e.g., rabbits, groundhogs, squirrels, raccoons, ruffed grouse, cardinals, blue jays, sparrows, goldfinches and bluebirds).

WHITE-TAILED DEER

Ideally, food plots for deer should constitute 2 to 5 percent of a management area (your property), with a mixture of warm- and cool-season forage plots and grain plots incorporated into your food plot program. However, research has shown that as little as 1 percent of the land area in high-quality forage plots produces measurable benefits to deer. It is important to plant warm- and cool-season plots in different fields or different sections of a field. That is, don't take away available food in preparation to plant something else. For example, iron-clay cowpeas provide nutritious forage until the first frost, which is usually in mid-October. If the plot is mowed, disced and planted to clovers in early September, forage is taken away when it is needed most (late summer). Likewise, arrowleaf clover provides quality forage through late June. If a plot of arrowleaf clover is disced in May to plant jointvetch and/or cowpeas, a prime food source is removed during a period when it is really needed (just before fawning and during early antler development).

Separate acreage should be devoted to both warm -and cool-season forages where white-tailed deer is a focal species. Separate fields can be planted or half of a field dedicated to warm-season and the other half to cool-season forages. In this photo, crimson clover has been planted as a border around a patch of corn. Deer and turkeys love this arrangement!

Half of this plot is managed in ladino white clover, while the right half is being planted to a warm-season mixture. Providing year-round quality forage for whitetails is important.

Generally, forage plots for deer are between ¼ and two acres. Several smaller plots (two acres or less each) are usually better than fewer larger plots because several smaller plots can be spread out over the management area, encompassing more deer home ranges, thus benefiting more deer. The determining factors for the minimum and maximum food plot size are shade effect, deer density and distance to cover. Food plots should be large enough and wide enough to allow most plantings at least four hours of direct sunlight. If forage plots are over-grazed, additional habitat management, larger plots and/or an increased antlerless harvest are needed (see ***Quality Deer Management: Guidelines for Implementation***, PB 1643).

For optimum use, plots should be positioned in areas where deer feel comfortable and travel regularly. Usually, this is where two or more habitats meet – where brushy cover and mature woods meet, where a brushy creek bottom flows through an old-

This is one of the demonstration fields that has been used to determine germination and growth rates, deer preference, resistance to grazing, nutritional quality and herbicide recommendations for a wide variety of forages since 1999. Forages are planted in 0.10-acre cells. Yield and consumption are monitored through stationary and mobile exclusion cages, placed at random within each cell at the end of each month.

field or where an odd corner of an agricultural field is not planted. For hunting purposes, deer will most often move into a food plot during daylight hours where cover is no more than 50 yards away.

The following forage plot mixtures for white-tailed deer were developed after five years of experimentation where many forages were compared side by side with respect to germination, growth, deer preference, resistance to browsing and nutritional quality (see Appendix 2).

When grown on the proper site and soil amendments are added as recommended, all of these forage mixtures exceed the nutritional demands of white-tailed deer while the forages are actively growing. Depending upon growth stage, expect crude protein levels to exceed 20 percent, with total digestible nutrients constituting more than 65 percent of the forage.

Warm-Season Forage Plots

Warm-season forage plots provide nutrients necessary for lactation, fawn growth and antler development. Warm-season plots are excellent areas to hunt during the early season before mast (acorns) becomes available. Warm-season plots should be planted after danger of frost and before the overly dry conditions of summer prevail. Planting usually occurs mid-April through early June. Quality warm-season forages should be available through summer until the first frost of autumn.

Warm-season forage mixture for uplands or bottomlands

20# iron-clay cowpeas
10# Quail Haven re-seeding soybeans
6# lablab
5# peredovik sunflowers

Approximate price per acre: $69; without lablab or Quail Haven soybeans: $42

Soybeans may be the all-time favorite warm-season forage of white-tailed deer, but they do not tolerate browsing well, especially when young. Unless a large field is planted to soybeans and/or the deer density is relatively low (fewer than 20 deer per square mile), soybeans are not recommended for food plots. Usually, deer eat soybean plants soon after germination and there is little or no forage left in the plot. The exception to this is the re-seeding soybeans (e.g., Quail Haven), which withstand browsing pressure quite well.

Iron-clay cowpeas and lablab provide excellent forage for deer, especially in late summer/early fall when the palatability of natural forage (forbs) is decreased. Iron-clay cowpeas, lablab and re-seeding soybeans withstand browsing pressure relatively well and grow on a wide variety of sites, including drought-prone areas with heavy clays. This combination is recommended for sites that are droughty and/or clayey, as well as bottomland sites. When planted on bottomland sites, American jointvetch and alyceclover may be added to this mixture, if desired.

This is what a warm-season forage plot should look like in late summer – plenty of nutritious forage climbing over sparse sunflowers. Forage availability is not a problem where deer populations are kept in check with the habitat. Weed management is relatively easy in warm-season plots. Techniques are outlined in the section ***Managing Forage Plots*** on page 22.

Although deer may browse newly appearing heads of sunflowers, sunflowers are not added to this mixture as a forage, but for substrate the cowpeas, lablab and re-seeding soybeans can climb and grow upon later in the season, allowing the legumes to produce additional forage per acre. If you cannot find lablab or re-seeding soybeans, or feel they are too expensive (approximately $3.50–$5.00 per pound), just increase the rate of cowpeas appropriately (60 pounds per acre).

Warm-season forage mixture for bottomlands

7#	American jointvetch (*Aeschynomene*)
7#	alyceclover
2#	rape
20#	buckwheat

Approximate price per acre: $50

This photo shows the warm-season mixture for bottomlands. It is important to include buckwheat and a forage rape with this mixture because the jointvetch and alyceclover are relatively slow to get established. The buckwheat and rape will fade out later in the summer when the jointvetch and alyceclover begin to produce considerable forage.

This mixture is recommended for bottomland sites with loamy soils. In this mixture, buckwheat germinates very quickly, providing soil stabilization and available forage soon after planting. Although the Brassicas (e.g., forage rapes) are considered cool-season plants, they also can produce abundant forage through spring and early summer in a bottomland field where it is relatively cool and moist. The high expense of this mixture is attributable to American jointvetch, which usually costs from $3.50 to $5.00 per pound.

Cool-Season Forage Plots

Cool-season plots produce forage during the cooler months. A large mast crop (acorns and beechnuts) will influence use by deer. Cool-season forage plots should provide plenty of digestible energy through winter, enabling deer to enter spring in good shape. Forage high in protein (16–18 percent) is needed during March, April and May for maximum antler growth and reproductive demands. If planted before mid-September with adequate rainfall, annual cool-season forage plots should begin providing quality forage for grazing by mid-October, persisting until the plants die the following spring/early summer. Perennial cool-season plots are slower to establish. Therefore, an annual cool-season grain (e.g., oats or wheat) should be added to perennial forage mixtures (see ***The Need for an Annual Cool-Season Grain***, on page 10). If planted in the fall, perennial cool-season forages begin to produce substantial forage the following March.

Cool-season annual mixture for uplands

10#	crimson clover
5#	arrowleaf clover
20#	Austrian winter peas
25#	oats, rye or wheat

Approximate price per acre: $29

Crimson and arrowleaf clover are recommended for just about any site, but especially those that are too dry during the summer to support perennial clovers. Both crimson and arrowleaf re-seed really well, which allows them to be maintained for years without re-seeding. It is important to include both of these in an annual clover mix because crimson germinates and establishes quicker than arrowleaf, but arrowleaf persists about two months longer than crimson.

If you are planting on poor ground and/or don't want to spend too much money, this is the mixture to use. This annual mixture is as close to a foolproof food plot as it gets! Plus, there is no mixture that will attract deer and turkeys any better than this one. Crimson and arrowleaf clover are both adapted to a wide variety of soil types and do well even on dry hills and ridgetops. Both are excellent re-seeders, which enables these plantings to be managed year after year without re-seeding, providing the appropriate herbicides and management techniques are used (see ***Plot maintenance* — Annual cool-season forage plots** on page 25). Both crimson and arrowleaf clover are important components in this mixture. Crimson clover germinates and begins to produce quality forage faster than arrowleaf. Arrowleaf clover, however, flowers and dies at least six weeks later than crimson clover (late June/early July), thus extending the period of production for this mixture

Cool-season annual "shooter's" plot

100# oats (approximately 3–4 bushels)
Approximate price per acre: $25

If you are primarily interested in attracting deer to an area to make them more visible and facilitate hunting, planting a plot of oats will do the job. No cool-season plant attracts deer more than a lush stand of green oats – that is one reason why oats are recommended in every cool-season forage mixture listed for white-tailed deer. Don't think, however, you can just disc over a field, sow the oats and deer will come. It is still important to get the pH between 6.0 and 6.5, adjust P and K levels to medium, if not high; and add 100–200 pounds of ammonium nitrate per acre as the plot is getting established. When the soil is amended correctly, a stand of oats is quite nutritious (test plots contained 26.5 percent crude protein with 70.5 percent total digestible nutrients – 23 March 2003).

It is important to plant a variety of oats that is relatively winter-hardy, such as Mitchell, Coker 227, Arkansas 833 or Harrison. As the oats mature in the spring, palatability and digestibility will decrease substantially. At this time, the plot can be disced under in preparation for an annual warm-season planting or left fallow for planting the following fall. Another option is using a burndown herbicide (e.g., Roundup) to prepare the field for planting a warm-season plot with a no-till drill. This technique conserves soil moisture and may reduce "downtime" between cool-season and warm-season production. Yet another option is allow the oats to stand through the summer (making the seed available for wildlife), spray incoming weeds as appropriate and disc in late August. At this time, you might allow the oats to re-seed (oats re-seed quite well if seed production is adequate and if a substantial amount of seed remain after wildlife feed on the plot) or re-plant the plot in a cool-season mixture.

Cool-season perennial mixture for uplands

4# ladino white clover
5# red clover
4# berseem clover
1# chicory
1# rape
25# oats or wheat
Approximate price per acre: $48
Without chicory and berseem clover: $32

This is an excellent perennial mixture; however, do not expect to retain ladino clover on exposed sites that become excessively dry during the summer. The cool-season annual mixture is much better suited to those sites. Regal ladino is well adapted to clayey sites and Osceola ladino is adapted to clay or sandy loams. There are several other varieties of ladino clover to choose from as well, including Advantage, California, Durana and others. Some are better adapted to wet conditions; some better adapted to drier conditions. All are excellent for-

Perennial clovers can be maintained longer on sites that are relatively moist through the year. Excessive drying during the summer will thin stands, sometimes to the point that re-seeding is necessary. Always include an annual (e.g., oats and rape) in perennial clover mixtures to provide quick growth, soil stabilization and available forage soon after planting.

ages for deer. The most important consideration is matching the planting to the site. Expect high use of this plot for several years, provided the plot is managed correctly (i.e., annual top-dressing with lime and fertilizer and weed control). Red clover and chicory will tolerate dry conditions fairly well (especially chicory). Chicory, however, makes this mixture relatively expensive (chicory usually costs $8–10 per pound), but it does not have to be included. If chicory is not included, the seeding rate of red clover and ladino clover should be increased

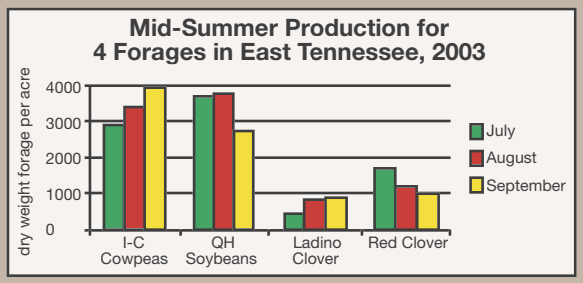
Berseem clover is an annual that can be added to a perennial clover mix. Berseem germinates and grows relatively quickly, providing forage much sooner than perennial clovers.

Red clover is classified as a biennial clover and has real potential as forage for white-tailed deer (see sidebar). When grown with perennial white clovers (e.g., ladino), red clover enables the plot to produce substantial forage longer through the summer than if white clovers were grown alone.

Red Clover – not just for cattle!

Red clover should be considered seriously by anyone planting a perennial cool-season forage plot for white-tailed deer. Red clover is classified as a biennial clover (with several varieties available); however, with proper management, it can be retained in a food plot for several years along with other clovers, such as ladino white clover. Red clover is more tolerant of dry conditions and very productive where soils have been amended properly. In recent years, red clover has gotten bad publicity by some companies that sell commercial food plot mixtures, calling red clover "cattle clover." Their claim is that red clover is too stemmy to be considered as a deer forage. These claims are wrong. Red clover does produce relatively large stems, but this is not what deer eat. Deer eat the foliage produced on the ends of the stems!

In side-by-side tests with many other forages over a five-year period, red clover has consistently been a high-preference plant for whitetails. In addition, its ability to produce extremely high-quality forage through the summer months has been remarkable. During the summer of 2003, red clover (Red Gold variety) was preferred by deer and produced more biomass (only foliage was sampled, not stems) over all other perennial cool-season forages (e.g., Advantage ladino white clover, Puna chicory, white-dutch clover, birdsfoot trefoil). Only certain warm-season forages out-performed red clover during this period.



Monthly production for 4 forages during summer 2003 from experimental plots in East Tennessee where wild white-tailed deer fed at will. Production was measured by collecting forage from mobile exclusion cages placed randomly at the end of each month within plots.

one pound each. Berseem clover is an annual clover added to this mixture because it germinates and grows relatively quickly and is a high-preference plant for deer. Rape is included because of its ability to withstand cold winter weather and provide forage even after hard frosts and snows when clovers are often "wilted down." This is often a critical time for deer when forage availability is quite low.

Cool-season perennial mixture for relatively dry sites

7#	alfalfa
4#	red clover
3#	chicory
2#	birdsfoot trefoil
25#	oats or wheat

Approximate price per acre: $73

This is a perennial plot for upland areas that are prone to becoming quite dry during summer. Expect stand thinning to occur during prolonged dry periods; however, with proper management, the stand can be retained and invigorated. Exposed sites that become excessively dry should be planted with the cool-season annual mixture. Alfalfa is sensitive to acid soils and low fertility and alfalfa weevils can become problematic. To maintain alfalfa, the pH should be raised to 7.0, both macro- (phosphorus and potassium) and micronutrients (especially sulfur and boron) need to be applied and insecticides will be necessary to combat alfalfa weevil infestations (1–2 pints of Furadan® or 1–2 pints of Lorsban® or 4–8 ounces of Pounce® per acre).

Chicory is rated as a relatively high-preference plant for whitetails (see Appendix 2). Chicory is tolerant of moderately dry conditions and makes an excellent addition to perennial clover plots, especially on those sites that become dry enough during the summer to stress clovers.

Alfalfa requires considerable management effort. Not only are soil amendments needed, but alfalfa weevils are often problematic. Control is usually necessary in the spring — recommendations are provided in the text.

Nonetheless, this forage mixture should persist for many years if top-dressed annually according to a soil test and sprayed for weevils and weeds when necessary. This mixture is not cheap (alfalfa costs approximately $3.50 per pound; chicory costs approximately $8.50 per pound; birdsfoot trefoil costs approximately $5.50 per pound); therefore, it is important to realize the management effort needed to retain this stand before planting.

Cool-season perennial mixture for moist bottomland sites

5#	alsike clover
4#	ladino white clover
2#	rape
25#	oats or wheat

Approximate price per acre: $35

This perennial mixture is well-suited for bottomland sites that are fairly moist most of the time. Weed control will be necessary and the plot should be top-dressed annually.

The Need for an Annual Cool-Season Grain

All of the cool-season mixtures listed above contain an annual component. Annual plantings complete their life cycle in one growing season and, depending on the plant, variety and management strategy, may or may not re-seed themselves. Biennials normally require two growing seasons to complete their life cycle. Perennials continue living after flowering and bearing seed and, depending upon management, may be present for many years. Because clovers, alfalfa and birdsfoot trefoil are relatively slow to get established, it is important to include a

cool-season grain (oats, rye or wheat) in the mixture. [Note: barley is not included because white-tailed deer did not eat barley when other forages were available.] Cool-season grains germinate and establish quickly, providing forage soon after planting. In addition, because establishment is relatively fast, cool-season grains help prevent soil erosion. Another reason to include these annual grasses in a cool-season forage mixture is because they serve as a "nurse crop" for perennial legumes through the first winter after planting and die the following spring/summer. This allows perennial legumes to establish a good stand before summer.

This series of pictures illustrates the typical progression of an annual (e.g., oats) planted in a perennial clover mix. This plot was sown in September 1999. Soon after planting, the oats germinated and became established, providing forage for deer quickly. By May, the oats had matured and produced seedheads and the clover had become well established. While growing, the oats served as a "nurse crop" for the ladino white clover. By July, the oats had died and started to fall over. By September, the dead oats had "melted" into the clover (the plot was not bushhogged), leaving a pure clover stand that can be maintained for several years with the appropriate management techniques (see ***Plot maintenance - Perennial cool-season forage plots*** on page 26).

Ruffed grouse don't prefer perennial grasses either!

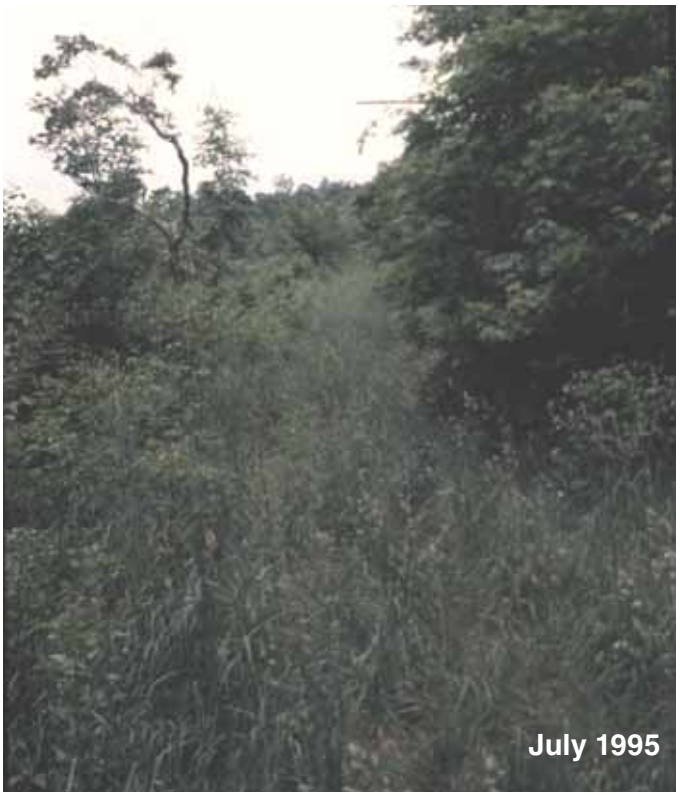
From 2000–2002, 53 ruffed grouse were collected during March in western North Carolina to determine their physiological condition and to see what grouse were eating during this time of year. The effort was part of a regional project – the Appalachian Cooperative Grouse Research Project – that studied the ecology and management of ruffed grouse in the central and southern Appalachians. Crop contents from all birds killed were identified, weighed and preserved. All of the grouse were killed from gated roads that were initially planted in an orchardgrass/white-dutch clover mixture. Leaves and flowers of herbaceous plants were found in 92 percent of the 53 crops examined and comprised 40 percent of the material in the crops over the three-year period. Other foods included evergreen and deciduous leaves, acorns, ferns, buds and twigs, soft fruits, etc. Of the herbaceous material eaten, cinquefoil and clover represented the vast majority, followed by avens and ragwort. The interesting thing was that orchardgrass, which was the dominant cover on most of the roads, was not present in any of the grouse crops. In fact, the graduate student who sorted through the crops of 326 grouse colected from NC, VA, WV, KY, MD and PA reported, "Grasses were not eaten much at all at any site in any year. I did get a few (very few) grasses in crops, but their quantities were very minimal (usually not measurable) and were classified as 'trace' (<0.1 gram dry mass). Apparently grouse ate grass incidentally while foraging on the forbs."

(Bob Long, M.S. Thesis, West Virginia University)

Don't Plant Perennial Cool-Season Grasses

Do not include tall fescue, orchardgrass, brome-grasses, bluegrass or timothy in any food plot mixture! Perennial grasses rank at the bottom in terms of forage preference by white-tailed deer. In the experimental plots used to determine the above recommendations, there was no measure of deer foraging on tall fescue or orchardgrass at all, in any year or season (see Appendix 2). Noted food habit studies of white-tailed deer across the South over the past 50 years also have noted a lack of perennial grasses in the diet. Not only are they not preferred, perennial grasses are competitive and usually choke out clovers by the second growing season, leaving nothing but a rank field of grass with relatively high lignin content, providing low palatability, low

These 2 photos show plots of oats and orchardgrass in the same field during April. The difference in growth and use by deer is obvious. Oats has consistently been the most preferred cool-season forage by white-tailed deer every year since the demonstration fields were established, while virtually no measure of grazing has ever been recorded in the orchardgrass plots during any season of the year. In addition, crude protein and total digestible nutrients are both considerably higher in oats (until maturity) than orchardgrass (see Appendix 2). Which would you rather have in your forage food plot?



This woods road was limed, fertilized and sown with a mixture of white dutch clover and orchardgrass in the fall of 1993. By July 1995, the clover was out-competed and disappeared from the site, resulting in a road of orchardgrass, which offered poor-quality forage, poor structure for poults and fewer invertebrates. Perennial cool-season grasses should never be included in a planting mixture where wildlife is a consideration.

digestibility and low nutrition. Even if other desired forages were not choked out completely, why would you want a certain percentage of your food plot taken up by non-preferred plants with lower nutritional quality? It doesn't make sense!

Are you interested in wild turkeys, ruffed grouse or bobwhites using your plot(s)? If so, then there are more reasons why you shouldn't plant perennial cool-season grasses. Because of the sod-forming nature of these grasses, a dense mat is created at ground level. This inhibits travel for young turkeys, grouse and quail. Research in the southern Appalachians showed wild turkey and grouse broods used only the periphery of openings dominated by orchardgrass, while openings of naturally occurring weeds arising from the seedbank were used entirely.

Grain Plots

Grain plots are primarily warm-season annual plots; however, they provide important sources of energy during fall and winter, particularly when the hard mast crop is poor. Corn is by far the favorite among white-tailed deer; however, grain sorghum and/or several types of peas can be planted along with corn. Peas climb up the corn and milo stalks in late summer and provide quality warm-season forage until the first frost. Strips of corn 100–150-feet wide adjacent to strips of forage plots (listed previously) make excellent sources of food and cover for deer, rabbits, wild turkeys, bobwhites and doves. When sowing grain plots, keep in mind a lighter seeding rate is better than a heavy seeding rate. Grain plots seeded in excess of the recommended rate generally produce less seed. Also, larger plots (2–3 acres, or more) are usually warranted when growing grain plots. Smaller plots, especially when located near drainages, may be decimated in a night or two by raccoons.

Corn/Milo mixture

8# quality seed corn
3# grain sorghum (milo)
20# iron-clay cowpeas or 10# catjang cowpeas
Approximate cost: $27

Weed control may be necessary and can be difficult when peas are included in the mix. A pre-emergence application of 2 pounds Atrazine® per acre is recommended to control various broadleaf and grass weeds in corn and grain sorghum plantings. However, the addition of peas restricts you from being able to use Atrazine®. When forage legumes are included, 2–3 pints of Prowl® applied pre-emergence is recommended.

Corn plots may be drilled with a corn planter, but this is not necessary. Successful grain plots are possible by simply discing and covering the seed 1–2 inches after sowing. Corn is a heavy nitrogen user. It is very important to amend the soil as recommended by a soil test. Recommended seed corn is open-pollinated (less expensive) or hybrid field corn (more expensive) commonly grown for feed. Seed corn prices are variable and fluctuate year to year. Both seed corn and grain sorghum are often available free through local chapters of Quail Unlimited. A 50-pound bag of seed corn will plant four acres of corn alone and even more if other seeds are included in a mixture. Seed variety of grain sorghum is very important. Preference should be given to tall varieties and bird-resistant varieties. Tall varieties compete with weeds (and corn) better and bird-resistant varieties help prevent seed crop depredation through the summer by house sparrows, grackles and starlings. KS 989 is a good tall, bird-resistant variety of grain sorghum.

WILD TURKEYS

All the cool-season forage plots listed for white-tailed deer will attract wild turkeys as well. Expect heavy use in late winter/early spring after the acorn crop disappears and turkeys begin searching for green patches. In addition, wild turkeys will use both warm-season forage plots and perennial cool-season plots as "bugging grounds." These plots usually harbor an abundance of insects and other invertebrates that are critical components in the diet of wild turkey poults during early- to mid-summer.

Wheat is also a valuable food source for many species of wildlife. Turkeys, deer, rabbits, groundhogs, quail, doves and many species of songbirds eat the forage and/or seed produced. Whenever turkeys and quail are a primary consideration, wheat should be considered over oats in forage plot mixtures listed for deer. If the soil is amended properly, green wheat forage can be quite nutritious (test plots contained 24.9 percent crude protein with 69.6 percent total digestible nutrients – 23 March 2003). If the plots are not overgrazed and allowed

Corn is a great source of carbohydrates and energy for wildlife during the fall and winter. During years with a large acorn crop, corn plots may not be used much. When this occurs, leave the corn standing. Excellent brood cover for wild turkeys and bobwhites is created the following spring and summer by forbs germinating from the seedbank, while the corn is preserved by the shucks. Later, during the second fall after planting, the plot can be bushhogged a few strips at a time to make the remaining corn more available.

to mature and produce seed, a quality food source is available for birds the summer after planting. If allowed to set fallow, these fields (as well as corn/milo fields) can provide excellent brood habitat for wild turkeys and bobwhites the following summer (second summer after planting) as a variety of forbs become established from the seedbank.

Wild turkeys readily feed upon available grain during fall and winter. The grain plots listed for deer and doves are also excellent choices for wild turkeys. Chufa (a variety of yellow nutsedge) is another popular planting for wild turkeys. Turkeys feed upon the nut-like tubers produced among the roots of chufa. Be aware, however, that chufa grows best in sandy soils and turkeys cannot feed upon the tubers unless they can scratch down into the soil far enough to turn up the roots. This is not possible in heavy clays unless the soil is disced after the chufa has matured. For these reasons, chufa plots are most successful in sandy or sandy-loam soils.

MOURNING DOVES

Doves are attracted to many different seeds and grains, including corn, milo, millets, sunflowers and buckwheat. Larger food plots (5–20 acres) are recommended to attract large numbers of doves. Freshly cut grain fields are preferred feeding spots for doves. Doves do not scratch and are "weak-beaked;" therefore, they prefer feeding upon loose grain (rather than corn still attached to the cob) or other seed in relatively open sites with some bare ground available. Bushhogging and strip discing can make seeds more available and feeding sites more attractive. Do not bushhog an entire field at once, but mow and/or disc sections or strips to provide seed throughout the fall and winter. Doves also prefer fields with structure (e.g., trees or powerlines) nearby that allow them to perch and loaf near the field. In addition to perching sites, a source of water and grit will make the area more attractive for doves.

Weed control can be a problem in dove fields, but be aware that several naturally occurring weeds (e.g., ragweed, barnyardgrass, tropic croton, red-

Photos by Marion Barnes

Grain fields are most attractive to doves when seed is scattered by bushhogging or silage chopping. Either way, don't clear an entire field, but cut strips, leaving food available for later in the season.

root amaranth, pokeberry, Carolina geranium, foxtail grasses, fall panicum) produce seed favored by doves and actually can make a food plot more attractive to these birds. Where certain broadleaf weeds (e.g., cocklebur, sicklepod) are problematic, grasses (e.g., milo and millets) should be substituted for forbs (e.g. sunflowers) because 2,4-D then can be used for weed control. Where grasses (especially crabgrass and johnsongrass) are problematic, a pure stand of sunflowers or buckwheat allows the use of grass-selective herbicides (e.g., 8-10 ounces of Select® per acre) to control grass weeds.

Mixed plot for doves

10# white proso millet
10# dove proso millet
10# browntop millet
5# peredovic sunflowers or 3# grain sorghum

Approximate cost: $25

Research has shown white proso millet is the preferred seed for mourning doves, followed closely by dove proso millet and browntop millet. Regardless of type, if a good crop of millet (including foxtail and pearl) is established, doves will come. The propensity for doves to feed on sunflowers is no secret; however, where deer are abundant, sunflower heads may be consumed before maturing.

Corn/milo plot for doves

10# quality seed corn
3# grain sorghum (milo)

Approximate cost: $17

Pure stands of corn or milo may be planted according to the rates given in Appendix 1. These grains also can be mixed, if desired, and planted at the rate shown above. A pre-emergence application of 2 pounds of Atrazine® per acre is recommended to control various broadleaf and grass weeds.

Sunflower plot

25# peredovic sunflowers (black-oil type)

Approximate cost: $13

Sunflower fields are normally managed by bushhogging sections or strips before and during the dove season. Fields of sunflowers also can be burned after the plants mature and turn brown to attract birds. Burning releases the seed and creates an open structure at ground level that doves prefer. For weed control, 3 pints per acre of Prowl® should be applied pre-emergence, then disced to approximately 1 inch deep before planting. Treflan® (1.5–2.0 pints per acre) may be tank mixed with Prowl® for additional weed control. Select® (10 ounces per acre) or Poast Plus® (2.5 pints per acre) may be used for post-emergence grass control.

Managing Wheat Fields for Dove Hunting

Hunting over baited fields is always a concern for dove hunters (at least most of them!). Because mourning doves are migratory, the US Fish and Wildlife Service regulates the restrictions placed on dove hunting. The US Fish and Wildlife Service allows dove hunting over mowed or cut grain fields as well as fields grown specifically for doves and other wildlife. In addition, "Lands planted by means of top-sowing or aerial seeding can be hunted [for doves] where seeds are present solely as the result of a normal agricultural planting or normal soil stabilization practice. Normal agricultural planting, harvesting or post-harvest manipulation means a planting or harvesting undertaken for the purpose of producing and gathering a crop, or manipulation after such harvest and removal of grain, that is conducted in accordance with official recommendations of state Extension specialists of the Cooperative State Research, Education

and Extension Service of the US Department of Agriculture." (Note: By policy, the Service does not make a distinction between agricultural fields planted with the intent to harvest and those planted without such intent as long as the planting is in accordance with Cooperative Extension Service recommendations.) (Excerpts from Title 50, Code of Federal Regulations, Parts 20.11 and 20.21i)

This means dove hunting over harvested and non-harvested agricultural fields is legal. Further, it is legal to hunt doves on, over or from fields of top-sown or drilled winter wheat as long as the seeding rate does not exceed that recommended by the state Extension Service. Nonetheless, you should always check current and local laws before manipulating and hunting fields for doves.

Winter wheat is one of the most popular plantings for wildlife food plots. And for good reason – both the forage and seed are nutritious and fed upon by a myriad of wildlife species, both game and non-game. A planting of wheat has other benefits as well. If allowed to set fallow for a year after maturity, excellent brood habitat is created for wild turkeys and bobwhites by forbs germinating from the seedbank during the second summer after a fall planting.

Recommended rates (UT Extension) for top-sowing winter wheat on a prepared seedbed.

Use	Seeding rate*	Seeding dates
Winter cover	1–1.5 bushels per acre	Sept 15 – Oct 20
Fall grazing	2–3 bushels per acre	Sept 1 – Oct 1
Cover, wildlife enhancement or fall grazing	1.5–3 bushels per acre	Aug 15 – Oct 15

**Seeding rate may be increased 50 percent if using combine-run seed.*

The following summer, after the wheat has produced seed and died, the field can be burned to attract doves again. When the dead foliage is consumed by fire, the seeds are released and made readily available to ground-feeding birds (if not already consumed by wild turkeys, songbirds, small mammals and/or deer).

BOBWHITE QUAIL

Bobwhites use a variety of grain plots, annual lespedezas and weedy fields for seed. In addition to the mixtures listed for doves, quail benefit from mixtures that include cowpeas and soybeans when the deer density is low enough to allow these plants to produce seed. Food plots for quail should not be nearly as large as those for doves. Quail require all of their habitat needs in close proximity. As a result, they are often associated with habitat edges. Food plots for quail should be long and narrow, ideally along a field border situated close to blocks of natural cover (e.g., oldfields, thickets and woodlots) or brushy fencerows or hedgerows. A prime location would be adjacent to the corner where a fallow field and a rowcrop field (separated by a brushy hedgerow) meet a cutover area or some other type of thicket.

Quail broods frequent forage plots and weedy fields as they search for insects and other invertebrates. Optimally, fields intended for use by quail should be relatively open at ground level with a canopy of forbs (weeds) overhead. This type of

environment enables quail chicks in search of invertebrates to move about easily while protected by the "umbrella cover."

"Weeds" that should be encouraged for bobwhites include ragweed, partridge pea, beggar's-lice, Carolina geranium, milk pea, butterfly pea, smartweeds, blackberry, pokeberry, native lespedezas, morninglories, annual panicgrasses and foxtail grasses. These plants are important for bobwhites, for both food and cover. To stimulate these plants, disc blocks and/or strips adjacent to field borders in late winter. This disturbs the soil and encourages seed in the seedbank to germinate. The plant composition created by discing not only provides a food source, but also serves as cover for quail, rabbits and many other small animals. Discing around fields serves as a firebreak as well. Burning oldfields every two or three years is by far the best way to maintain early successional habitat favored by many wildlife species, including bobwhites, wild turkeys, rabbits and deer.

Burning is by far the best way to manage fields for wildlife. Burning consumes the litter layer, allowing small wildlife to travel through the field easily. Burning also stimulates plant growth and allows the seedbank to germinate, creating a "natural food plot" for many wildlife species. The bottom picture was taken in July after the field was burned in March. Conditions for brooding quail and turkeys were optimum, browsing by deer was obvious and rabbits were seen throughout the field when the picture was taken.

Do not plant tall fescue, orchardgrass, bromegrasses, bluegrass or timothy! They can be detrimental to bobwhites and other wildlife species for several reasons. Perennial cool-season grasses displace good nesting and brood-rearing habitat (such as native warm-season grasses and the associated "weeds" described above). The dense structure of perennial cool-season grasses at ground level precludes the mobility of quail chicks and other small wildlife species (see ***Don't Plant Perennial Cool-Season Grasses*** on page 12). Also, fields dominated by these grasses typically do not harbor as many invertebrates as fields predominately comprised of forbs (broad-leaved herbaceous plants), providing less food for young quail, wild turkeys and ruffed grouse. When invertebrates are less abundant, broods have to spend more time searching for food, which leads to increased energy expended and increased exposure. Later in life, when seeds become more important in the diet, the thatch produced by perennial cool-season grasses limits seed availability (if any is present). Further, consumption of tall fescue seed by bobwhites leads to weight loss, cloacal swelling and, ultimately, increased mortality. For these reasons, it is obvious that cool-season perennial grasses displace quality habitat for bobwhites and, over time, can lead to increased mortality and reduced recruitment into the fall population.

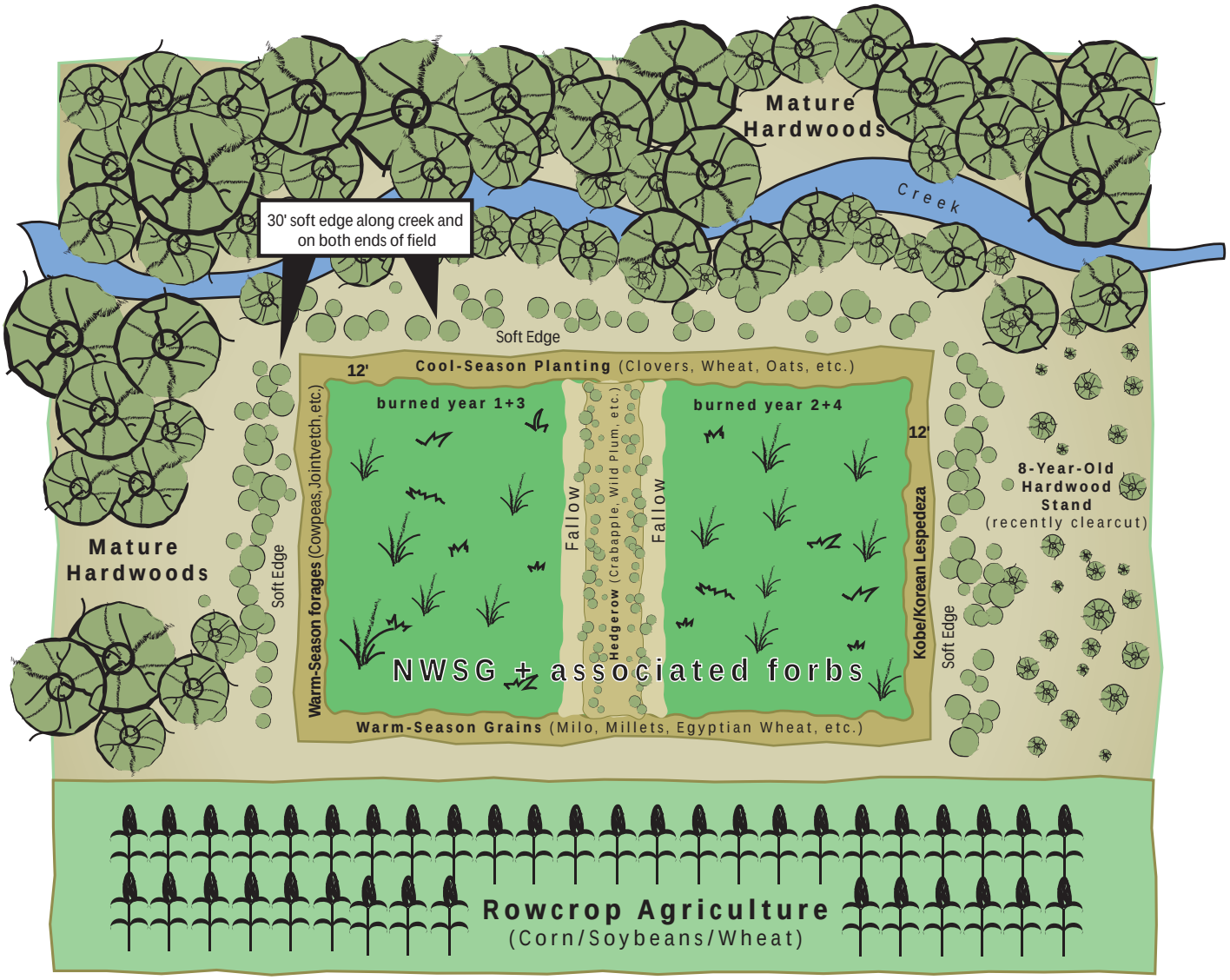
Fields can be made more attractive to feeding, brooding and nesting bobwhites by killing perennial cool-season grasses and allowing the various forbs listed above to establish. Perennial cool-season grasses are killed most effectively by spraying while they are actively growing. Burndown herbicides (e.g., glyphosate) are recommended when the field is dominated by these grasses. Grass-selective herbicides (e.g., Select®) may be used when desirable grasses (e.g., native warm-season grasses) are not in abundance across the field. Other selective herbicides (e.g., Plateau®) can be used to kill tall fescue when desirable forbs and grasses are present. Refer to labels for rates and application recommendations. Also, see ***Plot Preparation — Getting Rid of Perennial Grasses*** on page 23 for additional information on controlling perennial cool-season grasses.

Firebreak Management

Prescribed fire is the most effective and efficient management technique used to enhance and maintain quality early successional habitat. Prescribed fire is also highly recommended to improve habitat conditions for many wildlife species in forest stands, including pine stands and hardwood stands. Whenever controlled burning is conducted, it is very important to establish a firebreak around the area before burning to help keep fire from spreading into areas where burning is not intended. Most firebreaks around fields are created with a tractor and a disc; bulldozers may be used to establish firebreaks within forest stands (some of which may be used as woods roads).

Photo by Mike Hansbrough

Planting firebreaks is an excellent way to provide a quality food source adjacent to cover. This firebreak has been planted to clovers and is used to contain fire when burning the native warm-season grasses between the firebreak and the road, which is on the left side of the photo.



This illustration shows the proper arrangement, juxtaposition and management for bobwhites and other wildlife species. A 4-acre field of native warm-season grasses has been established and is being managed with prescribed fire. A hedgerow of soft mast-bearing shrubs and trees was created to break the field into two sections. Firebreaks are planted to various mixtures, providing a supplemental food source.

Firebreaks should be established well ahead of the projected burning date. If you plan to burn in late winter/early spring, it is a good idea to establish your firebreak the previous fall. This allows the firebreak to be planted to a cool-season food plot, if desired. If the firebreak is located adjacent to woods, it may be necessary to disc after the leaves fall or re-discing may be necessary, as fire can move across a firebreak filled with leaves and/or pine needles.

When managing for quail, blocks of cover (fields) should be created with strips of food (planted firebreaks), as opposed to blocks of food and strips of cover. This is because cover is almost always the limiting factor for bobwhites. This technique provides good juxtaposition of food and cover.

Firebreaks can be managed in several different ways. They can be planted to cool-season forage plots, warm-season forage plots, grain plots or left fallow to stimulate the seedbank and establish naturally occurring legumes and other forbs. Managing firebreaks for year-round food resources is recommended. This can be done by planting different sections (depending on your objectives) of your firebreak in different types of food plots. Several different seed mixtures are possible to provide quality food strips for quail. An example is given in the figure on page 18.

One long side of the firebreak was planted to a cool-season forage strip. This section will provide green forage during winter and spring and invertebrates during the brood-rearing season. The other long side was planted in a warm-season mixture to provide supplemental seed in late summer through fall and winter. One short side was planted in warm-season legumes for seed production, brood habitat and forage for deer, rabbits and groundhogs during summer. One short side was planted in lespedeza to provide seed for bobwhites during winter. Firebreaks adjacent to the central hedgerow were left fallow to stimulate desirable weed growth, which will provide seed, invertebrates and sites for dusting. All of these food sources are in close proximity to quality nesting, brood-rearing and escape cover. This juxtaposition helps decrease the required travel and exposure of a given pair, brood or covey.

A word about Native Warm-Season Grasses

Native warm-season grasses (including big bluestem, little bluestem, broomsedge bluestem, indiangrass, switchgrass, sideoats grama and eastern gamagrass) are planted (or stimulated and encouraged by burning and using selective herbicides) to provide cover for wildlife; in particular, nesting and escape cover for quail, rabbits and several species of songbirds. Nwsg grow in bunches and, when sown and managed correctly, contain open ground between bunches. Bobwhites prefer to nest at the base of these bunchgrasses and use the open spaces as “runways” for travel and feeding. White-tailed deer also use fields of nwsg as bedding sites and fawning areas. Nwsg are not, however, planted as food plots for wildlife.

Photo by Mike Hansbrough

Annual cool-season firebreak mixture

5# crimson clover
20# Austrian winter peas
50# wheat
Approximate cost: $23

An annual cool-season mixture is recommended for firebreaks. This facilitates the need to disc every year or two in late summer/early fall. This mixture is adapted from the annual cool-season forage plot recommended for deer, except wheat is included and at a higher rate because seed production is desired. If Austrian winter peas are not included, just increase the percentage of crimson clover (another 5 pounds) as appropriate.

Annual warm-season firebreak mixture (forb and grass)

15# iron-clay cowpeas
20# soybeans
10# buckwheat
5# browntop millet
5# grain sorghum (milo)
Approximate cost: $26

Photo by Jerry Rhinehardt

This is the mixture used for the Tennessee 4-H Food And Cover Establishment (FACE) plots. This mixture produces an abundance of seed for birds; however, seed production from soybeans, cowpeas and buckwheat may be limited in areas with a high deer density. Sunflowers (3 pounds) can be added to this mixture if desired.

Annual warm-season firebreak mixture (grass only)

7# white proso millet
7# browntop millet
5# Egyptian wheat
5# grain sorghum (milo)
Approximate cost: $20

Deer eat very little grass during summer; thus, this mixture does well even where there is a high deer density.

Annual warm-season firebreak mixture (lespedeza)

15# Kobe/Korean lespedeza
2# partridge pea
Approximate cost: $40
Without partridge pea: $16

Kobe and Korean lespedeza produce seed readily fed upon by quail during fall and winter. Using annual lespedezas in a firebreak facilitates discing in late winter, just prior to burning a field in March or April.

Bobwhites relish seed from Kobe/Korean lespedeza, which are available through winter, making areas planted to these lespedezas primary feedings spots from December through February. The best time to plant is late winter (mid-Feb–mid-Mar). Both Kobe and Korean lespedeza are good re-seeders, which allows them to be retained by discing in late winter (many stands will re-seed without discing). If not already present in the seedbank, partridge pea is a good addition to this mixture. Partridge pea seed, however, is expensive (approximately $12 per pound).

WATERFOWL

Food plots in areas that can be flooded 8–12 inches are magnets for ducks. A shallow dike with some type of water-control structure (e.g., flashboard riser) enables the water level to be manipulated over the field. Flooding should be conducted gradually beginning September through November (according to objectives), with full flood occurring by late November. Drawdowns also should be conducted gradually and completed by late February, if another crop is to be grown.

Natural Resources Conservation Service

A water-control structure allows the water level to be manipulated when fields are flooded for waterfowl.

It is important to realize food plots for ducks cannot be manipulated like those for doves. Current federal regulations allow waterfowl hunting over standing crops and harvested crops (flooded or not). Crops, however, cannot be manipulated except by standard agricultural practices used to establish, manage and harvest the crop. Grain inadvertently scattered through harvest operations, entering or exiting the field, placing decoys or retrieving birds is not considered bait. Nonetheless, you should always check the current US Fish and Wildlife Service and state hunting regulations before hunting.

The main consideration when establishing a food source for waterfowl is deterioration of seed after inundation (flooding). Naturally occurring moist-soil plants typically persist longer than agricultural crops. For example, many moist-soil plants (e.g., smartweeds, sedges, panicgrasses) experience only 20–25 percent deterioration after flooding for 90 days. In addition, most agricultural crops do not contain enough protein to provide a complete diet for waterfowl. It is for these reasons that naturally occurring moist-soil plants should be encouraged either in the same flooded unit or in an adjacent flooded unit to provide optimum feeding conditions for waterfowl.

Millet mixture

15# browntop millet
15# white proso millet
Approximate cost: $21

Browntop and white proso millet are highly sought after by several duck species. Browntop millet has a maturation date of only 60 days (white proso, 70 days) and a deterioration rate of only 25 percent after 90 days of inundation, making this mixture most worthy of consideration.

Natural Resources Conservation Service

Managing naturally occurring moist-soil vegetation will attract lots of ducks, such as these mallards. The U.S. Fish and Wildlife Service allows vegetation within moist-soil areas to be manipulated (e.g., bushhogging and burning) for duck hunting; however, crops (e.g., planted millets, corn, chufa), whether grown for ducks or agriculture, cannot.

Japanese millet

25# Japanese millet
Approximate cost: $18

Japanese millet can be flooded shallowly, but not inundated, soon after establishment. This supports wetland habitat into the growing season and helps provide weed control. Japanese millet has a maturation date of 90 days after germination and a deterioration rate of 57 percent after 90 days of inundation. Often, Japanese millet re-establishes in an area where previously grown if it is allowed to mature and produce seed. "Naturalized" Japanese millet (that coming up naturally at least one growing season after it was planted) can be manipulated legally, as can other naturally occurring moist-soil plants.

Grain mixture

7# quality seed corn
5# grain sorghum (milo)
Approximate cost: $17

Corn and milo have deterioration rates of 50 and 42 percent, respectively, after 90 days. Soybeans should not be flooded for ducks because they decompose rapidly (86 percent over 90 days) and may cause food impaction within duck crops (throat), which can be fatal.

Chufa

40# chufa
Approximate cost: $132

Chufa can be planted for ducks, just as for wild turkeys. Ducks relish the tubers, much as turkeys do. Chufa grows best in well-drained sandy loams, but can be grown in predominantly clay soils as well. This is not a problem when planted for ducks (as it is for turkeys) because the area is later flooded, which makes the soil relatively soft, enabling ducks to get to the tubers. Chufa does best in high-fertility soils; therefore, P and K levels may be raised to high levels (31–120 and 161–320 pounds available per acre, respectively). After the chufa has grown to 6–12 inches in height, top dress with ammonium nitrate (100–200 pounds per acre). Chufa matures approximately 100 days after germination. Broadleaf weeds can be controlled with 2,4-D and problem grasses can be controlled with Select®. "Clean" chufa plots typically produce greater yields than weedy plots. Chufa plantings can be expensive (approximately $3.50 per pound).

Winter wheat

100# wheat (1½–2 bushels)
Approximate cost: $25

Wheat sown in the fall can be flooded after it reaches about 6 inches in height. This produces an excellent food source for Canada geese and American wigeon.

MANAGING FORAGE PLOTS

To establish and maintain quality food plots for wildlife, management is necessary. This is especially true for perennial plots. Food plot management involves liming, fertilizing, herbicide and insecticide applications, mowing, discing and rotational planting.

Maintaining soil pH at the appropriate level is critical. Soil pH can limit plant growth by restricting nutrient availability to plants. In acid soils, nutrients may be bound to soil particles; thus, only a limited amount of any fertilizer applied is actually available to the plant. This condition is corrected by liming. Liming corrects soil acidity, improves

Site and nutrient availability are major considerations when planting food plots. Liming is absolutely critical to increase soil pH, improve availability of nutrients, improve nitrogen fixation among legumes and increase herbicide effectiveness. Hiring a lime truck from the local fertilizer supplier is much more efficient and economical than buying and applying bagged lime.

nutrient availability, supplies calcium and magnesium, improves nitrogen fixation in legumes, reduces nutrient leaching and improves the efficacy of herbicides. On acid soils (pH < 5.8), liming is the most important step in establishing and managing successful food plots. After the pH has been corrected, annual top-dressing with the appropriate fertilizers will boost available nutrition and growth. Consider liming fields by contracting a lime truck (ag lime) from a local farm supply store – it is much more cost effective. Lime trucks typically have a six-ton minimum order. At $16 per ton (price is higher in some areas, lower in others), the order will cost about $100 for six tons of lime. Compared to bagged lime, this may be the biggest bargain of all time. A 50-pound bag of pulverized dolomitic lime costs approximately $1.89 per bag – $75 per ton. A 40-pound bag of pelletized lime costs approximately $2.89 per bag – $145 per ton. Plus, you have to handle and spread bagged lime yourself! Be aware that **ag lime, pulverized lime and pelletized lime have the same neutralizing properties**. The notion that less pelletized lime is needed is wrong. Pelletized lime is largely a waste of money unless you are applying it on very small acreage.

Weed control is another problem and is absolutely necessary for many types of food plots, especially forage plots. The seedbank in your soil is full of weed seeds. Ever since Eve ate the fruit, we have had a problem with weeds (Genesis 3:17-18) and it is doubtful the situation will improve much in the near future! There are many herbicides available for a myriad of applications. Appendix 4 lists several commonly used herbicides for managing wildlife food plots. The applications listed do not represent the only possibilities, but have been used with success for the stated objectives. Before using any herbicide, be sure to read the label and follow directions.

Plot Preparation — Getting Rid of Perennial Grasses

Preparing the site before planting is extremely important, especially if perennial grasses are present and/or if you are planting a perennial food plot. If perennial grasses are not controlled (especially tall fescue, bermudagrass and johnsongrass), they will present major competition problems later. The most widely used multi-purpose herbicide is glyphosate. It is available under several trade names with various formulations. The most familiar trade name is Roundup®. Roundup UltraMax®

Grasses should not be included in warm-season forage plots for deer. Not only do deer seldom eat grasses in the summer, but the worst weed problems are grasses. In this photo, johnsongrass has completely overtaken a field of cowpeas (evident in the exclusion cage). Several herbicides are available to prevent this problem.

offers a higher concentration of glyphosate (50.2 percent) and has surfactant included in the product. Other brands offer reduced concentrations of glyphosate and may or may not include surfactant; however, the price is usually considerably lower.

The use of surfactants is critical for success of post-emergence herbicide applications. Surfactants are water- or oil-soluble substances added to herbicides to modify or enhance the effectiveness of the active ingredient. Surfactants are surface-active agents that produce physical changes at the interface of the liquid herbicide mixture and the surface of the plant. Surfactants help herbicides stick, spread, wet, penetrate and disperse on the surface of plants. Hence, surfactants are not added to pre-emergence applications, unless no-till drilling seed and weeds are already present. In short, surfactants make many herbicides more effective by aiding the herbicide to penetrate the plant.

If tall fescue or orchardgrass is present where you intend to plant, spray 1.5–2.0 quarts of a glyphosate herbicide per acre in the fall before a spring planting or 2 quarts per acre in the spring before a fall planting. It is critical that the grass be burned, hayed, grazed or mowed before spraying. Burning, grazing or haying is best. This provides a "clean" field for spraying, free of thatch and dead material that will block much of the herbicide from contacting the growing grass. The grass should be growing vigorously and 6–10 inches in height when sprayed for best results.

If bermudagrass is the dominant field cover, the field should be burned in late winter. Bermudagrass should be sprayed the following summer with imazapyr (48 ounces of Chopper® or 24 ounces of Arsenal® AC per acre with surfactant). An application of a glyphosate herbicide at 2 quarts per acre mixed with 12 ounces of Select® per acre is another option. It is not advisable to plant a perennial plot in the fall after spraying bermudagrass. Instead, plant an annual plot and wait to see if the bermudagrass returns the following summer. If it does, growth should be fairly sparse, but don't let that fool you! It will spread across the field in a couple of growing seasons if not sprayed again. Because bermudagrass does best in full sunlight, a warm-season annual (e.g., iron-clay cowpeas and lablab) can be planted at this time to help "smother" residual bermudagrass by shading. Once you have control of the bermudagrass, then plant a perennial cool-season forage if desired.

If johnsongrass is a problem, wait until it reaches 18–24 inches in height at the whorl and spray with 2 quarts of a glyphosate herbicide or 8 ounces of Select® per acre with surfactant added. Another way to control johnsongrass is with a pre-emergence herbicide application (spraying immediately after planting). Control of residual sprouts is then much easier (with a grass-selective herbicide) if a broadleaf plot (e.g., cowpeas and/or lablab) is established. A pre-emergence application of Pursuit® DG (2 ounces per acre) when planting legumes (e.g., clovers, alfalfa, cowpeas, lablab) provides excellent control. Efficacy of pre-emergence herbicide applications is increased when applied within a day or two of a rain event. Precipitation is necessary to carry the herbicide down into the top couple inches of soil where the weed seed will be germinating. Johnsongrass also can be controlled with a rope wick applicator and a 50:50 solution of glyphosate and water. The solution is "wiped" on the taller johnsongrass stems and leaves and does not kill clovers, cowpeas or other plants underneath.

Plot Maintenance

Warm-season forage plots

Weed control in warm-season forage plots is relatively easy. To begin, only forbs should be planted in warm-season forage plots — no grasses. This is because deer eat very little grass during summer and the worst warm-season weeds are grasses — crabgrass, johnsongrass and bermudagrass.

This series of photos shows the importance of weed control in forage plots. The picture at the top shows a plot of iron-clay cowpeas that was not sprayed. The middle photo is from a plot of iron-clay cowpeas (grown adjacent to the plot in the top photo) that was sprayed pre-emergence with 2 ounces of Pursuit® DG per acre. The bottom photo shows the two plots side by side a few

Grass-selective herbicides, such as Select® or Poast Plus®, can be applied post-emergence over any of these forages to help control grass weeds (remember to add surfactant). Pursuit® can be used to control non-leguminous warm-season broadleaf weeds, such as cocklebur, groundcherry/nightshade, jimsonweed, morninglories, pigweeds, prickly sida, ragweed, lambsquarters, spurges and others. If applied post-emergence, all of these weeds should be sprayed before they flower. Best results with Pursuit® are usually realized when plots are sprayed pre-emergence. Treflan® and Prowl® are

pre-emergence/pre-plant incorporated herbicides that can be used with most warm-season food plot plantings. All of these herbicides, however, do not control all weeds equally. Refer to labels for species controlled by each. When planting mixtures of legumes and sunflowers (such as the mixture listed on page 6), Treflan® or Prowl® is recommended because Pursuit® will kill sunflowers.

Bushhogging is another practice used to reduce weed competition, especially when hard-to-control weeds (e.g., horseweed) are present or when other annual weeds are present late in the growing season (September/August). Plots should be mowed before weeds flower and produce seed. If weeds get too tall for optimum spraying efficacy (see herbicide labels for optimum heights to control different weeds with various herbicides), mow as appropriate, then spray as weeds begin to grow afterwards. If annual warm-season weeds are present in late summer, just mow as needed to keep them from flowering – spraying at this time is generally a waste of money.

Annual cool-season forage plots

Cool-season legumes can be sprayed pre-or post-emergence with Pursuit® just like warm-season legumes. Treflan® (1.5 pints per acre) or Prowl® (2 - 3 pints per acre) can be sprayed pre-emergence/pre-plant before establishing cool-season plots. The appropriate herbicide depends on what is being planted (refer to herbicide labels) and the problem weed.

Annual cool-season forage plots don't have to be! Good re-seeding annual clovers, such as crimson and arrowleaf, can be managed year after year without re-planting. After the annual clovers and cool-season grains (oats, rye or wheat) have died and gone to seed in June or July, bushhog the plot. Weeds will begin to germinate from the seedbank and grow. Before the weeds flower, spray the entire plot with a glyphosate herbicide (plus surfactant) at 2 quarts per acre. It is important to spray before the weeds flower. Not only is a better kill realized, it also helps reduce the seedbank. Bushhog the plot again after the weeds die. If additional weeds appear before Labor Day, spray again at the same rate. In late August/early September, top-dress with the appropriate amount of lime and fertilizer and disc the plot. You have effectively re-sown your annual plot without planting! If Brassicas (e.g., dwarf essex rape) and/or additional cool-season grains are desired, they can be top-sown before (oats) or after (rape) discing.

Annual clovers can be managed so that re-seeding is not necessary.

Photo at upper left shows how a stand of crimson and arrowleaf clover, planted in the fall, should look in April — lush and green.

Photo at left shows how a stand of crimson clover and oats should look in June — brown and dead with a few weeds starting to come in. Through the summer, the plot should be sprayed with a glyphosate herbicide (such as Roundup®) to kill all incoming weeds before they flower. Around Labor Day, the plot should be top-dressed as necessary with lime and fertilizer and disced to effectively re-seed the plot.

Photo above shows a 2-year-old plot of arrowleaf clover in March. The right side was disced the previous September, while the left side was not. The difference is dramatic.

If cool-season grains (e.g., oats or wheat) are planted alone, broadleaf weeds, such as henbit, deadnettle and chickweed, can be controlled with Overdrive® (4 - 8 ounces per acre with surfactant added). This is a forb-selective herbicide that will not kill grasses and may be more effective than 2,4-D. Spray cool-season broadleaf weeds before they reach 4 inches in height for best results.

Perennial cool-season forage plots

Perennial cool-season forages are vulnerable to a host of weeds. The biggest threats during fall and winter are the cool-season broadleaf weeds, especially henbit, purple deadnettle and common chickweed.

These weeds can be especially problematic in the year of establishment because perennial forages are relatively slow to get started. This makes pre-emergence/pre-plant herbicides (e.g. Treflan® and Prowl®) particularly important. Treflan® (1.5 pints per acre) can be used with perennial legumes and other forb plantings, such as rape and chicory. Pursuit® does an excellent job at reducing problem weeds when applied pre-emergence, however, it should not be used when planting non-legumes, such as rape and chicory. The addition of a cool-season annual grain also helps with initial weed problems because these grasses (e.g., oats and wheat) germinate quickly.

In established perennial legume plots (e.g., ladino white clover, alfalfa, birdsfoot trefoil), an application of Pursuit® DG (2 ounces per acre with surfactant added) or Butyrac® 200 (1 - 3 quarts per acre with surfactant added) is effective in controlling many cool-season and warm-season weeds. Do not spray seedling legumes until at least three fully expanded trifoliate leaves have appeared and do not spray Pursuit® DG over cool-season grain seedlings if you want to retain them. In general, weeds are most susceptible before they reach 4 inches in height.

For control of grasses, especially crabgrass, rhizome johnsongrass, residual tall fescue and bermudagrass, an application of Select® (8 ounces per acre) or Poast Plus® (2 pints per acre) with a non-ionic surfactant added is recommended when grasses are actively growing. Following an herbicide application during spring or summer, top-dressing in September with the appropriate amount of lime and fertilizer will have your perennial forage plots looking good. Treatment for white grubs (Japanese beetles and June bugs) may be necessary in the third or fourth year after establishment.

Purple deadnettle (left) and henbit (right) are common cool-season weeds that can become a real problem if not controlled.

MANAGING OLD LOGGING ROADS FOR WILDLIFE

Planting and maintaining old logging roads (a.k.a. “woods roads”) in quality forages can do more than reduce erosion, it also can improve habitat for a variety of wildlife species by creating linear wildlife openings.

Linear openings can be particularly important to wildlife in areas that are vastly forested where there is relatively little early successional growth. Where white-tailed deer is the focal species and it is desired to establish 2–5 percent of the area in food plots, planting woods roads is often a good way to get the needed acreage planted without having to clear additional forest land, which can be quite expensive. Planting woods roads can impact more animals per acre of ground planted than food plots when the road traverses and winds through an area, encompassing the home range of more animals.

It is important to realize all of the planting procedures outlined under ***Initial Considerations*** also apply when planting woods roads. The foremost consideration is the amount of light reaching the road, which is the biggest limitation when maintaining forages in wooded areas. Unless the adjacent stand has been thinned or regenerated recently, the road will need “daylighting” – that is, trees will need to be removed along at least one side

If a woods road gets a lot of traffic, it is not sensible to plant the road itself. Instead the sides of the road should be "daylighted" and planted, such as this road where crimson clover has been planted along the sides.

When woods roads do not receive much traffic, the road itself can be planted. This road was initially planted to ladino white clover and oats. After three years, a solid stand of clover remains. Encroaching japangrass has been sprayed along the sides. Can't you just see a deer feeding or a gobbler strutting his stuff along this road?!?

of the road to allow sufficient sunlight to reach the road for the forages to grow.

Roads can be managed for wildlife in a variety of ways if the road is gated to public traffic. If the road is gated to public traffic, yet still gets a considerable amount of traffic from land managers, it probably should be graveled. These roads still can be managed for wildlife by clearing and planting the sides of the roads.

Roadsides also can be left fallow. Woody growth can be suppressed by spraying a woody-selective herbicide (e.g., Arsenal® AC and/or Garlon®). Mowing every other year will stimulate and encourage additional herbaceous growth from the seedbank. If the road is gated and does not get much traffic, the road itself can be planted.

Many of the same forages used in food plots can be planted on woods roads; however, some are better suited than others. For example, crimson clover, subterranean clover and white clovers are all relatively shade tolerant. Ladino white clover persists well on roads traversing through bottomlands and on hillsides with an eastern or northern exposure. Ladino white clover does not, however, do well on southern or western exposures. Red clover and alfalfa do not respond to traffic as well as the white clovers. Taller forages, such as sweetclover and arrowleaf clover, are not usually desirable on roads and do not stand up to traffic well.

Soil erosion is often associated with woods roads and logging decks after logging. In fact, research from the Coweeta Hydrologic Lab near Franklin, North Carolina has shown more than 95 percent of the erosion and siltation into creeks following logging opperations comes from improperly constructed roads, not the logging itself. Because erosion is such an important factor, many land managers have been led to the false assumption that it is necessary to include tall fescue or orchardgrass in a mixture sown on woods roads. **This is not true and certainly counterproductive for wildlife**!

Germination and growth of annual cool-season grasses (e.g., oats, wheat, annual ryegrass) are considerably faster than perennial cool-season grasses, which is important for reducing run-off from winter rains. The preference for oats and wheat as forage over tall fescue and orchardgrass was discussed under ***Cool-Season Forage Plots*** for white-tailed deer and the value of wheat seed and resulting brood habitat for wild turkeys and bobwhite quail was mentioned under ***Wild Turkeys***. This practice also benefits ruffed grouse in the same manner when implemented on woods roads where grouse occur (see sidebar on page 11).

It should be noted also that, for a number of reasons, native warm-season grasses are not suited for planting woods roads either. Nwsg are established for wildlife to provide cover, not forage (see sidebar on page 19). Deer, rabbits, groundhogs and other species rarely eat nwsg. In fact, all perennial grasses (whether native or not) are simply not preferred over forbs. Cover along old logging roads is not a limiting factor, as slash, blackberries and other weedy growth is in abundance all along these roadsides. The primary limitation for wildlife in vastly forested tracts is forage, particularly during the fall and winter months. That is why roads are planted to

cool-season forages instead of warm-season forages. In addition, establishment of nwsg is relatively slow, which is not desirable on sites that need cover established quickly to protect against erosion.

Perennial woods road mixture

4# ladino white clover
2# white-dutch clover
2# birdsfoot trefoil
50# oats or wheat
Approximate cost: $38

Oats and wheat germinate and grow relatively quickly, helping to prevent soil erosion while providing quality forage for wildlife. The rate of a cool-season grain should be doubled over that for a food plot because erosion is such a consideration. This mixture will do best in bottomland areas and on slopes facing east and north where there is more moisture.

In vastly forested areas, woods roads can receive a lot of use when planted to desirable species. This clover road in the mountains of NC has seen much use by deer, wild turkeys, black bears and ruffed grouse.

Annual woods road mixture

15# crimson clover
50# oats or wheat
Approximate cost: $25

This annual mixture can be managed as in a food plot (to retain the crimson clover) or it could be left fallow to encourage naturally occurring forbs and grasses.

Annual woods road planting

120# wheat (2 bushels)
Approximate cost: $25

Sowing a road to wheat protects it from erosion. In addition, forage and seed for wildlife is produced. During the summer following establishment (after the wheat has gone to seed and died), naturally occurring grasses and forbs in the seedbank will germinate and create excellent wildlife habitat for future years and protect against erosion. Wild strawberry, low panicgrasses, beggar's-lice, cinquefoil, asters and blackberry provide forage and seed for deer, turkeys, grouse and songbirds, while the perfect structure for brood habitat is created. Roads managed as such should be mowed every other year in the winter and sprayed with a woody-selective herbicide as necessary to kill encroaching woody species.

CONCLUSIONS

Planting and managing food plots can be very rewarding. To work with the land and watch wildlife respond to and benefit from your efforts can be intoxicating. Planting and maintaining quality food plots, however, requires planning, dedication and can be fairly expensive. It requires year-round effort, especially if you hope to actually increase the carrying capacity of your property.

Perhaps the most important thing to realize is there is no "magic bean." There is no single planting that provides a high-quality year-round food source for wildlife. Multiple plantings in the appropriate sites are absolutely necessary to make a real difference in terms of available nutrients and energy for wildlife. Pay no attention to all the ads and gimmicks. There are no worthy short cuts to quality food plots and there is no "trophy in the bag." Establishing quality food plots requires knowledge of farming practices. Managing food plots is simply farming for wildlife!

Finally, the savvy manager realizes **habitat management is the most fundamental component in managing wildlife populations and that food plots are secondary to sound timber management, oldfield management and the judicious use of prescribed fire and herbicides where appropriate**. That being said, let there be no doubt that incorporating quality food plots into a sound habitat management program will enable wildlife populations to respond in ways they were previously unable.

Working with the land and seeing wildlife respond to your efforts is very rewarding. Growing and maintaining quality food plots is an excellent way to make wildlife more visible while providing increased nutrition needed throughout the year.

Appendix 1. Planting guide for wildlife food plots.

Crop Species[1]	Seeding Rate (lbs/ac)[2]		Planting Date
Cool-Season Legumes[3]			
Alsike clover (perennial)	10		Sept 1 – Oct 1
Arrowleaf clover (annual)	10		Aug 15 – Oct 1
Ball clover (annual)	5		Aug 15 – Oct 1
Berseem clover (annual)	20		Aug 15 – Oct 1
Crimson clover (annual)	25		Aug 15 – Oct 1
Ladino white clover (perennial)	8		Sept 1 – Oct 1; Feb 15 – Apr 1
Red clover (biennial)	15		Sept 1 – Oct 1; Feb 15 – Apr 1
Rose clover (annual)	20		Aug 15 – Oct 1
Subterranean clover (annual)	15		Aug 15 – Oct 1
White-dutch clover (perennial)	6		Sept 1 – Oct 1; Feb 15 – Apr 1
Sweetclover, yellow or white (biennial)	20		Sept 1 – Oct 1; Feb 20 – Apr 1
Alfalfa (perennial)	20		Aug 15 – Sept 15; Mar 1 – May 1
Austrian winter peas (annual)	50		Aug 15 – Oct 1
Birdsfoot trefoil (perennial)	10		Aug 15 – Oct 1; Feb 20 – Apr 1
Cool-Season Grasses			
		lbs/bushel	
Oats (annual)	100	32	Sept 1 – Oct 15; Feb 15 – Mar 15
Rye (annual)	100	56	Sept 1 – Oct 15
Triticale (annual)	100	48	Sept 1 – Oct 15
Wheat (annual)	100	60	Aug 15 – Oct 15
Ryegrass (annual or perennial)	30		Aug 15 – Oct 15; Feb 15 – Apr 1
Warm-Season Legumes[3]			
Alyceclover (annual)	20		Apr 1 – June 1
American jointvetch (annual)	15		Apr 1 – June 1
Catjang cowpeas (annual)	30		Apr 1 – June 15
Iron-clay cowpeas (annual)	75		May 1 – June 15
Lablab (annual)	20		May 1 – June 15
Soybeans (annual)	85	60	May 1 – June 15
Re-seeding soybeans (annual)	40		May 1 – June 15
Kobe and Korean lespedeza (annual)	30		Feb 15 – Mar 15
Partridge pea (annual)	15		Mar 1 – June 1
Warm-Season Grasses			
Corn (annual)	13		Apr 1 – May 15
Grain sorghum (milo) (annual)	10		Apr 15 – June 15
Egyptian wheat (annual)	15		Apr 15 – June 15
Browntop millet (annual)	30		Apr 15 – June 15
German (foxtail) millet (annual)	25		Apr 15 – June 15
Japanese millet (annual)	25		May 1 – Aug 31
Pearl millet (annual)	30		Apr 15 – June 15
Dove proso millet (annual)	35		Apr 15 – June 15
White proso millet (annual)	35		Apr 15 – June 15
Other Plantings			
Buckwheat (annual; warm-season)	40		Apr 15 – June 1
Chicory (perennial; cool-season)	10		Apr 1 – May 15
Chufa (annual; warm-season)	50		Apr 15 – June 15
Rape (annual; cool-season)	8		Mar 1 – May 15; Aug 15 – Oct 1
Sesame (annual; warm-season)	12		Apr 15 – June 1
Sunflower (annual; warm-season)	25		Apr 15 – May 15
Turnips (annual; cool-season)	8		Mar 1 – May 15; Aug 15 – Oct 1

[1]Most commercial mixes are comprised of three or more of the species (or varieties) included in this chart.

[2]All seeding rates are for a single-species planting. When planting mixtures, the seeding rate for each species included should be reduced according to the number of species in the mixture, the composition preferred and the growth form and desired structure of the resulting stand. Seeding rates are given for broadcast plantings. Drilled plantings may require less seed.

[3]All legume seed should be inoculated with species-specific inoculant prior to planting unless the seed was purchased pre-inoculated (see Appendix 4).

Planting Depth	Optimum pH	Preferred Soil Type
¼″	5.8 – 6.5	Adapted to cool climate; moist, bottomland soils
¼″	6.0 – 6.5	Fertile, well-drained sandy loams and light clay
¼″	5.8 – 7.0	Widely adapted; tolerates poor drainage and relatively low fertility
¼″	6.0 – 7.5	Requires highly fertile, moist soils
¼″	5.8 – 7.0	Well-drained sandy loams to heavy clays; moderately shade tolerant
¼″	6.0 – 6.5	Fertile, bottomland, moist - sandy loam to clay; mildly shade tolerant
¼″	6.0 – 7.0	Sandy loamy to clay; tolerates wide range of moisture regimes
¼″	6.0 – 7.0	Sandy loam to clay; tolerant to drought and low soil fertility
¼″	5.8 – 7.0	Well-drained sandy-loam and clay upland sites; mildly shade tolerant
¼″	6.0 – 6.5	Widely adapted - best on fertile, moist bottomland; mildly shade tolerant
¼″	6.5 – 7.0	Well-drained
¼″	6.5 – 7.0	Well-drained loams
1 - 2″	6.0 – 7.0	Heavy clay, moderately fertile
¼″	6.0 – 7.0	Well-drained
1 - 2″	5.8 – 6.5	Well-drained, light-textured
1 - 2″	5.8 – 6.5	Well-drained, light-textured clay or sandy soils; not poorly drained soils
1 - 2″	5.8 – 6.5	Well-drained, light-textured clay or sandy soils; not poorly drained soils
1 - 2″	5.8 – 6.5	Well-drained, light-textured - not poorly drained soils
¼ - ½″	5.8 – 6.5	Well-drained, most textures; tolerates poorly drained soils
¼″	6.5 – 7.0	Moderately- to well-drained soils, including bottomland sites
¼″	5.5 – 6.5	Moist, wet, light-textured loams are best—not droughty soils
½ - 1″	5.5 – 7.5	Widely adapted, well-drained
½ - 1″	5.5 – 7.5	Well-drained soils; drought tolerant; tolerates relatively low fertility
1″	5.5 – 7.5	Well-drained soils; drought tolerant; tolerates relatively low fertility
1 - 2″	5.8 – 6.5	Widely adapted, well-drained soils
½ - 1″	5.8 – 6.5	Well-drained soils
½ - 1″	5.8 – 6.5	Widely adapted
½ - 1″	6.0 – 6.5	Sandy loam to clay
1 - 2″	5.8 – 6.5	Widely adapted, well-drained
1″	5.8 – 6.5	Widely adapted, well-drained
¼ - ½″	5.8 – 6.5	Widely adapted, well-drained
¼ - ½″	5.5 – 6.5	Well-drained
¼ - ½″	5.5 – 6.5	Well-drained
¼ - ½ ″	5.5 – 7.0	Moist soils; tolerates shallow flooding after becoming establishment
¼ - ½ ″	5.5 – 6.5	Well-drained
¼ - ½ ″	5.5 – 6.5	Well-drained
¼ - ½″	6.0 – 6.5	Well-drained; tolerates dry sites
½ - 1″	6.0 – 7.0	Widely adapted; tolerates relatively low fertility
¼″	5.8 – 6.5	Widely adapted; drought tolerant
1 - 2″	5.8 – 6.5	Moderately- to well-drained sandy or loam soils; avoid clay soils
½ - 1″	5.8 – 6.5	Widely adapted
½″	5.8 – 6.5	Well-drained clayey loams
1 - 2″	5.8 – 6.5	Widely adapted, well-drained
¼″	5.8 – 6.5	Widely adapted

Appendix 2.

Growth, deer preference and nutritional information for selected forages in the Mid-South region as determined after 5 years of experimentation using side-by-side comparisons and collecting data (measuring and clipping forage) inside and outside stationary and mobile exclusion cages.

Species	Germination and Initial Growth Rate	Grazing Preference	Resistance to Browsing	Crude Protein (percent)[1]	Total Digestible Nutrients (percent)[1]	Date Forage Collected	Quality Forage Available[2,3]
Cool-season legumes							
Arrowleaf clover	slow	high	excellent	31.0	82.8	23 Apr 03	March – June
Berseem clover	moderate	high	excellent	24.8	80.7	23 Apr 03	October – December; March – May
Crimson clover	moderate	high	excellent	28.4	82.7	23 Apr 03	October – December; March – April
Alsike clover	slow	high	excellent	—	—	—	March – July; October – December
Ladino white clover	slow	high	excellent	31.5	79.7	Apr 02	March – June; October – December
Red clover	slow	high	excellent	23.7	70.1	30 June 03	March – August; October – December
Sweetclover	slow	moderate	good	31.1	79.3	Apr 02	March – early June
White-dutch clover	slow	moderate	excellent	31.3	79.7	Apr 02	March – June; September – December
Alfalfa	slow	moderate	excellent	29.1	77.0	Apr 02	March – early August; September – December
Austrian winter peas	relatively fast	high	fair	28.0	78.4	23 Apr 03	September – April
Birdsfoot trefoil	slow	relatively low	good	28.2	77.4	Apr 02	March – July; September – December
Crown vetch	extremely slow	low	good	16.9	56.2	July 04	September – August (after establishment)
Hairy vetch	moderate	low	good	—	—	—	September – April
Cool-season grasses							
Barley	fast	very low	excellent	23.9	68.9	22 Mar 03	September – mid April
Oats	fast	high	excellent	26.5	70.5	22 Mar 03	September – mid April
Wheat	fast	high	excellent	24.9	69.6	22 Mar 03	September – mid April
Rye	fast	high	excellent	23.6	69.0	22 Mar 03	September – mid April
Ryegrass	fast	low	excellent	—	—	—	September – mid April

Appendix 2. (cont.)

Species	Germination and Initial Growth Rate	Grazing Preference	Resistance to Browsing	Crude Protein (percent)[1]	Total Digestible Nutrients (percent)[1]	Date Forage Collected	Quality Forage Available[2,3]
Orchardgrass	slow	no use recorded	n/a	14.6	61.4	Apr 02	n/a
Tall fescue	slow	no use recorded	n/a	16.6	67.3	Apr 02	n/a
Matuagrass	relatively slow	relatively low	excellent	22.0	80.5	22 Mar 03	November – April
Warm-season legumes							
Alyceclover	slow	moderate	good	20.8	64.1	July 04	July – October
American jointvetch	slow	moderate	good	25.3	74.5	July 01	July – October
Iron-clay cowpeas	moderate	relatively high	good	29.7	78.3	July 01	June – October
Lablab	moderate	relatively high	good	25.7	67.2	July 01	June – October
Soybeans	moderate	high	poor	28.6	71.4	July 04	June – October
Quail Haven soybeans	moderate	relatively high	excellent	24.5	—	8 Aug 03	June – October
Other plantings							
Buckwheat	fast	moderate	excellent	—	—	—	May – September
Chicory	moderate	relatively high	good	25.4	74.4	March 04	November– December; March – July; September – December
Rape	moderate	moderate	good	32.9	87.7	July 01	October – early April
Turnips	moderate	relatively low	good	—	—	—	October – early April

[1]Levels of crude protein and total digestible nutrients vary greatly with respect to plant maturity, soil fertility and soil moisture. These figures merely represent what the forages are capable of on certain sites at certain times of the year.
[2]This represents the general time period(s) when forage production is best, starting from the time of planting and going through the following year. Forage availability is naturally dependent upon many factors, such as time of planting, soil conditions, weather and weed control.
[3]Perennial cool-season legumes (as well as chicory) generally do not produce considerable forage during the fall of establishment. Production is best the following spring and early summer, then picks up again the following fall. In addition, clovers and chicory normally "wilt down" in the winter following hard frosts and very cold temperatures. In milder winters, mid-winter production may be significant.

Appendix 3.

Innoculating legume seed for successful wildlife food plots.

Legumes are plants that bear seed in a pod and have a symbiotic relationship with certain species of nitrogen-fixing bacteria (e.g., *Rhizobium* spp., *Bradyrhizobium* spp.). These bacteria attach themselves to the roots of legumes and form nodules. From these nodules, the bacteria extract nitrogen from the air. *Rhizobia* and others obtain energy from the plant, while the plant receives nitrogen produced by the bacteria. Thus, both bacteria and plant benefit from the relationship. This phenomenon is important when planting wildlife food plots for three reasons: 1) minimal nitrogen fertilization is required (thus, you save money), 2) nitrogen is not a limiting factor to properly inoculated plants and 3) weed competition is reduced because little nitrogen fertilizer is applied.

Particular legumes require specific bacteria; no one species of bacteria will inoculate all legumes. Therefore, it is important to use species-specific inoculant for the legume planted. Although bacteria, such as *Rhizobia*, are found naturally in the soil, it is critical to inoculate seed prior to planting to ensure the proper bacteria is in contact with the seed. Seed of many improved varieties of legumes may be pre-inoculated. This means the seed has been inoculated already with the proper bacteria prior to bagging. Pre-inoculated seed is coated to protect the bacteria and usually has an off-white or gray color. Because the bacteria are present under the coating surrounding the seed, pre-inoculated seed do not need to be inoculated if the seed is sown before the expiration date on the seed tag. Check the seed certification tag to determine if the seed has been pre-inoculated, the germination test date and the inoculant expiration date. If the inoculant has expired, additional inoculation may be necessary.

If the seed is not pre-inoculated, the following procedure will ensure proper inoculation.

1. Buy inoculant suited specifically for each legume planted. Inoculant has a limited life span (it is a bag of live bacteria), so it is important to check the expiration date.
2. Never expose the package of inoculant to heat or direct sunlight (especially the dashboard of a truck), as this will kill the bacteria. To ensure viability, inoculant should be refrigerated.
3. Most inoculants come packaged in a medium of peat, which is black. This material must be mixed with just enough water to form a "slurry."
4. It is critical that the inoculant adheres to the seed. If not, the entire process may be useless. A commercial "sticker" should be used to stick the inoculant to the seed. Some stickers contain gum arabic, which is recommended for its ability to sustain high numbers of bacteria on the seed. If a commercial sticker is not available, a solution of 4 parts water to 1 part sugar can be used as a substitute. Do not use cola as a sticker because the pH of most soft drinks is very low and the acid solution may kill the bacteria.
5. Mix the sticker with the inoculant as directed on the package to form a slurry. Add slurry to seed and mix well, making sure all seeds are coated with inoculant. The coated seed should be allowed to sit in the shade and dry. Do not place in the sun to dry. The seed should be dry enough to sow in about an hour. Do not mix inoculated seed with fertilizers, because the salts in fertilizer can kill the bacteria in the inoculant.

Properly inoculated seed may later produce up to 200 pounds of nitrogen per acre, depending on species of legume planted. This is very beneficial in reducing fertilization costs, especially when following a legume crop with a grass, such as corn, grain sorghum, wheat or oats.

Legumes commonly grown for wildlife and their associated inoculant groups[1].		
Legume group	**Inoculant code**	**Bacterium**
Alfalfa Sweetclover	A	*Sinorhizobium meliloti*
Alsike clover Ball clover Ladino white clover Red clover White-dutch clover	B	*Rhizobium leguminosarum* biovar *trifolii*
Austrian winter peas Field peas Flat peas Hairy vetch Sweet peas	C	*Rhizobium leguminosarum* biovar *viceae*
Alyceclover American jointvetch Cowpeas Lablab Lespedezas Partridge pea Velvet bean	EL	*Bradyrhizobium* spp.
Prairieclover Sainfoin	F	*Rhizobium* spp. (*Petalostemum*) *Rhizobium* spp. (*Onobrychis*)
Birdsfoot trefoil	K	*Mesorhizobium loti*
Crownvetch	M	*Rhizobium* spp. (*Coronilla*)
Arrowleaf clover	O	*Rhizobium leguminosarum* biovar *trifolii*
Berseem clover Crimson clover	R	*Rhizobium leguminosarum* biovar *trifolii*
Soybeans	S	*Bradyrhizobium japonicum*
Rose clover Subterranean clover	WR	*Rhizobium leguminosarum* biovar *trifolii*
[1]For additional information regarding LiphaTech Nitragin® Brand inoculants and Nitra-Coat® sticking agent, call 1-800-558-		

Inoculated seed should be allowed to dry in the shade. The seed should be ready to plant in an hour or so. If allowed to dry in direct sunlight, the bacteria may be killed.

Properly inoculated seed is obvious. You can see the black peat from the inoculation mixture stuck all over these peas.

Appendix 4.

Various herbicides[1] and possible applications for establishing and managing wildlife food plots.

Trade Name	Common Name	Suggested Rate per Acre	Application	Crop	Manufacturer	Approximate Cost	Purpose for Spraying
Roundup	glyphosate	1 – 5 quarts	post-emergence	—	several	varies	Spraying existing vegetation for new plots
Pursuit DG	imazethapyr	2 ounces	pre- or post-emergence	legumes	BASF	$155 per 14.4 ounces	Controlling forb and grass weeds in legume plots
Prowl 3.3 EC	pendimethalin	2 – 3 pints	pre- or post-emergence	several	BASF	$55 per 2.5 gallons	Controlling forb and grass weeds in legume plots and sunflower plots
Select 2EC	clethodim	8 – 10 ounces	post-emergence	forbs	Valent	$175 per gallon	Controlling grass weeds
Poast Plus	sethoxydim	2 – 3 pints	post-emergence	forbs	BASF	$125 per 2.5 gallons	Controlling grass weeds
Arsenal AC	imazapyr	6 – 24 ounces	post-emergence	—	BASF	$480 per gallon	Controlling woody succession
Garlon 3-A	triclopyr	2 pints – 2 gallons	post-emergence	—	Dow AgroSciences	$73 per gallon	Controlling woody succession
2,4-D Amine	2,4-D	1 – 2 pints	post-emergence	grasses	several	$7 per quart	Controlling forb weeds
Butyrac 200	2,4-DB	1 – 4 pints	post-emergence	legumes	several	$30 per gallon	Controlling non-leguminous forb weeds
Treflan HFP	trifluralin	1 – 2 pints	pre- or post-emergence	several	Dow AgroSciences	$83 per 2.5 gallons	Controlling forb and grass weeds
Atrazine 4L	atrazine	2 pints	pre- or post-emergence	corn, grain sorghum	several	$25 per 2.5 gallons	Controlling forb and grass weeds
Overdrive	dicamba and diflufenzopyr	4 – 8 ounces	pre- or post-emergence	grasses	BASF	$36 per pound	Controlling forb weeds

[1]Use of brand, trade or company names in this publication is for clarity and information; it does not imply approval of the product or company to the exclusion of others, which may be of similar composition or equal value. Always be sure to read, understand and follow directions and precautions on herbicide labels before use. As herbicides, herbicide labels and their availability and recommendations may change, it is best to consult your local Extension agent, state wildlife agency or farm supply distributor for the latest recommendations on herbicide use.

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Much of the information concerning forages for white-tailed deer would not have been available if not for graduate students, Ryan Basinger and John Gruchy, who helped tirelessly in planting, spraying and collecting biomass and nutritional data. Marion Barnes (Clemson Extension Service), Gary Bates (University of Tennessee Extension) and Kent Kammermeyer (Georgia Department of Natural Resources) reviewed a previous manuscript and provided helpful comments and suggestions.

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Flowering and Fruiting

Of Southern Browse Species

L. K. Halls

Southern Forest Experiment Station
Forest Service
U. S. Department of Agriculture

1973

Flowering and Fruiting of Southern Browse Species

L. K. Halls [1]

Flowering and fruiting dates are reported for 14 browse species growing in the open and beneath trees in an east Texas pine-hardwood forest. Dates for individual species generally were not influenced by tree cover. Usually flowers bloomed earliest when March temperatures were highest. In the open, plants generally produced fruit more consistently and abundantly and at an earlier age than beneath the trees. American beautyberry and yaupon yielded the most fruit. Honeysuckle and yaupon fruits persisted longest through the winter.

Additional keywords: Phenology, fruit yields, *Pinus elliottii, P. taeda.*

Because plant fruits are a vital food source for wild birds and mammals, wildlife managers need to know when various plants bear fruits and how much they yield. This paper describes the flowering and fruiting characteristics of 14 common species of woody vines, shrubs, and small trees in southern forests. The information is based on observations made at the Stephen F. Austin Experimental Forest near Nacogdoches, Texas, from 1963 through 1972. Certain phases of the study were reported previously (Halls and Alcaniz, 1968 and 1972).

SITE TREATMENTS

A sawtimber-size stand of shortleaf *(Pinus echinata* Mill.) and loblolly *(P. taeda* L.) pines was thinned to a tree basal area of 70 sq. ft. per acre. Understory vegetation was cut or killed with chemicals before planting of 1-year-old seedlings. Nine plants of each of the 14 species were spaced equally within each of four contiguous ¼-acre blocks. Shrubs and vines were planted 5 feet apart; small trees, 10 feet apart.

The same planting schedule and arrangement were implemented in a nearby abandoned field. Here the land was disked before planting, and weeds were controlled by disking until the study plants were definitely established and thereafter by mowing.

Twenty-four plants of each species (three from each block in the two planting sites) were selected for flowering and fruiting observations. A few of these plants died during the study. The age when plants first bore mature fruits was noted. Thereafter, the seasonal development of flowers and fruits was recorded from beginning date of growth until final fruit fall the following winter. Samples of mature fruits were collected, dried at 70°C., and weighed to compute an average ovendry weight per fruit. This figure was multiplied by number of fruits per plant to obtain the total annual yield. Number of mature fruits per gram, moisture content, and ratio of pulp to seed were calculated when a sufficient sample was available from 1967 through 1972.

Temperatures were continuously recorded by hygrothermographs at both study locations, and daily rainfall was measured by a standard rain gage nearby.

WEATHER RECORDS

Rainfall.—Annual rainfall ranged from a low of 32 inches in 1967 to a high of 66 inches in 1968 (table 1). For 7 years out of 9 it was below the longtime average of 46 inches. Droughts of several weeks duration occurred

[1] On the staff of the Wildlife Habitat and Silviculture Laboratory, which is maintained at Nacogdoches, Texas, by the Southern Forest Experiment Station in cooperation with the School of Forestry, Stephen F. Austin State University.

in the summers of 1964 and 1965. Total rainfall in 1966 was very close to the yearly average. The 1967 rainfall was 14 inches below average, and soils were especially dry from June through November. In contrast, rainfall was much above average in 1968 and through May 1969. This wet period was in turn followed by a prolonged dry period that extended through June 1972. Heavy rains occurred in July, and rainfall was above average for the remainder of the year.

Table 1.—*Seasonal rainfall (inches) at Stephen F. Austin Experimental Forest*

Year	Winter	Spring	Summer	Fall	Total
1964	9.4	13.2	7.2	8.9	38.7
1965	10.9	11.9	7.2	11.7	41.7
1966	11.7	15.1	12.6	6.8	46.2
1967	6.6	11.2	6.3	8.0	32.1
1968	13.0	26.7	14.0	12.4	66.1
1969	15.1	13.6	5.2	8.8	42.7
1970	9.6	8.4	6.9	9.0	33.9
1971	4.8	9.1	7.0	16.0	36.9
1972	8.0	8.5	12.9	15.5	44.9

Temperature.—From 1964 through 1972 the average maximum monthly temperature was 78.7°F. in the open and 76.9°F. beneath the trees. Occasionally, however, the maximum temperature was higher under the trees. The widest differences occurred in the falls of 1966 and 1968 and in the summer and fall of 1969, when temperatures in the open were 4° to 8°F. above those in the shade. The highest maximum temperature, 95.0°F., was reported in August.

The average daily minimum temperature was 52.8°F. in the open and 53.4°F. beneath trees. The lowest mean minimum temperature, 35.6°F., occurred in February.

In comparison to longtime Weather Bureau records at nearby Nacogdoches, the following months were several degrees colder than normal: January in 1964, 1966, 1970; February from 1964 through 1968; March in 1965 and 1969; and July and August in 1968. Temperatures were considerably warmer than average in January and February of 1969, 1971, and 1972; March 1967 and 1972; April 1965 and 1967; June 1971; July 1969; August 1964, 1969, and 1970; and September 1971.

The date of the last spring freeze varied from March 9 in 1967 to April 7 in 1971, and the first freeze in fall ranged from October 19 in 1967 to November 15 in 1972. The length of the frost-free season was from 205 days in 1970 to 234 days in 1968.

SEASONAL DEVELOPMENT OF FLOWERS

Flowering dates for most species were not consistently influenced by tree cover. However, American beautyberry flowered a few days earlier in the open; and flowering dogwood, sassafras, and common greenbrier flowered a few days earlier beneath trees (fig. 1).

Flowering of almost all species was earliest in 1967 and 1972, when March temperatures were highest. Generally flowers bloomed late when March was cool; but this relationship was inconsistent, particularly for species blooming in May and June. January and February temperatures had no obvious effect on flower initiation, nor did amount of precipitation. In a wet spring some species would flower early and others late. Such diverse responses to the same environmental factors have been noted elsewhere (Blaisdell, 1958).

The interval between first flower emergence and peak of bloom was shortest for rusty blackhaw, common greenbrier, and saw greenbrier (3 to 5 days) and longest for flowering dogwood plants in the open (14 to 16 days). Other species had average intervals of 6 to 10 days.

In a typical year species bloomed in the following order: (1) flowering dogwood and sassafras, (2) rusty blackhaw, red mulberry, and smallflower pawpaw, (3) yaupon and common greenbrier, (4) saw greenbrier, dwarf live oak, Japanese honeysuckle, and Alabama supplejack, (5) sweetbay magnolia and muscadine grape, and (6) American beautyberry.

Flowering dogwood and sassafras formed buds in early winter and reached their peak of bloom in late March or early April. Since frosts often killed sassafras flowers, only the late blooms developed into mature fruits. Although dogwood flowers were often discolored by a freeze, the fruits were rarely damaged. When fruits set, they generally grew to maturity.

For rusty blackhaw, red mulberry, and smallflower pawpaw,[2] blooming usually peaked during the first or second week in April. Red mulberry blossoms were occasionally nipped by late freezes, and only a small proportion of all three species' flowers developed into mature fruits.

Yaupon and common greenbrier flowered late enough (mid-April) so that they were never damaged by a freeze. Yaupon produced abundant flowers; but common greenbrier, only a few.

Flowering peaked in late April for saw greenbrier, dwarf live oak, Japanese honeysuckle, and Alabama supplejack. Greenbrier flowers were sparse. Live oak continued to form new flowers several weeks after the peak of bloom; many of the flowers aborted and were replaced by others. Honeysuckle also formed a few flowers throughout the summer and fall if rainfall was above average; these late blooms seldom developed into mature fruits, however. Supplejack flowers were present only briefly in the spring, and most of them developed into mature fruit.

Sweetbay magnolia and muscadine grape flowered in mid-May. The magnolia's sparse flowers developed into one or two full-size cones and a few immature fruits. Grape flowers were also sparse; and many of the developing fruits aborted, especially in hot, dry weather.

Flowering of American beautyberry did not peak until June. Although flowers continued to form through summer and autumn when moisture was plentiful, late blooms seldom developed into mature fruits.

FRUITING

Age at first fruiting.—Whether planted in the open or under trees, American beautyberry first produced fruit at age 2 years. All other species except red mulberry produced mature fruit at an earlier age in open than beneath trees (table 2). In the open, sweetbay magnolia and common greenbrier bore fruit at age 6; and most other species, at 3 or 4 years. Beneath trees, the beginning fruit-bearing age ranged from 5 to 9 years. Sweetbay magnolia, dwarf live oak, saw greenbrier, rusty blackhaw, and muscadine grape plants beneath trees did not bear fruit during the study.

[2] In this study the flowering and fruiting dates were earlier for smallflower pawpaw and red mulberry, and the fruiting dates were later for Alabama supplejack and rusty blackhaw than the dates presented in taxonomic texts (Vines, 1960; Correll and Johnston, 1970).

Table 2.—*Age at which species first bore mature fruit*

Species	Open	Beneath trees
	-- *Years* --	
Smallflower pawpaw	4	7
Alabama supplejack	3	8
American beautyberry	2	2
Flowering dogwood	4	9
Yaupon	4	7
Japanese honeysuckle	3	5
Sweetbay magnolia	6	(1)
Red mulberry	4	2
Dwarf live oak	4	(1)
Sassafras	4	8
Saw greenbrier	4	(1)
Common greenbrier	6	9
Rusty blackhaw	5	(1)
Muscadine grape	4	(1)

[1] Plants beneath trees did not bear fruit by 1972.

The proportion of fruit-bearers was much higher for plants growing in the open than for those beneath trees (table 3). Usually this proportion increased as the plants grew older; however, this trend was not consistent for several species. On the average, American beautyberry and Japanese honeysuckle had the highest proportion of plants bearing fruit.

Season of fruiting.—Usually when a plant bloomed early, the fruit matured early; but for several species there was no relationship between dates when flowers appeared and dates when fruit matured. For example, in any given year a species might flower earlier than average but bear mature fruit later than usual.

Generally, the fruits of Alabama supplejack, American beautyberry, and red mulberry matured at least 10 days later on plants beneath trees than on those in the open. No consistent difference between locations was observed for other species.

Red mulberry was the only species that bore mature fruit in the spring (May), and the interval from first appearance to end of drop was only about 6 weeks. Smallflower pawpaw, sweetbay magnolia, sassafras, and muscadine grape produced mature fruit in summer or

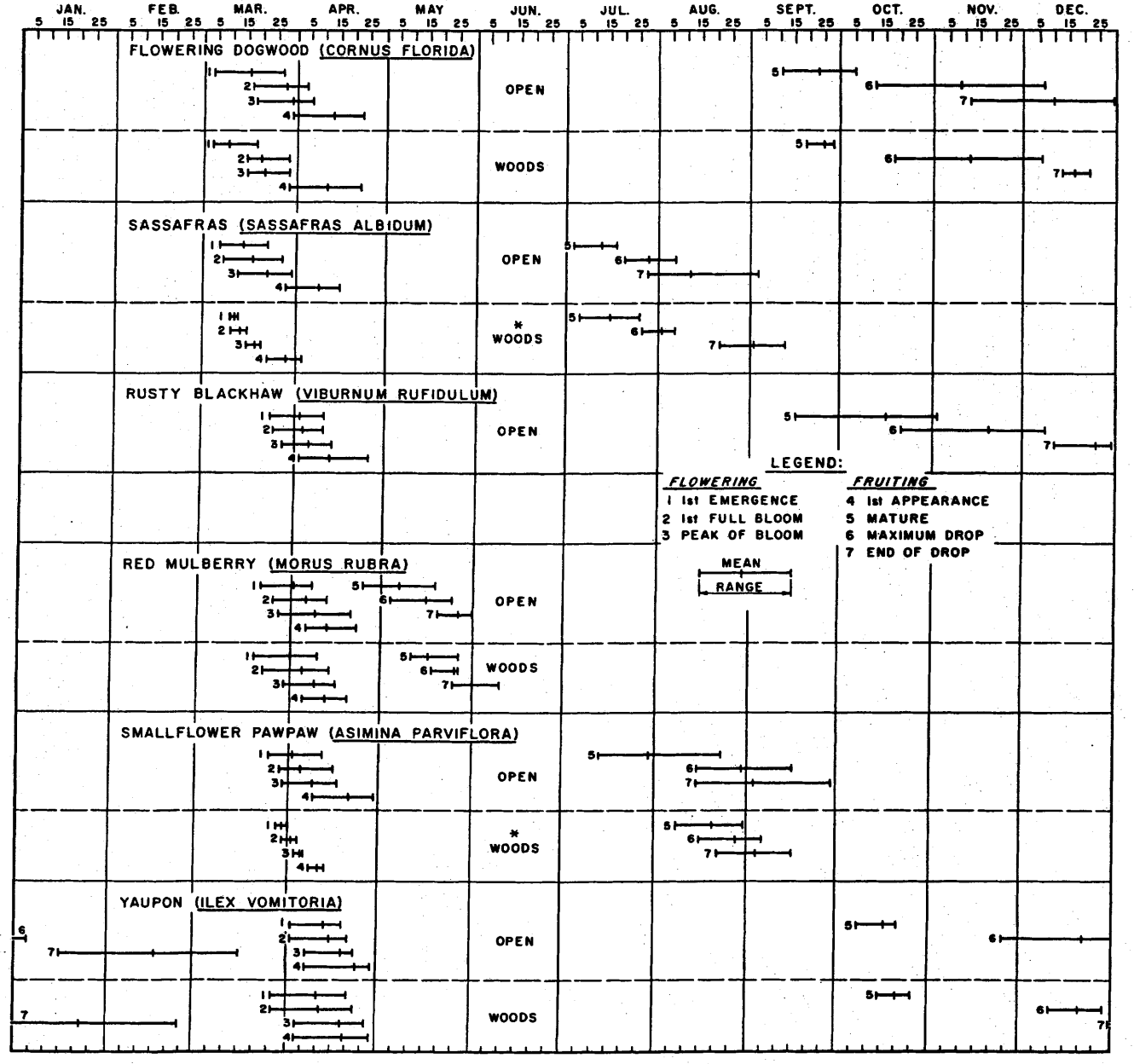
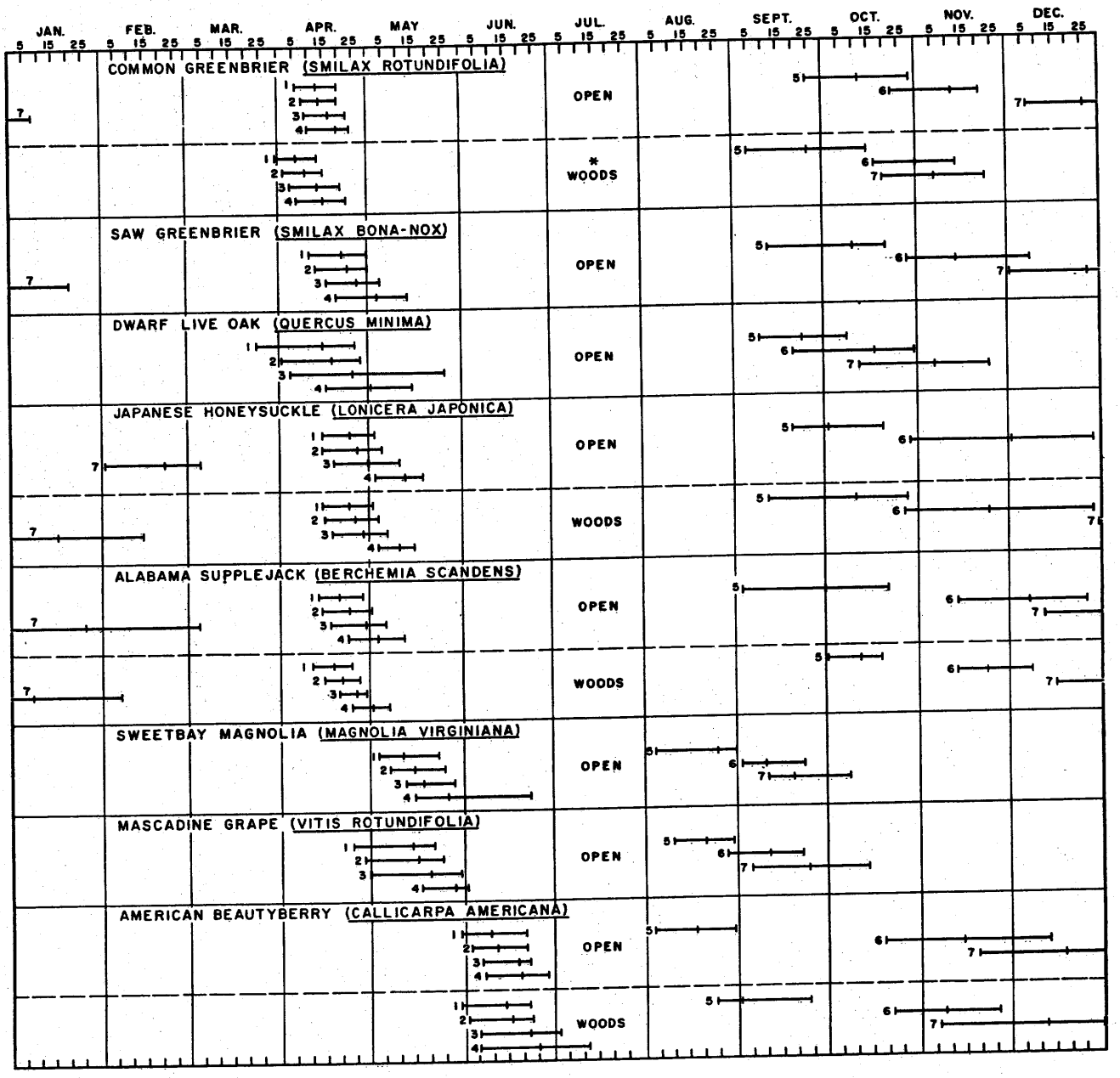


Figure 1.—*Flowering and fruiting chronology of plants growing in the open and beneath trees. (* indicates that data are available only for 2 years.)*


JAN.
FEB.
MAR.
APR.
MAY
JUN.
JUL.
AUG.
SEPT.
OCT.
NOV.
DEC.
5 15 25
COMMON GREENBRIER (SMILAX ROTUNDIFOLIA)
OPEN
* WOODS
SAW GREENBRIER (SMILAX BONA-NOX)
OPEN
DWARF LIVE OAK (QUERCUS MINIMA)
OPEN
JAPANESE HONEYSUCKLE (LONICERA JAPONICA)
OPEN
WOODS
ALABAMA SUPPLEJACK (BERCHEMIA SCANDENS)
OPEN
WOODS
SWEETBAY MAGNOLIA (MAGNOLIA VIRGINIANA)
OPEN
MASCADINE GRAPE (VITIS ROTUNDIFOLIA)
OPEN
AMERICAN BEAUTYBERRY (CALLICARPA AMERICANA)
OPEN
WOODS

early fall; but almost all their fruit dropped by October. Fruit persisted through November or December on all other species and through most of the winter on yaupon and honeysuckle. In these two species, the end of drop was later for plants in the open, probably because they produced much more fruit than those in the woods.

Fruit yields.—In any year the yields were apt to be high for one species and low for another. The period of high production also varied considerably between species. Wright (1953) previously noted that there was little correlation among woody species in the occurrence of good seed years.

American beautyberry yielded more fruit than any other species during this study (table 3). In the open, plants grew rapidly the first few years and produced abundant fruit. Yields peaked at 1,722 grams per plant in 1966, when plants were 5 years old. The following year, however, the plants deteriorated; and many stems died back. This general decadence continued through 1969, and fruit yields declined sharply to 107 grams. In 1970 many of the old stems sprouted at the base, and the plants again produced a substantial fruit crop. During the next 2 years, severe dieback of stems diminished fruit yields. In the woods, the young plants developed more slowly; and they produced less fruit. Beginning in 1965 the yields tended to be relatively high and low on alternate years.

Yaupon had the second highest yield per fruiting plant; but because this species is dioecious—i.e., has separate staminate (male) and pistillate (female) plants—the proportion of total plants bearing fruit was relatively small. The ratio of fruit yields between open- and woods-grown plants was 19:1. After plants in the open began to bear fruit (age 4), their yields tended to be high or low on alternate years. In 1972 the yield per fruiting plant was the highest recorded for any species during the study.

The alternate high and low yields of American beautyberry growing beneath trees and of yaupon in the open were apparently unrelated to weather conditions. Rather, as noted in other studies (Kozlowski, 1971), the variance seemed to be a physiological characteristic of individual plants.

Seven other species produced fruit both in the open and beneath trees, but yields from woods-grown plants were insignificant. In the open, smallflower pawpaw and flowering dogwood plants yielded only small quantities of fruit in their early years; but in 1971 and 1972 their yields were much higher. Apparently the plants were just approaching their optimum potential then. In contrast, the fruit yields for Japanese honeysuckle were highest when the plants were 4 to 6 years old and considerably less thereafter. Yields of Alabama supplejack were substantial and relatively consistent between years. Although sassafras yields were typically small, substantial quantities were produced occasionally. The fruit yields of red mulberry and common greenbrier were always small. Red mulberry plants beneath trees became heavily invested with white peach scale in 1968 and 1969, and by 1971 all plants had died.

Five species produced fruit in the open but not beneath trees. Yields were never very large for sweetbay magnolia and common greenbrier. Rusty blackhaw produced small amounts of fruit through 1971, but a large increase in 1972 indicated that the species was just beginning to reach its potential. Dwarf live oak plants produced moderate amounts of acorns each year, with relatively high yields in 1971; during the last 3 years of the study, each plant bore fruit. In muscadine grape, yields per fruiting plant were fairly consistent between years, but only a small proportion of the plants bore fruit.

Fruit and seed characteristics.—Table 4 lists the species observed and describes their fruits and seeds. Information on the kind, color, and size of fruits and seeds was taken from taxonomic texts; data on the number of fruit per gram, moisture content, and pulp to seed ratios were derived in this study. Berries, drupes, aggregates, cones, and acorns were included.

The fleshy berries, aggregates, and berry-like fruits had high moisture contents; for example, moisture in American beautyberry, red mulberry, and muscadine grape averaged about 80 percent of total weight. Sassafras had the least moisture content (47 percent); and Alabama supplejack, the highest (60 percent) for the drupes. Only seeds were sampled for dwarf live oak and sweetbay magnolia; their mean moisture content was 45 percent or less.

Table 3.—*Fruit yields of browse plants growing in the open and beneath pine trees*

Species	Year	Open		Beneath trees	
		Yield per fruiting plant	Plants bearing fruit	Yield per fruiting plant	Plants bearing fruit
		Grams	*Percent*	*Grams*	*Percent*
Smallflower pawpaw	1967	7	11	0	0
	1968	3	22	0	0
	1969	0	0	0	0
	1970	0	0	0	0
	1971	77	17	33	10
	1972	135	67	22	20
Alabama supplejack	1965	2	25	0	0
	1966	129	33	0	0
	1967	141	33	0	0
	1968	196	33	0	0
	1969	173	33	0	0
	1970	165	33	1	10
	1971	874	42	6	10
	1972	258	42	0	0
American beautyberry	1963	49	91	1	26
	1964	578	91	2	75
	1965	1,554	100	17	25
	1966	1,772	100	65	91
	1967	585	100	29	58
	1968	231	100	133	100
	1969	107	100	51	58
	1970	834	100	240	58
	1971	342	100	18	58
	1972	183	83	26	83
Flowering dogwood	1965	1	25	0	0
	1966	13	58	0	0
	1967	5	58	0	0
	1968	4	17	0	0
	1969	150	58	0	0
	1970	9	50	9	42
	1971	269	100	3	25
	1972	788	100	38	83
Yaupon	1965	1	17	0	0
	1966	93	25	0	0
	1967	36	25	0	0
	1968	339	42	19	8
	1969	150	42	28	8
	1970	336	42	5	42
	1971	270	42	39	42
	1972	2,212	42	88	50
Japanese honeysuckle	1965	4	100	0	0
	1966	138	100	0	0
	1967	127	100	1	17
	1968	222	100	3	42
	1969	43	100	5	92
	1970	68	100	11	92
	1971	23	100	6	92
	1972	26	100	2	92
Sweetbay magnolia	1968	20	42	0	0
	1969	3	42	0	0
	1970	5	27	0	0
	1971	16	64	0	0
	1972	6	33	0	0

Table 3.—*Fruit yields of browse plants growing in the open and beneath pine trees* (Continued)

Species	Year	Open		Beneath trees	
		Yield per fruiting plant	Plants bearing fruit	Yield per fruiting plant	Plants bearing fruit
		Grams	*Percent*	*Grams*	*Percent*
Red mulberry	1965	0	0	2	8
	1966	0	0	2	8
	1967	7	50	0	0
	1968	22	58	3	17
	1969	17	58	1	8
	1970	10	50	3	25
	1971	6	42	0	[1]0
	1972	10	50	0	0
Dwarf live oak	1967	5	75	0	0
	1968	50	75	0	0
	1969	67	88	0	0
	1970	60	100	0	0
	1971	201	100	0	0
	1972	45	100	0	0
Sassafras	1967	5	8	0	0
	1968	19	17	0	0
	1969	154	33	0	0
	1970	3	25	0	0
	1971	48	25	91	10
	1972	129	33	129	10
Saw greenbrier	1965	1	8	0	0
	1966	11	25	0	0
	1967	11	17	0	0
	1968	13	25	0	0
	1969	4	25	0	0
	1970	2	50	0	0
	1971	8	42	0	0
	1972	2	17	0	0
Common greenbrier	1967	1	33	0	0
	1968	2	67	0	0
	1969	7	100	0	0
	1970	10	100	1	8
	1971	1	67	0	0
	1972	6	58	2	17
Rusty blackhaw	1967	2	8	0	0
	1968	0	0	0	0
	1969	6	8	0	0
	1970	2	8	0	0
	1971	4	8	0	0
	1972	84	58	0	0
Muscadine grape	1967	56	17	0	0
	1968	107	18	0	0
	1969	388	18	0	0
	1970	239	27	0	0
	1971	300	36	0	0
	1972	149	36	0	0

[1]All plants beneath trees had died by 1971.

Table 4.—*Fruit and seed characteristics of 14 woody species*

Species	Fruit							Seed	Pulp/seed ratio	
	Kind	Color	Size	Number per gram		Moisture content (percent)				
				Mean	*Range*	*Mean*	*Range*		*Mean*	*Range*
Smallflower pawpaw *(Asimina parviflora)*	Fleshy berry	Black at maturity	5-12 cm. long	0.4	0.3-0.7	64	62-66	Several, 1.5-3 cm. long, bony, turgid, flattened, dark brown	1:1.23	[1] 1:1.23-1.24
Alabama supplejack *(Berchemia scandens)*	Juicy drupe	Bluish-black	About 8 mm. long	22.4	16.1-28.4	60	53-66	A 2-celled stone	1:1.23	1:0.90-1.71
American beautyberry *(Callicarpa americana)*	Berry-like drupe	Reddish-purple	3-6 mm. long wide	71.6	64.9-79.7	80	75-84	4, about 1.5 mm. long	1:0.68	1:0.38-0.98
Flowering dogwood *(Cornus florida)*	Drupe	Bright red to yellow	1-1.5 cm. long	7.0	5.2-7.8	53	52-56	1-2, about 9 mm. long pale brown	1:0.96	1:0.85-1.05
Yaupon *(Ilex vomitoria)*	Drupe	Shiny red	About 6 mm. long	13.7	11.7-15.5	51	46-60	Usually 4 1-seeded stones, up to 4 mm. long	1:0.69	1:0.65-0.76
Japanese honeysuckle *(Lonicera japonica)*	Berry	Black	About 7 mm. in diameter	17.8	12.7-23.0	68	61-72	Several, irregularly ridged	1:0.35	1:0.27-0.45
Sweetbay magnolia *(Magnolia virginiana)*	A cone with drupe-like seeds	Red	4-5 cm. long	12.1	[2] 9.3-15.0	41	[2] 37-45	Each follicle with 1-2 seeds, about 7 mm. long, red	. . .	. . .
Red mulberry *(Morus rubra)*	An aggregate of small drupes	Dark purple	2-3 cm. long	8.7	6.2-11.5	78	72-81	1-2 mm. long	1:0.31	[1] 1:0.26-0.35
Dwarf live oak *(Quercus minima)*	Acorn	Glossy brown	Cup 10-15 mm. broad, 8-16 mm. high	0.8	[2] 0.6-0.9	45	[2] 37-54	15-20 mm. long, 8-12 mm. thick, ¼ to ½ included in cup	. .	. . .
Sassafras *(Sassafras albidum)*	Drupe, borne on red pedicel	Lustrous blue	About 1 cm. long	6.2	6.0-6.9	47	43-50	Solitary stone, light brown, about 6 mm. long	1:0.73	1:0.60-0.81
Saw greenbrier *(Smilax bona-nox)*	Berry	Glaucous, black	About 6 mm. thick	12.7	8.4-16.5	64	59-69	Usually solitary, 4-5 mm. long, reddish brown with black basal disk	1:1.59	1:1.00-1.91
Common greenbrier *(Smilax rotundifolia)*	Berry	Blue-black	6-8 mm. thick	13.0	10.0-16.1	64	58-69	Usually 2-3, about 4-6 mm. thick	1:1.23	1:0.93-1.76
Rusty blackhaw *(Viburnum rufidulum)*	Drupe	Blue-black	8-15 mm. long	5.2	4.0-7.0	52	44-58	Solitary, flattened	1:0.50	1:0.41-0.56
Muscadine grape *(Vitis rotundifolia)*	Berry	Purple-black	12-25 mm. in diameter	1.4	1.2-1.6	81	78-84	2-3, 7-8 mm. long, 4-5 mm. thick	1:0.28	1:0.18-0.36

[1] Samples taken only 2 years.
[2] Includes only the seed portion of fruit.

The proportion of pulp to seed was highest for muscadine grape, red mulberry, and Japanese honeysuckle, and lowest for smallflower pawpaw, Alabama supplejack, and greenbriers. These ratios are significant in wildlife management since the nutrient content of seeds differs considerably from that of the pulpy and fleshy portions of fruit. Usually the seeds contain more crude protein than the pulp. The value of a fruit with a large proportion of seeds depends mainly on how well the animal digests the seeds (Wainio and Forbes, 1941).

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Flowering and fruiting dates are reported for 14 browse species growing in the open and beneath trees in an east Texas pine-hardwood forest. Dates for individual species generally were not influenced by tree cover. In the open, plants generally produced fruit more consistently and abundantly and at an earlier age than beneath the trees.

Great Trinity Forest Management Plan

Wildlife Management

Designing Hardwood Tree Plantings for Wildlife

Planting and Care of Fine Hardwood Seedlings

Hardwood Tree Improvement and Regeneration Center
North Central Research Station
USDA Forest Service
Department of Forestry and Natural Resources
Purdue University

Designing Hardwood Tree Plantings for Wildlife

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Woody plants can be of value to many wildlife species. The species of tree or shrub, or the location, size, and shape of planting can all have an impact on wildlife. The purpose of this paper is to discuss the benefits of trees and shrubs for wildlife and how to design tree and shrub plantings for wildlife. Some of the practices may conflict with other management goals and may have to be modified for individual priorities.

Trees and Shrubs for Wildlife

The species you select for a tree planting should depend on the growing conditions of the site and the wildlife species that you want to manage. Talk to a professional forester to help you select the tree species best suited for your growing conditions. A professional biologist, such as a Department of Natural Resources District Biologist (www.in.gov/dnr/fishwild/huntguide1/wbiolo.htm), can assist you with planning a tree planting for wildlife.

There is no specific formula for developing wildlife habitat. For example, acorns are eaten by a wide variety of wildlife species including tree squirrels, pheasants, wild turkey, and deer. However, planting oaks does not guarantee you will observe these species. But you will find that an increased variety of tree and shrub species will increase the types of food available at different times of the year, and the number of foraging and nesting niches. Improved forage and nesting niches increases wildlife use.

Each tree and shrub species is susceptible to specific diseases and pests and can endure varying degrees of environmental stress. By planting a diversity of trees and shrubs, one can minimize the probability that the entire wildlife planting would be destroyed as a result of prolonged drought, flooding, or disease and pest outbreaks.

Shrubs can be planted as part of a fencerow or travel lane; they can be combined with other conservation plantings, or they can be established along the edges of tree plantings. Many species of shrubs are of value to wildlife (Table 1). The fruit or nuts from shrubs such as dogwoods (*Cornus* spp.) and viburnums (*Viburnum* spp.) are an important food source. Soft (berries and fruit) and hard (nuts) mast produced by various tree species is a valuable

food source for wildlife (Table 2). Shrubs can be particularly important because several species of wildlife, especially songbirds, prefer to feed or nest on or near the ground. Shrubs also provide good protective cover for these types of wildlife. Pines and other softwoods provide limited food, but are an excellent source of winter and roosting cover, and they can provide important foraging substrate for insectivorous birds, especially migrating warblers. Tree plantings can benefit wildlife in many ways, particularly when combined with other conservation practices, or as a connection or corridor between patches of existing habitat.

The age of a tree planting is an important consideration for wildlife. Young tree plantings are of greatest value to early-successional wildlife that requires thick brushy cover. These include cottontail rabbit (*Sylvilagus floridanus*), woodcock (*Scolopax minor*), and numerous songbirds. Although trees typically do not produce a significant amount of mast until 20+ years of age, young tree plantings can serve as important resting and insect foraging areas for migrating songbirds.

Plantings for Wildlife

Location

Tree and shrub plantings can be useful in connecting patches of forested areas. Planting corridors of trees, shrubs, or both between woodlots can

provide travel lanes for terrestrial wildlife. Hard and soft mast-producing species can provide additional food benefits to a travel corridor. The width of the corridor should be as wide as possible; a minimum of 50 to 100 feet is best. Narrow corridors are still used by some wildlife, but these do not necessarily benefit them because predators and their prey both use these travel corridors. Predators moving through narrow corridors of habitat can efficiently find their prey that has taken up residence there. Wildlife corridors can be composed of one of the following:

- At least three rows of shrubs, one row of a soft mast tree species, and one row of a hard mast tree species. (Mast is the fruit or nuts produced by certain tree species.)
- When shrubs are a limiting habitat factor, create a shrubs-only corridor consisting of a minimum of five rows of shrubs. The tallest species should be located in center rows.
- When winter cover is a limiting habitat factor, create a corridor consisting of three rows of pine, one row of a hard mast tree species, and one row of shrubs.

See Table 1 for shrub species valuable to wildlife and Table 2 for tree species valuable to wildlife.

Shrub plantings on the edge of existing woodlots can improve habitat for edge species of wildlife. (Edge species are wildlife that thrives along areas where the edge of one habitat type meets the edge of one or more of another habitat type.) Plant one to four rows of shrubs along the boundary between a woodlot and a field.

Spacing

Plant spacing should depend on your goals and the surrounding habitat conditions. Some tree plantings for wildlife are established at 20 x 20 ft spacing. Wider spacing will delay crown closure and allow sunlight penetration for a longer period of time. The planting will have a diversity of annual and perennial forbs interspersed among the trees that will benefit some species of wildlife. A spacing of 9 x 9 ft or 10 x 8 ft is typical and is a good compromise between the needs of wildlife and timber production (Payne and Bryant 1994). If wide-spacing planting conflicts with other goals, establish the tree planting adjacent to early-successional habitats that provide similar structure such as weedy areas, old fields, or grass plantings. Skip rows throughout the planting to encourage herbaceous and shrub mixes within the tree planting (Payne and Bryant 1994).

A wider spacing does not benefit all species of wildlife. Decrease spacing in all areas of the planting to establish thick winter cover (or escape cover), if this type of cover is lacking elsewhere on the property. There are no definitive answers when it comes to spacing. Cost, existing and surrounding habitat, wildlife goals, and timber goals should all influence spacing decisions. Consult a professional forester, wildlife biologist, or county Extension educator for more information.

Maintenance

Herbicide treatment is required for optimal establishment and growth of tree plantings in most situations. Minimize or eliminate mowing around tree plantings. The timing of maintenance depends on the density and type of competing vegetation. Grasses, forbs, shrubs, and vines that grow in the planting will enhance its value for wildlife.

Many landowners are interested in obtaining timber from tree plantings. Often this requires grapevine control, but grapevines are a good soft mast source, nesting, and foraging habitat for wildlife. If grapevine control is necessary to meet timber goals, limit it to crop trees and leave vines on non-crop trees and along the edges of the tree planting.

If thinning of tree plantings is necessary for timber production, girdle the non-crop trees rather than remove them. Standing dead trees (snags) are beneficial to many species of wildlife such as woodpeckers, chickadees, and tree squirrels.

Size and Shape of Plantings

Many species of wildlife prefer habitat with a high amount of edge, that is, areas where two or more distinct habitat types meet. Edge habitats are valuable to wildlife because the plant community is often more diverse along edges, and more

than one habitat requirement for wildlife species is close together. Typically, trees and shrubs are planted in linear rows and square or rectangular blocks. This design does not maximize edge habitat. Irregular plantings that incorporate curves will be more valuable to wildlife. Abrupt edges are of lesser value to wildlife than edges with a transition zone or buffer.

Variety

Plant diversity is important for wildlife, both in structure and composition. Multi-layered vegetation will attract more wildlife species than monocultures. Tree plantings that incorporate shrub borders will provide additional food and cover values for wildlife. Various mast-producing

Table 1. *Selected shrub species valuable to wildlife*[1]

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
American Plum (*Prunus americana*)	MWD - ED	30	Fruit eaten by songbirds. Recommended for quail and turkey.
Arrowwood (*Vibrunum dentatum*)	MWD - WD	9	Fruit eaten by songbirds.
Ash, Prickly (*Xanthoxylum americanum*)	SPD - WD	9	
Bayberry, Northern (*Myrica pensylvanica*)	MWD - ED	2 - 8	Fruit and seeds eaten by songbirds. Low, brushy stature provides concealment for ground-dwelling wildlife.
Blackhaw (*Viburnum prunifolium*)	MWD - WD	20	Fruit eaten by songbirds, quail, fox, and turkey.
Bladdernut (*Staphylea trifolia*)	SPD - WD	10	
Chokecherry (*Prunus virginiana*)	SPD - WD	18	Fruit eaten by songbirds.
Chokeberry, Black (*Aronia melanocarpa*)	SPD - WD	10	Fruit eaten by songbirds. Recommended for turkey.
Coralberry (*Symphoricarpos orbiculatus*)	MWD - WD	5	Fruit eaten by songbirds, quail, and ruffed grouse.
Crabapple, Flowering (*Malus* spp.)	SPD - WD	8 - 20	Fruit eaten by birds, deer, and small mammals.
Devils Walking Stick (*Aralia spinosa*)	SPD - MWD	20	Fruit eaten by birds.
Dogwood, Alternate Leaf (*Cornus alternifolia*)	SPD - WD	18	Fruit eaten by birds. Twigs browsed by deer and rabbits.
Dogwood, Flowering (*Cornus florida*)	MWD - WD	30	Recommended for quail and turkey.
Dogwood, Gray (*Cornus racemosa*)	SPD - WD	8	Fruit eaten by pheasant, turkey, and grouse.
Dogwood, Red Osier (*Cornus sericea*)	VPD - WD	10	Fruit eaten by songbirds, grouse, quail, and turkey. Twigs browsed by deer and rabbits.
Dogwood, Rough Leaved (*Cornus drummondii*)	PD - WD	18	Fruit eaten by songbirds, grouse, quail, turkey, and pheasant. Twigs browsed by rabbits and deer.
Dogwood, Silky (*Cornus amomum*)	VPD - WD	10	Sometimes browsed by rabbits and deer.
Eastern Wahoo (*Euonymus atropurpureus*)	SPD - WD	12	Fruit eaten by birds.
Elderberry (*Sambucus canadensis*)	VPD - WD	9	Fruit eaten by many birds including pheasant and dove. Recommended for quail and turkey.
Hazel Alder (*Alnus serrulata*)	VPD - WD	18	Deer browse on the twigs.

Table 1 continued on next page.

Table 1 continued from previous page.

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
Hazelnut (*Corylus americana*)	MWD - WD	15	Small nut eaten by squirrel, deer, jays, grouse, and pheasant. Recommended for quail and turkey.
Highbush Cranberry (*Viburnum trilobum*)	VPD - WD	9	Fruit eaten by grouse, pheasant, and songbirds. Recommended for turkey.
Indigobush (*Amorpha fruticosa*)	VPD - WD	6	
Leadplant (*Amorpha canescens*)	WD - ED	3	
Nannyberry (*Viburnum lentago*)	SPD - WD	18	Fruit eaten by songbirds. Recommended for turkey.
New Jersey Tea (*Ceanothus americanus*)	WD - ED	3	Quail and wild turkey eat the three-celled capsule.
Ninebark (*Physocarpus opulifolius*)	VPD - WD	10	Fruit are small dry bladders. Recommended for turkey.
Pawpaw (*Asimina triloba*)	SPD - WD	20	Fruit eaten by opossum, squirrels, raccoon, and fox.
Prairie Crab (*Malus ioensis*)	PD - WD	30	Fruit eaten by opossum, squirrel, raccoon, and fox. Recommended for turkey.
Redbud (*Cercis canadensis*)	MWD - WD	30	Seeds eaten by a few songbirds.
Shrubby St. Johnswort (*Hypericum prolificum*)	SPD - WD	6	
Spicebush (*Lindera benzoin*)	VPD - WD	9	Twigs and fruit eaten by songbirds, grouse, rabbit, opossum, quail, and deer. Recommended for turkey.
Spirea (*Spiraea alba*) (*Spirea tomentosa*)	VPD - WD	4	Buds eaten by ruffed grouse. Twigs browsed by deer and rabbits.
Sumac, Shining (*Rhus copallina*)	MWD - ED	8	Fruit eaten by songbirds, quail, dove, and pheasant. Recommended for turkey.
Sumac, Smooth (*Rhus glabra*)	MWD - ED	12	Twigs and fruit eaten by songbirds, pheasant, and dove. Recommended for quail and turkey.
Sumac, Staghorn (*Rhus typhina*)	MWD - ED	15	Fruit eaten by songbirds, quail, dove, and pheasant. Twigs browsed by rabbits and deer. Good for turkey.
Wild Blackberry (*Rubus allegheniensis*)	MWD - ED	5	Provides cover and food for birds and mammals. Recommended for quail and turkey.
Wild Black Raspberry (*Rubus occidentalis*)	MWD - WD	5	
Wild Sweet Crabapple (*Malus coronaria*)	SPD - ED	30	Recommended for quail and turkey.
Willow, Prairie (*Salix humilis*)	PD - SPD	13	Use where prairie requires woody vegetation for the targeted species, such as perches for dickcissels.
Winterberry (*Ilex verticillata*)	VPD - WD	15	Buds and twigs browsed by deer and rabbits.
Witch-hazel (*Hamamelis virginiana*)	SPD - WD	18	Seeds, buds, and twigs eaten by deer, rabbit, quail, and pheasant.

[1] Adapted from USDA-NRCS Conservation Practice Standard 645, Upland Wildlife Habitat Management, Indiana NRCS Field Office Technical Guide.

[2] Key for soil drainage class suitability: ED = excessively drained; WD = well drained; MWD = moderately well drained; SPD = somewhat poorly drained; PD = poorly drained; and VPD = very poorly drained.

Table 2. *Selected tree species valuable to wildlife*[1]

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
Pine/Softwoods			
Baldcypress *(Taxodium distichum)*	VPD - WD	80	Waterfowl occasionally consume seeds. Trees also serve as perching areas for song and wading birds.
Cedar, Eastern Red *(Juniperus virginiana)*	SPD - ED	45	Berries consumed by songbirds. Recommended for turkey.
Cedar, Northern White *(Thuja occidentalis)*	PD - WD	40	Foliage often browsed by deer in late winter as an emergency food source. Recommended for turkey.
Hemlock, Eastern *(Tsuga canadensis)*	SPD - WD	70	The dense low foliage of young plants makes good winter cover for grouse, turkey, deer, and other wildlife. Excellent nesting habitat. Small winged seeds fed on by chickadees, pine siskins, crossbills, and red squirrels; twigs browsed by deer and rabbits.
Pine, Eastern White *(Pinus strobus)*	MWD - WD	90	Pines make excellent roosting trees for many species of birds. Seeds are eaten by a wide variety of birds, squirrels, and mice. Recommended for turkey.
Pine, Jack *(Pinus banksiana)*	WD - ED	40	Pines make excellent roosting trees for many species of birds. Seeds are eaten by a wide variety of birds, squirrels, and mice. Recommended for turkey.
Pine, Virginia *(Pinus virginiana)*	MWD - ED	40	
Non-Mast Producing Species			
Aspen, Bigtooth *(Populus grandidentata)*	MWD - WD	70	Twigs and bark consumed by deer and beavers. Buds and catkins eaten by ruffed grouse.
Cottonwood, Eastern *(Populus deltoides)*	PD - ED	90	Recommended for turkey.
Sycamore, American *(Platanus occidentalis)*	PD - WD	90	Sycamore has low food value to wildlife; however, this species forms an important structural component of bottomlands and floodplains.
Soft Mast Producing Species			
Ash, Green *(Fraxinus pennsylvanica)*	VPD - WD	60	Seeds eaten by squirrels, quail, and songbirds.
Ash, White *(Fraxinus americana)*	MWD - WD	70	Seeds eaten by squirrels, quail, and songbirds. Recommended for turkey.
Birch, River *(Betula nigra)*	VPD - WD	50	Stands of birch serve as important cover for riparian dwelling animals.
Cherry, Black *(Prunus serotina)*	MWD - WD	70	Familiar fruits eaten by many species of songbirds, ruffed grouse, and pheasant. Recommended for turkey.
Gum, Black *(Nyssa sylvatica)*	PD - WD	60	Fruits consumed by songbirds and pileated woodpeckers. Recommended for turkey.
Hackberry *(Celtis occidentalis)*	SPD - WD	50	Fruits sparingly eaten by songbirds, including cedar waxwings and robins during winter. Recommended for turkey.
Hawthorn, Cockspur *(Crataegus crusgalli)*	ED - SPD	30	Fruits are important winter food source for many songbirds including ruffed grouse. Fruit eaten by deer, fox, rabbit, pheasant, and turkey. Excellent nesting habitat for songbirds.
Hawthorn, Green *(Crataegus viridis)*	ED - SPD	30	
Hawthorn, Washington *(Crataegus phaenopyrum)*	ED - SPD	30	
Kentucky Coffeetree *(Gymnocladus dioicus)*	SPD - WD	50	Fruits relished by squirrels, opossum, raccoon, and songbirds.

Table 2 continued on next page.

Table 2 continued from previous page.

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
Maple, Black *(Acer nigrum)*	MWD - WD	70	Samaras are widely consumed by birds and squirrels. Browsed by deer. Recommended for turkey.
Maple, Red *(Acer rubrum)*	VPD - WD	70	
Maple, Silver *(Acer saccharinum)*	VPD - WD	80	
Maple, Sugar *(Acer saccharum)*	MWD - WD	70	
Persimmon *(Diospyros virginiana)*	MWD - WD	50	Raccoons as well as some songbirds readily consume large berries.
Sassafras *(Sassafras albidum)*	ED - SPD	40	Browsed by deer, rabbits, beaver, fox squirrel, and woodchuck. Fruit eaten by raccoons, squirrels, woodchucks, and many songbirds. Recommended for quail.
Serviceberry *(Amelanchier arborea)*	MWD - WD	30	Purplish fruits rapidly consumed by birds. Recommended for turkey.
Sweetgum *(Liquidambar styraciflua)*	PD - WD	85	Seeds consumed by finches in winter.
Tuliptree *(Liriodendron tulipifera)*	MWD - WD	90	Seeds eaten by songbirds, squirrels, quail, and turkey.
Hard Mast Producing Species			
Beech, American *(Fagus grandifolia)*	MWD - WD	75	Nuts consumed by deer and squirrels. Recommended for turkey.
Buckeye, Ohio *(Aesculus glabra)*	SPD - WD	60	Nuts sparingly consumed by eastern fox squirrels.
Butternut *(Juglans cinerea)*	MWD - WD	50	Elliptical nuts consumed by squirrels.
Hickory, Bitternut *(Carya cordiformis)*	SPD - WD	50	The nuts of these species constitute an important food source for squirrels and wood ducks. Recommended for turkey.
Hickory, Mockernut *(Carya tomentosa)*	ED - MWD	50	The nuts of these species constitute an important food source for squirrels and wood ducks Recommended for turkey.
Hickory, Pignut *(Carya glabra)*	WD - ED	50	
Hickory, Shagbark *(Carya ovata)*	MWD - WD	70	The loose shaggy bark makes excellent bat roosting sites. Recommended for turkey.
Oak, Black *(Quercus velutina)*	MWD - ED	60	Acorns from oaks are perhaps the most important food source for a variety of wildlife including woodpeckers, squirrels, and deer. Recommended for turkey.
Oak, Bur *(Quercus macrocarpa)*	PD - ED	80	
Oak, Cherrybark *(Quercus pagoda)*	SPD - WD	75	
Oak, Chinquapin *(Quercus muhlenbergii)*	MWD - ED	60	
Oak, Pin *(Quercus palustris)*	VPD - WD	75	The smaller pin oak acorns are particularly favored by wood ducks.
Oak, Red *(Quercus rubra)*	MWD - WD	80	

Table 2 continued on next page.

Table 2 continued from previous page.

Common Name (Scientific Name)	Soil Drainage Class Suitability[2]	Ave. Mature Height (ft.)	Wildlife Information
Oak, Scarlet *(Quercus coccinea)*	MWD - ED	70	Acorns from oaks are perhaps the most important food source for a variety of wildlife including woodpeckers, squirrels, and deer. Recommended for turkey.
Oak, Shingle *(Quercus imbricaria)*	SPD - WD	50	
Oak, Shumard *(Quercus shumardii)*	SPD - WD	75	
Oak, Swamp Chestnut *(Quercus michauxii)*	SPD - WD	70	
Oak, Swamp White *(Quercus bicolor)*	VPD - WD	70	
Oak, White *(Quercus alba)*	MWD - WD	90	
Pecan *(Carya illinoensis)*	SPD - WD	120	Ellipsoid nuts readily consumed by a variety of wildlife.
Walnut, Black *(Juglans nigra)*	MWD - WD	80	Nuts consumed by squirrels.

[1] Adapted from USDA-NRCS Conservation Practice Standard 645, Upland Wildlife Habitat Management, Indiana NRCS Field Office Technical Guide.

[2] Key for soil drainage class suitability: ED = excessively drained; WD = well drained; MWD = moderately well drained; SPD = somewhat poorly drained; PD = poorly drained; and VPD = very poorly drained.

species produce food at different times throughout the growing season. Planting adjacent blocks in different years will provide added structural diversity.

Summary

Tree and shrub plantings can be beneficial to wildlife. The amount of value depends on a variety of factors and includes not only the specific characteristics of the planting, but the type and quality of surrounding habitat and the habitat requirements of wildlife species. Following the guidelines presented in this paper will enhance plantings for wildlife. However, every situation is unique. Thus, there is no substitute for consulting with a professional wildlife biologist (www.in.gov/dnr/fishwild/huntguide1/wbiolo.htm).

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Woody Plants and Wildlife: Brush Sculpting in South Texas and Edwards Plateau

Texas Agricultural Extension Service
The Texas A&M University System

L-5332
9-99

Woody Plants and Wildlife

Brush Sculpting in South Texas and the Edwards Plateau

Robert K. Lyons, Tim F. Ginnett and Richard B. Taylor*

Our perspective is changing on the value of brush or woody plants. When Texas rangeland was used primarily for livestock, managing brush meant eradicating it, or at least removing certain unwanted species. Now rangeland owners are shifting to multiple use, which includes managing for wildlife, recreation and aesthetic value. Accordingly, our view of woody plants has changed to one that values these plants in appropriate amounts for wildlife and other benefits.

The essential elements of wildlife habitat include food, cover and water. Because woody plants provide some or all of these requirements, managing these plants is important. Woody plants provide food in the form of leaves, flowers, pollen, nectar, mast and fruit. Some woody plants also provide cover, which protects and shelters wildlife from predators and inclement weather. The kind and amount of cover required varies among wildlife species. Many birds also use these plants for nesting, nighttime roosting and daytime loafing. Plants such as cacti even provide water.

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Species	Loc.		Food			Cover			Water
	STP	EP	Forage	Mast	Fruit	Protection	Nesting	Roosting	
Agarito, desert holly, *Mahonia trifoliolata*	✔	✔							
Allthorn, *Koeberlinia spinosa*	✔	✔							
Amargosa, *Castela texana*	✔	✔							
Anaqua, *Ehretia anacua*	✔	✔							
Blackbrush, *Acacia rigidula*	✔	✔							
Blackcherry, *Prunus serotina*		✔							
Brasil, *Condalia hookeri*	✔	✔							
Catclaw acacia, *Acacia greggii*	✔	✔							
Catclaw mimosa, *Mimosa spp.*	✔	✔							
Cedar elm, *Ulmus crassifolia*	✔	✔							
Cenizo, purple sage, *Leucophyllum frutescens*	✔	✔							
Coma, *Bumelia celastrinum*	✔								
Coyotillo, *Karwinskia humboldtiana*	✔	✔							
Creosotebush, *Larrea tridentata*	✔	✔							
Desert yaupon, *Schaefferia cuneifolia*	✔	✔							
Elbowbush, *Forestiera pubescens*		✔							
Ephedra, *Ephedra spp.*	✔	✔							
Evergreen sumac, *Rhus virens*	✔	✔							
Feather dalea, *Dalea formosa*	✔	✔							
Flameleaf sumac, *Rhus glabra*		✔							
Four-wing saltbrush, *Atriplex canescens*	✔	✔							
Fragrant mimosa, *Mimosa borealis*		✔							
Granjeno, spiny hackberry, *Celtis pallida*	✔	✔							
Greenbrier, *Smilax spp.*	✔	✔							

Green condalia, *Condalia viridis*		✔							
Guajillo, *Acacia berlandieri*	✔	✔							
Guayacan, *Guaiacum angustifolium*	✔	✔							
Gum bumelia, *Bumelia lanuginosa*	✔	✔							
Hercules'-club pricklyash, *Zanthoxylum clava-hercules*		✔							
Hogplum, *Colubrina texensis*	✔	✔							
Honey mesquite, *Prosopis glandulosa*	✔	✔							
Hoptree, *Ptelea spp.*		✔							
Huisache, *Acacia smallii*	✔	✔							
Juniper, *Juniperus spp.*		✔							
Knife-leaf condalia, *Condalia spathulata*	✔								
Lantana, *Lantana spp.*	✔	✔							
Lime prickly-ash, *Zanthoxylum fagara*	✔								
Littleleaf sumac, *Rhus microphylla*	✔	✔							
Lotebush, *Ziziphus obtusifolia*	✔	✔							
Mexican buckeye, *Ungnadia speciosa*	✔	✔							
Mountain laurel, *Sophora secundiflora*	✔	✔							
Narrowleaf forestiera, *Forestiera angustifolia*	✔	✔							
Netleaf hackberry, *Celtis reticulata*		✔							
Oaks, *Quercus spp.*	✔	✔							
Palo verde, *Parkinsonia texana*	✔								
Pecan, *Carya illinoensis*	✔	✔							
Poison ivy, *Toxicodendron radicans*	✔	✔							
Possum-haw holly, *Ilex decidua*		✔							
Pricklypear cactus, *Opuntia spp.*	✔	✔							
Redbud, *Cercis canadensis*		✔							
Retama, *Parkinsonia aculeata*	✔	✔							

Roemer acacia, *Acacia roemeriana*	✔	✔							
Rusty blackhaw, *Viburnum rufidulum*		✔							
Shrubby blue sage, *Salvia ballotiflora*	✔	✔							
Skunkbush sumac, *Rhus aromatica*		✔							
Southwest bernardia, *Bernardia myricifolia*	✔	✔							
Sugar hackberry, *Celtis laevigata*	✔	✔							
Sweet mountain grape, *Vitis monticola*		✔							
Tasajillo, *Opuntia leptocaulis*	✔	✔							
Texas ebony, *Pithecellobium flexicaule*	✔								
Texas kidneywood, *Eysenhardtia texana*	✔	✔							
Texas persimmon, *Diospyros texana*	✔	✔							
Texas Sophora, Eve's necklace, *Sophora affinis*		✔							
Twisted acacia, *Acacia schaffneri*	✔	✔							
Walnut, *Juglans spp.*		✔							
Western soapberry, *Sapindus drummondii*	✔	✔							
Wild olive, *Cordia boissieri*	✔								
Whitebrush, beebrush, *Aloysia spp.*	✔	✔							
Wolfberry, *Lycium spp.*	✔	✔							
Yucca, *Yucca spp.*	✔	✔							

LEGEND:
- Butterflies, bees and other insects
- White-tailed deer
- Small mammals (e.g. squirrels, rabbits)
- Songbirds
- Game birds (quail, turkey, doves)

STP - South Texas Plains
EP - Edwards Plateau

Table 1. Classes of wildlife that benefit from various native plants.

Woody plants may also provide indirect benefits, including soil improvement from mulch, protected sites for certain beneficial plants to grow, mineral cycling, and nitrogen fixation by woody legumes such as mesquite and blackbrush. They also provide a cooler microclimate for birds, small mammals, reptiles and insects.

Even though woody plants are beneficial, it is still possible to have too much brush. Landowners should consider manipulating brush in some situations, depending on the wildlife species being managed and other goals. Brush sculpting is a way to achieve the desired balance between woody plant cover and herbaceous plant or grass production. Brush can be sculpted by mechanical, chemical and biological means and by prescribed burning. Treating individual plants, either mechanically or chemically, is especially useful in brush sculpting.

The brush-sculpting approach recognizes that woody plants aid wildlife and seeks to shape the landscape and habitat to benefit wildlife and accommodate other multiple uses. To sculpt brush for a wildlife habitat, landowners must know the woody plant species present and their value to wildlife. Some woody plants are more valuable than others, depending on the habitat requirements of the various wildlife species. However, the value of any particular plant species also depends on which other species are present. For example, live oak has only moderate value as white-tailed deer browse when favored plants such as kidneywood are abundant, but it may be a major part of the diet when other more highly favored species are unavailable.

In the table beginning on page 2, symbols represent the classes of wildlife that benefit from each plant species. In this bulletin, forage is broadly defined not only as the leaves and twigs that provide food for herbivores such as deer, but also as the flowers that are eaten and that provide nectar and pollen for birds and insects. Mast includes hard fruits such as acorns and mesquite pods, and fruit refers to soft fleshy fruits such as berries. Cover is divided into three categories:

- Protection from predators and the elements;
- Places for nesting by birds or small mammals; and
- Daytime loafing and nighttime roosting areas.

This publication does not rank plants according to how valuable they are to wildlife, but instead provides a basis for understanding that all woody plants offer at least some value to particular classes of wildlife. Rangeland must have a mixture of vegetation that includes as many different plants as possible, so that it can consistently supply the diverse needs of the various wildlife species. Landowners and managers who understand this concept can make informed decisions about which and how much woody vegetation to maintain.

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4,000 copies, New RS

Great Trinity Forest Management Plan

Wildlife Management

Artificial Nesting Structures

NRCS Natural Resources Conservation Service
Wildlife Habitat Management Institute

WILDLIFE HABITAT COUNCIL

Artificial Nesting Structures

January 2001 *Fish and Wildlife Habitat Management Leaflet* *Number 20*

General Information

Artificial nesting structures can be used to increase wildlife reproductive success in areas where natural nest sites are unavailable or unsuitable. While artificial nesting structures cannot replace natural nesting habitats, they can increase the number of nesting sites available in an area.

Many types of wildlife use artificial nesting structures, including songbirds, woodpeckers, waterfowl, raptors, squirrels and bats. While structures are generally designed to meet the nesting requirements of certain species, they may also be used by nontarget animals and provide roosting and winter cover for a variety of birds and mammals. Nest boxes, bat houses, nesting platforms or shelves, and nesting baskets, culverts, and cylinders are some of the common types of artificial nesting structures.

The most effective artificial nesting structures are those installed in close proximity to brood-rearing habitat, adequate escape/concealment cover, a reliable source of food and water, and other elements of the habitat of target species. Predators, competitors, and territory sizes for individual species also influence the usefulness of nesting structures. Nest monitoring and maintenance actions can be taken to limit competing or undesirable species, assess reproductive success, and provide an opportunity for landowners and managers to observe wildlife.

Cavity-nesting wildlife

Birds and mammals that nest in tree cavities are likely to use nest boxes. Primary cavity-nesting species, such as members of the woodpecker family, excavate nesting cavities in live or standing dead trees (snags). Secondary cavity nesters (e.g., some passerine--or perching--birds, owls, waterfowl, and mammals) use cavities abandoned by primary excavators and those formed by fungus, knots, and trees subject to decay. The presence of snags in forested areas is directly related to the quality and quantity of nesting habitat for many cavity-nesting species. Fifty-five species of cavity-nesting birds in North America use snags, and invertebrates inhabiting the dead wood provide a rich food source. Optimal nesting opportunities for cavity-nesting wildlife are typically found on forested tracts that contain 10-12 small (<12-inch diameter at breast height—dbh) and 2-5 large (>12-inch dbh) standing dead trees per acre. Sloughing bark on snags is also used by roosting bats. Table 1 provides a list of North American cavity-nesting birds.

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This leaflet is designed as an introduction to the use of artificial nesting structures to enhance wildlife habitats. When incorporated into comprehensive habitat management plans, artificial nesting structures can increase wildlife use in many areas. The success of any management strategy depends on targeting the habitat

Table 1. North American cavity-nesting birds.

Primary (excavator)	Secondary (nonexcavator)	Secondary (nonexcavator)
Northern flicker*	Black-bellied whistling duck*	Violet-green swallow*
Pileated woodpecker*	Wood duck*	Tree swallow*
Red-bellied woodpecker	Common goldeneye*	Purple martin*
Gila woodpecker	Barrow's goldeneye*	Black-capped chickadee*
Red-headed woodpecker	Bufflehead*	Carolina chickadee*
Acorn woodpecker	Hooded merganser*	Boreal chickadee*
Lewis' woodpecker	Common merganser*	Chestnut-backed chickadee*
Yellow-bellied sapsucker	American kestrel*	Mountain chickadee*
Williamson's sapsucker	Barn owl*	Tufted titmouse*
Hairy woodpecker*	Eastern screech owl*	Plain titmouse*
Downy woodpecker	Western screech owl*	Bridled titmouse*
Red-cockaded woodpecker	Whiskered screech owl	White-breasted nuthatch*
Ladder-backed woodpecker	Northern hawk owl	Red-breasted nuthatch*
Nuttall's woodpecker	Barred owl*	Brown-headed nuthatch*
Strickland's woodpecker	Boreal owl*	Pygmy nuthatch
White-headed woodpecker	Northern saw-whet owl*	Brown creeper
Black-backed woodpecker	Spotted owl*	House wren*
Three-toed woodpecker	Flammulated owl*	Winter wren
Golden-fronted woodpecker*	Elf owl	Carolina wren*
Black-capped chickadee*	Ferruginous pygmy owl	Bewick's wren*
	Northern pygmy owl	Eastern bluebird*
	Brown-crested flycatcher*	Western bluebird*
	Great-crested flycatcher*	Mountain bluebird*
	Ash-throated flycatcher*	Prothonotary warbler*

**Species known to use nest boxes.*

C. Rewa

Natural cavities provide nesting sites for many species of birds and mammals.

needs of the desired wildlife species, and assessing managed areas to ensure that the required habitat elements are present. Landowners and managers should be familiar with state and federally listed rare, threatened, or endangered plant and animal species to ensure their protection. Involvement of wildlife professionals in the identification of habitat management objectives and actions is encouraged.

Nesting Structure Basics

Besides overall habitat conditions, several factors influence the success of artificial nesting structures. These factors include construction materials used, structure design and placement, installation methods, use of

Site fidelity.—Cavity nesting waterfowl and other birds exhibit site fidelity, where nesting females return to the general area in which they were raised. When nest sites are destroyed by timber harvest, land development, and natural disturbances, returning females are forced to find other nesting cavities. Landowners and managers can supply artificial nesting structures to replace lost nest sites, and should limit the amount of disturbance during the nesting season.

Some cavity-nesting mammals in North America.

Yellow-pine chipmunk	Deer mouse
Northern flying squirrel	Common red-backed vole
Gray squirrel	Yellow-necked field mouse
Fox squirrel	Ermine
Red squirrel	Bats
Bushy-tailed woodrat	Raccoon

predator guards, and monitoring and maintenance performed. Wildlife managers must consider all of these factors to maximize the usefulness of nesting structures. For example, the best-designed structures will be of little use if they are placed in the wrong habitat type or are easily accessed by predators. Likewise, a well-designed structure placed in suitable habitat may not be used if it is not properly attached or is easily detached from its support by wind or storms.

Construction materials

Structures made of wood are relatively inexpensive and easy to build. Wood seems to be the most weather-resistant, insulating material, and most wildlife species prefer wood to metal or plastic structures. For most nest boxes, 3/4-inch rough-cut boards are best used for construction. Since cavity-nesting waterfowl do not carry nesting material to the nest, 3-4 inches of coarse sawdust or wood chips should be placed inside the nest box. Nest boxes intended for use by woodpeckers can be tightly packed with sawdust to resemble decaying woody material. Old nesting material should be removed at the start of each nesting season and replaced with fresh materials.

Monsanto, Pensacola, FL

Great-crested flycatcher.

While many artificial nesting structures are designed for cavity-nesters, some provide nesting sites for other wildlife. Nesting platforms, baskets, and cylinders are used by waterfowl, raptors, and other species. If wire mesh is used as nest support material, the weave must be tight enough to prevent eggs and young from falling

Basic Nest Box Characteristics

- ✓ Should be made of wood; cedar (preferred, most weather-resistant), cypress, redwood, or pine.
- ✓ Box should open from the side or top for maintenance and cleaning.
- ✓ Sides of nest box should enclose the floorboard (recessed 1/4 inch) to prevent rain seepage
- ✓ Nails, woodscrews, and hinges should be rust-proof.
- ✓ Entrance hole dimensions should accommodate the desired bird species; hole should not large enough to allow competitors and predators access.
- ✓ A double thick entrance and extended roof to deter predators like squirrels and raccoons.
- ✓ Ventilation holes or slits at the top of both sides, just beneath the roof of the box.
- ✓ Drainage holes (four or five) drilled into the bottom of the nest box to allow for drainage.
- ✓ Songbird nest box should not have a perch, which increase predator access; native songbirds do not use perches.
- ✓ Nest box should not be treated with green-preservative—it is poisonous to birds.
- ✓ Nest box should not be painted on the inside or painted bright, unnatural colors on the outside (may attract predators or exotic species).

WHC

Eastern bluebird.

through the wire. Culverts are typically made of concrete, and some nesting baskets/boxes are made from plastic buckets or open metal tubs. Closed metal boxes are generally not used, since they trap excessive heat which can kill eggs and young and stress adults. Artificial burrows have a solid, plywood top and are buried about six inches underground to prevent trampling by livestock. Milk cartons should not be used as nest boxes.

Structure design

A wide variety of artificial nesting structure designs have been developed over the years to accommodate cavity-nesting and other wildlife species. Designs range from simple platforms to complex, multi-compartment structures. Some of these designs are more successful than others, and most can be built or acquired from a variety of suppliers. Design schematics for a number of structures are provided throughout this leaflet.

Basic nest box designs can be modified to accommodate various species by altering dimensions or entrance hole sizes. The size of the entrance hole also influences the internal temperature of the box, predator accessibility, and use by competing nontarget species. Table 2 contains recommended nest box dimensions and entrance hole sizes for many cavity-nesting birds.

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Wood duck hens may lay eggs in the nests of others (dump nesting) where boxes are positioned in open areas.

Waterfowl.—Nest boxes for waterfowl should be placed in wooded areas close to or directly over water. Wood ducks, mergansers, buffleheads, and goldeneyes are tolerant of other nearby nesting species. Some waterfowl species exhibit a brood parasitism behavior known as dump nesting. Dump nesting occurs when a hen observes another female entering and exiting a nest box and is stimulated to lay her eggs in that nest. This behavior increases when several nest boxes are erected close to each other in highly visible areas. Studies show that hatching success decreases in areas with excessive dump nesting. It may be necessary to put a few nest boxes out in the open *initially* to attract nesting waterfowl. The nest boxes should be moved to more secluded spots along wooded edges close to water the season after nesting is observed. Once a female has successfully nested in a box, she is likely to return in following years.

Cavity-nesting waterfowl do not bring nesting materials to the nest. They use bark, decayed wood fibers, and other debris found in natural cavities and line the nest with down. Therefore, a 3- or 4-inch layer of coarse saw dust or wood chips should be added to boxes as nest building material.

C. Rewa

Wood duck nest box placed in wooded wetland setting.

Placement

Habitat requirements of target wildlife species and available habitat greatly influences nesting structure placement. Some species seek secluded nesting sites, while others prefer to nest in more open areas. Species-specific nesting preferences should be considered when deciding where to install nesting structures. Table 3 provides habitat preferences and nest site characteristics for a variety of cavity-nesting birds.

Structures should be made available and ready for occupants before the breeding season begins. Since some bird species begin nest site selection as early as February, most nesting structures should be installed and/or made ready the previous fall or by late January.

Installation

When installing nest structures, landowners should consider height above the ground, orientation, predator guards, and preferred natural nesting sites. Woodpeckers and bats prefer nest boxes that face east, providing greater morning sun exposure. Most birds and mammals favor entrances that face away from prevailing winds. Landowners and mangers should learn which natural habitat conditions are favored by the desired wildlife species. Cavity-nesting waterfowl nest on or near the water, and often prefer nesting structures that face open water and are clear of overhanging branches. Where beavers occur, landowners should avoid attaching nest structures to aspen or other tree species that are preferred beaver food sources.

Nest structures can be attached to poles, posts, or pipes on land or in the water. Nest boxes can also be attached to trees; however, it is hard to install predator guards on tree trunks. Supports should be sturdy enough to keep the structure from swaying or tipping over in high winds. Nest boxes can be attached to 4x4- or 4x6-inch treated wooden posts or trees by inserting a 4- to 6-inch lag bolt through a hole drilled in the back of the box, opposite the entrance hole. A large washer between the head of the lag bolt and the box should be used to secure the box to the support. The bolt should be checked each year and loosened as the tree grows. Wire should not be used to attach nest structures to live trees to avoid damaging the tree.

To ensure stability, the inside diameter of metal support poles should be at least two inches. Hex or carriage bolts can be used to attach structures to steel poles. Nest structures can be installed on or over water when it is iced over or when the water level is low. Nest boxes mounted over water should be four

Solutia, Inc.

Wood ducks readily use nest boxes.

Table 2. Nest box dimensions for some cavity-nesting birds (dimensions in inches).

Species	*Floor Area*	*Cavity depth*	*Entrance height*	*Diameter of entrance hole*
Wood duck*	8x12	15	9 1/2	3x4 oval
Hooded merganser*	10x12	23	17	4x3 oval
American kestrel	8x8	12-15	9-12	3
Barn owl*	12x40	15	7	6x6
Barred owl*	13x13	22-28	14-18	6-8
Saw-whet owl*	6x6	10-12	8-10	2 1/2
Screech owl*	8x8	12-15	9-12	3
Northern flicker*	7x7	16-18	14-16	2 1/2
Downy woodpecker**	4x4	8-10	6-8	1 1/4
Hairy woodpecker**	6x6	12-15	9-12	1 1/2
Lewis' woodpecker**	7x7	16-18	14-16	2 1/2
Pileated woodpecker**	8x8	16-24	12-20	3x4
Ash-throated flycatcher	6x6	8-10	6-8	2
Great-crested flycatcher	6x6	8-10	6-8	1 3/4
Brown-headed nuthatch***	4x4	8-10	6-8	1 1/4
Pygmy nuthatch***	4x4	8-10	6-8	1 1/4
Red-breasted nuthatch***	4x4	8-10	6-8	1 1/4
White-breasted nuthatch***	4x4	8-10	6-8	1 3/8
Tree swallow	5x5	8	6	1 3/8
Violet-green swallow	5x5	6-8	4-6	1 1/2
Eastern bluebird	5x5	6	10	1 3/8
Mountain bluebird	5x5	8-12	6-10	1 9/16
Western bluebird	5x5	8-12	6-10	1 1/2
Bewick's wren	4x4	6-8	4-6	1 1/2
Carolina wren	4x4	6-8	4-6	1 1/2
House wren	4x4	6-8	4-6	1 1/8
Black-capped chickadee	4x4	9	7	1 1/8
Carolina chickadee	4x4	9	7	1 1/4
Tufted titmouse	4x4	9	7	1 1/4

** put four inches of wood chips or coarse sawdust in bottom of nest box*

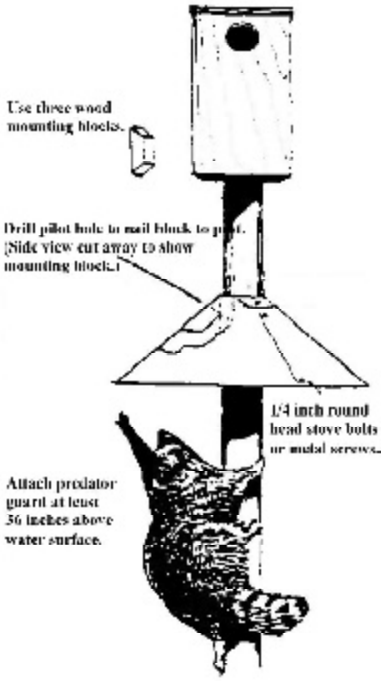
*** fill nest box tightly with sawdust, preferred if outer material is bark*

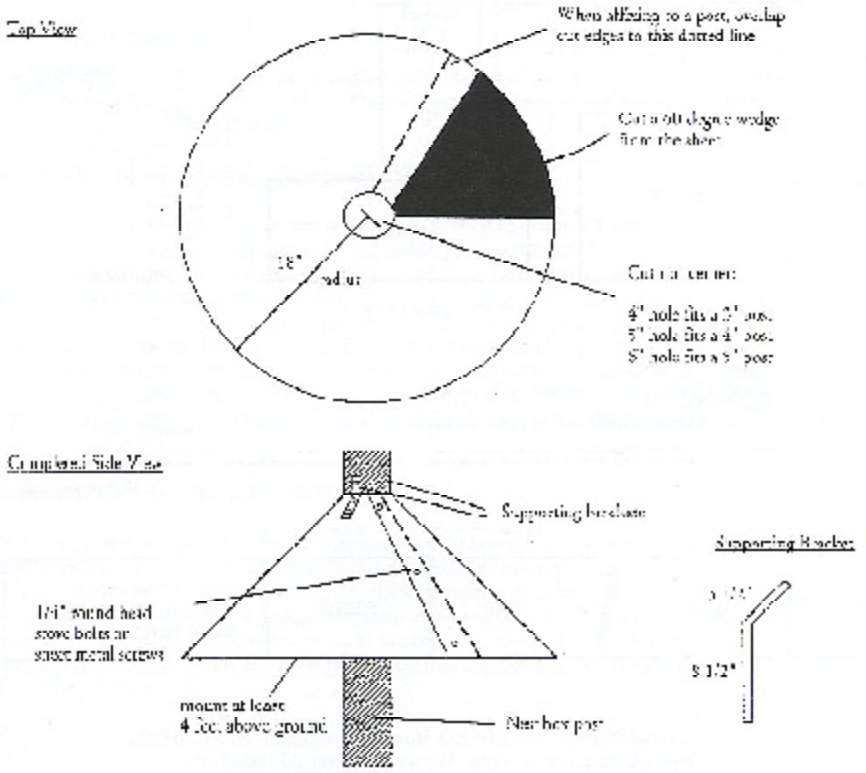
**** outer material should be bark*

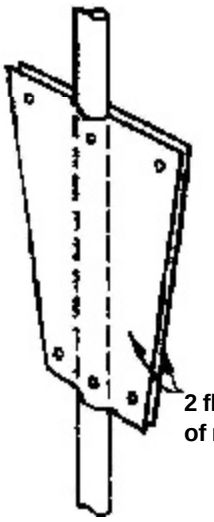
Conical predator guard

Below is a top view layout for cutting a predator guard from a 2 foot x 3 foot sheet of 26 gauge galvanized metal. The first cut is to remove a 60 degree wedge from the sheet. The center hole is then cut.

The side view shows a guard affixed to a wooden fence post. This is done by overlapping the edges of the 60-degree wedge to the slots indicated here. Bolts or screws are then used to form the sheet into a cone. Fasten the wood to the post with supporting brackets. Note 3 wooden mounting blocks on the back (inside) of the guard to fasten to the post. Fasten the blocks to the guard and post with screws. The predator guard should be placed on the post so the bottom of the guard is at least 4 feet from the ground.







The pipe, or sandwich guard (left) and the sheet metal band guard (right) provide alternatives to the conical predator guard. Heavy plastic, sheet metal, aluminum, and other materials can be used to make predator guards. Newspaper printers are good sources for large quantities of aluminum sheet metal, which is used in printing and then recycled.

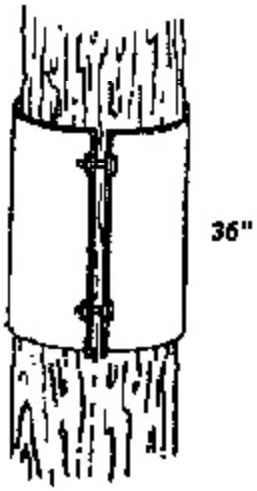


Table 3. Habitat requirements and nest box placement for some cavity-nesting birds.

Species	Nesting habitat and placement tips
Eastern bluebird Mountain bluebird Western bluebird	Open fields, meadows, backyards; old orchards; open rural country with scattered tree cover; place box 3-6 ft. above ground; entrance hole should face open areas, preferring east and north directions; Mountain and Western bluebirds may use some forest edge.
American kestrel	Pastures, fields, and open meadows with grazed or mowed vegetation; place box on solitary trees or posts in open fields or along edge of woodlots 10-30 ft. above ground.
Wood duck	Forested wetlands, swamps, ponds, lakes; place box in deciduous trees 6-30 ft. above ground, 30-100 ft. from nearest water source; space boxes 100 ft. apart.
Hooded merganser Common merganser	Prefer secluded wooded waterways, lakes, faster-moving rivers; place box on tree up to 6-30 ft. above ground, within 30-100 feet of water source.
Common goldeneye Barrow's goldeneye	Forested areas near permanent lakes and rivers and large, mature trees; place box in trees 6-30 ft. above ground, within 30-100 ft. of water source.
Screech owl	Forests, parks, woodland clearings, forest edges, especially in riparian areas; place box 10-30 ft. above ground facing north.
Great crested flycatcher	deciduous or mixed deciduous-coniferous forests and forest edges, woodands; place box on post or tree at forest edge, 3-20 ft. above ground.
Ash-throated flycatcher	Chaparral, mesquite thickets, savannas, deserts , and open deciduous and riparian woodlands; place box 3-20 ft. above ground.
Northern flicker	Pastures, woodlands, forest edges; place box 6-30 ft. above ground on pole or tree at forest edge or along fence rows.
Tree swallow	Open fields and other open habitats near riparian areas; place box on pole or post 5-15 ft. above ground with entrance hole facing east 30-100 ft. apart.
Violet-green swallow	Open or broken deciduous or mixed deciduous-coniferous forests, forest edge adjacent to open area; place box 9-15 ft. above ground.
White-breasted nuthatch	Deciduous, mixed deciduous-coniferous forests, woodlands, forest edges, with mature stands and decaying trees; place box 3-60 ft. above ground, entrance hole should face away from prevailing wind.
Red-breasted nuthatch	Coniferous, and mixed deciduous-coniferous forests, aspen woodlands, mature stands with decaying trees; place box 5-40 ft. above ground, entrance hole should face away from prevailing wind.
Pygmy nuthatch	Ponderosa, yellow, and Jeffrey pine forests, pinyon-juniper woodlands; place box 6-60 ft. above ground.
Brown-headed nuthatch	Open stands of pines, mixed pine-hardwood woodland; place box 2-10 ft. above ground.
Black-capped chickadee Carolina chickadee	Forests, woodlots, and areas with mature hardwood trees, forest edges, and meadows; area should receive 40-60% sunlight and entrance hole should face away from prevailing wind.
Mountain chickadee	Montane coniferous forests; place box 5-15 ft. above ground, preferably in a snag; entrance hole should face away from prevailing wind.
Chestnut-backed chickadee	Coniferous and mixed deciduous-coniferous forests, usually near riparian areas; place box 2-15 ft. above ground; entrance hole facing away from prevailing wind.
Carolina wren	Open deciduous woodlands (especially with thick underbrush), backyards, parks, gardens with trees or shrubs; place box 0-10 ft. above ground.
Prothonotary warbler	Swampy lowland forests and river bottom woodlands subject to flooding; place box 2-10 ft. above or near water.

to six feet above the water surface to avoid flooding. A slight forward tilt can help drain the structure and keep out precipitation. A post driver can be used to drive wooden or metal posts into the substrate of ponds or wetlands. Utility or fire companies may be able to help landowners raise tall nesting structures, such as raptor and heron platforms.

Floating nest platforms are usually held in place by anchor chains, weights, or buoys. They should be anchored at least 25 feet from shore, in water at least 18 inches deep. Floating platforms should be removed before the first major freeze to prevent damage from ice action and fluctuating water levels.

Predator guards

Predators (both native and introduced) can limit the reproductive success of wildlife using natural nest sites and artificial nesting structures. The rough surface of wooden posts and trees makes climbing easy for terrestrial predators such as snakes, raccoons, and domestic cats.

Artificial nesting structures, especially those close to water, should be fitted with predator guards to reduce the likelihood of nest predation. Heavy plastic, aluminum sheet metal, and other materials can be used to construct predator guards. Newspaper printers are good sources for large quantities of discarded aluminum sheet metal. Metal poles are more difficult to climb, but should at least be covered with repeated applications of axle grease where effective predator guards are difficult to install.

There are three basic types of predator guards: the conical guard, the pipe (sandwich) guard, and sheet metal tree band guard (see illustrations on page 7). Other structures such as coarse wire mesh extending out from around the nest box entrance hole may be used to prevent raccoons and other predators from reaching into the nest box.

C. Rewa

Predator guards help reduce loss of eggs and young to predation.

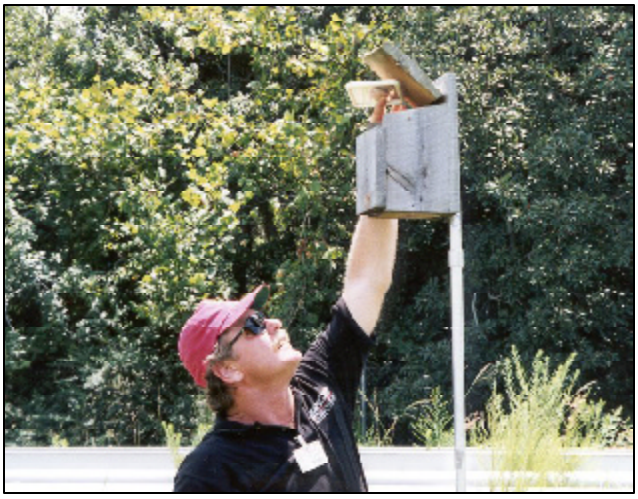
In addition to installing predator guards to discourage ground-dwelling predators, overhanging or low branches near nesting structure should be removed to discourage access by arboreal predators.

Monitoring and maintenance

Nesting structures can be monitored throughout the nesting season to track use and nest success, remove undesirable exotic species, and to clean the structure after young are fledged to make it available for late and second nesting attempts. Some birds and mammals tolerate limited levels of human disturbance, such as occasional (once a week or once every ten days) nest checks, but others do not. Nest checks should be completed quickly to minimize stress on parent birds and young. Intrusive monitoring of sensitive species (e.g., ferruginous hawks, ospreys, barn owls) should be limited to prevent nest abandonment.

Parasites cause problems for some nesting birds. To check for blowfly larvae, mites, and other pests, gently lift the nest off the box floor and tap it lightly. After

Woodpeckers.—Many woodpecker species will take advantage of nest boxes if mature trees and snags in which to excavate cavities are not available. Boxes should be tightly packed with sawdust to simulate decaying wood inside snags and dead limbs. Woodpeckers prefer boxes with bark exteriors, placed on the south or east side of trees (to maximize exposure to the sun).



Monsanto, Pensacola, FFL

Monitoring and maintenance can help ensure success of bluebird boxes and other nesting structures.

the pests drop to the box floor, sweep them out of the box. Since birds have a poor sense of smell, adults do not generally abandon nests that have been handled in this manner.

Well-built nesting structures can last 10-15 years if properly maintained. After a brood has left the structure, the old nesting material should be cleaned out to make room for a second clutch. Nest structures should be checked at least once per year before the breeding season starts to remove old nesting materials, mouse nests, insects, and other debris. Place fresh wood chips, shavings, or sawdust in nest boxes, if appropriate. Replacement parts and other repairs can be made to nest structures during annual maintenance checks. Nest monitoring results can be used by local birding organizations and state and federal government agencies to keep track of reproductive success and wildlife population trends.

Competitors

Competition for nest sites is often high among cavity-nesting wildlife species. Birds, small mammals, and insects compete for suitable sites. Deer mice and squirrels often inhabit nest structures during the winter months, and their nests should be removed during annual maintenance inspections if they are not the target species.

House sparrows and European starlings are not native to North America but thrive in backyard and suburban areas, frequently taking over nest sites used by native songbirds. House sparrows will kill the parents and young of bluebirds, chickadees, house wrens, and other native birds. An entrance hole diameter of less than 1 1/4 inches can preclude house sparrows from using nest boxes, but also excludes some native cavity-nesting birds. European starlings can be excluded by entrance hole diameters of no greater than 1 1/2 inches. Special starling guards are available to protect entrance holes of purple martin houses and other nesting structures.

If a house sparrow or starling nest is found during routine nest monitoring, the nest and its contents should be removed. These two introduced species are often persistent nesters and are not protected by federal law. Live trapping and humane destruction may be necessary in areas highly populated by house sparrows and starlings (traps are available at bird specialty stores). Local authorities can help landowners dispose of the birds properly. Frozen birds can be donated for scientific use, and to academic institutions or raptor rehabilitation centers.

Wasps and bees also build nests in bird houses. These insects can be discouraged by soaping the inside top of nest boxes. If insects such as paper wasps establish a nest in a vacant box, a low toxicity insecticide can be sprayed inside the box in the early morning (when the insects are still cold and sluggish) and the

K. Klimkiewicz

Non-native house sparrows aggressively compete for nest sites with native species.

Vulcan, Brooksville, FL

Screech owl young in nest box.

C. Rewa

Owl nest boxes can be attached to the side of buildings.

nest can be removed. Annual maintenance and monitoring help detect colonies of wasps and bees.

Types of Artificial Nesting Structures

Nest box

Nest boxes are probably the most common and easily recognized artificial nesting structures used today. Over 50 species of birds including waterfowl, raptors, songbirds, and woodpeckers are known to use nest boxes. A variety of nest box designs are provided throughout this leaflet, and box dimensions for various species are listed in Table 2. Some government and nonprofit organizations may supply nest boxes and/or building materials at no charge or at a reduced rate. Local community groups like scouts and ornithological society chapters can help landowners construct and erect nest boxes.

Like natural nesting cavities, nest boxes should not have perches mounted at the entrance hole. Box construction should limit the amount of light and precipitation that can enter the box. During construction, four 1/4- inch holes should be drilled in the bottom of the nest box for drainage, and ventilation slits should be provided on both sides just under the roof overhang. Hardware cloth attached to the inside front of waterfowl nest boxes serves as exit ladders for ducklings.

Great Horned Owl and Great Gray Owl Nesting Platforms

Great horned owls and great gray owls do not build their own nests. Both species typically use nests abandoned by red-tailed hawks, goshawks, eagles, and other large raptors. Artificial nesting platforms and cones are also used.

Great horned owls prefer platforms lodged in mature hardwood trees 15 to 50 feet above the ground. Nest sites should be relatively free from human disturbance, and foraging habitat should be available nearby. Platforms in quiet woodlot edges, shelterbelts with mature trees, and windbreaks are examples of suitable nesting sites.

Great gray owls prefer nest sites located in the interior of coniferous forests. Nesting platforms should be placed in mature trees at least 15 feet above the ground.

Monsanto, Pensacola, FL

Owl nest boxes ready for deployment.


Paul Jung

Purple Martin Housing Standards

Today, purple martins depend on humans to supply them with suitable nest sites. For more detailed information about purple martins, helpful management tips, and housing specifications and diagrams contact the Purple Martin Conservation Association (PMCA) at the Edinboro University of Pennsylvania at 814-734-4420 or visit the PMCA website at http://www.purplemartin.org.

The PMCA has developed a set of biologically-sound housing (for compartment or gourd system) standards for purple martins. Listed below are some purple martin housing basics. These birds have additional housing needs, and PMCA literature addresses those issues.

Housing materials: Although aluminum housing is often preferred for its ease of maintenance and accessibility, untreated wood apartments are also commonly used. Cypress and cedar are recommended, but pine or redwood are also used. The exterior of the apartments should be painted white. The interior should have no treatment, stain, or paint. Wood floors with a rough surface prevent nestlings from developing splayed legs. If the housing is made of plastic, the exterior should be a light color or white. The plastic should be opaque. Translucent plastic overheats quickly, killing the eggs, nestlings, or stressing the incubating parent martin. Gourds are also used as purple martin apartments.

Compartment size: A martin house contains at least four to six compartments, and the minimum size for each compartment is 6x6x6 inches. Larger compartments offer better protection from weather and predators.

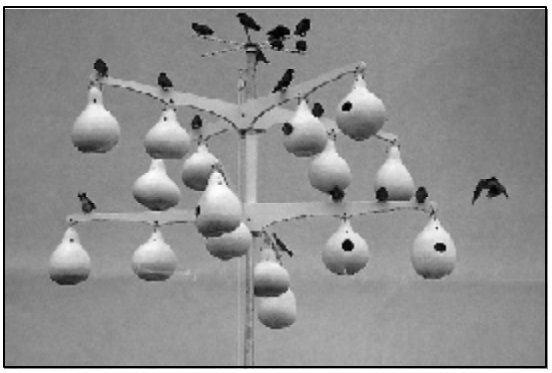
Entrance hole: Purple martins use round entrance holes with diameters ranging from 1 3/4 to 2 1/4 inches. Most housing features 2 1/8-inch diameter entrance holes. Door plugs should be used in the winter to close compartments to house sparrows, starlings, and other winter occupants. The entrance hole should be 1 to 1 1/2 inches above the floor of the compartment.

Height and placement of housing: Housing should be erected 12 to 20 feet above the ground on a metal pole or pressure-treated wood post set into the ground with concrete. The house should not sway or tip in high winds. The house should be placed in an open area at least 40 feet away from trees, but within 100 feet of human activity (home, marina, etc.).

Other considerations: Landlords should install a pole predator guard to discourage terrestrial predators. The compartments should have ventilation holes under the roof overhang and drainage holes in the compartment floor. Porch railings are desireable.

The martin housing must be able to be lowered and raised vertically in order to perform routine maintenance, cleaning, and nest monitoring. Housing on a winch or lanyard system or on a telescoping pole is highly recommended. House sparrows and European starlings frequently take over housing, so the landlord must check for nests, eggs, or occupants on a regular basis. Perches are not recommended sincethey attract these exotic species.


Aluminum purple martin house. Dave Holmes


Purple martins on gourd housing structure. WHC

Amoco

Many floating platform designs are used to provide suitable waterfowl nesting sites.

Nest Shelf

Nest shelves are used by American robins, eastern phoebes, and barn swallows. Since these species use mud in nest construction, nearby mud puddles or other water sources may enhance the attractiveness of nest shelves. Some birds prefer shelves placed under building overhangs or eaves, adjacent to open areas. Old nesting material should be removed after the breeding season is complete. A design for a typical nest shelf is provided on page 19.

Nesting platform

Ospreys, ferruginous hawks, golden eagles, great horned owls, great gray owls, great blue herons, black-capped night herons, double-crested cormorants, egrets, and occasionally bald eagles have been known to nest on platforms when suitable natural nest sites are limited or unavailable. Sticks are frequently wired to the platform to simulate previous use, which is attractive to these species. Nest platforms can be mounted on a single pole, a solid base such as a tree or tripod, or for species that nest along coastal or inland waterways, marine navigational structures. One nesting platform design is provided on page 24.

Floating platform

Many waterfowl species choose natural nesting sites on islands or along shorelines of lakes, ponds, rivers, and streams. Most waterfowl favor sites sheltered from prevailing winds, and preferred nesting cover varies with species. Floating platforms offer alternative nesting sites that provide protection from many predators. Floating platforms are used by common loons and Canada geese in areas where water levels fluctuate. Mallards, black ducks, pintails, blue-winged teal, and canvasbacks may also use floating platforms. Aquatic vegetation such as rushes and cattails can be secured to floating platforms in northern lakes to attract nesting loons. Canada geese prefer platforms covered with grass, straw, or hay. Nest material can be wired to the bottom of the platform to prevent it from blowing off. Other waterfowl species and turtles may use floating platforms for loafing. A floating nesting platform design is provided on page 22.

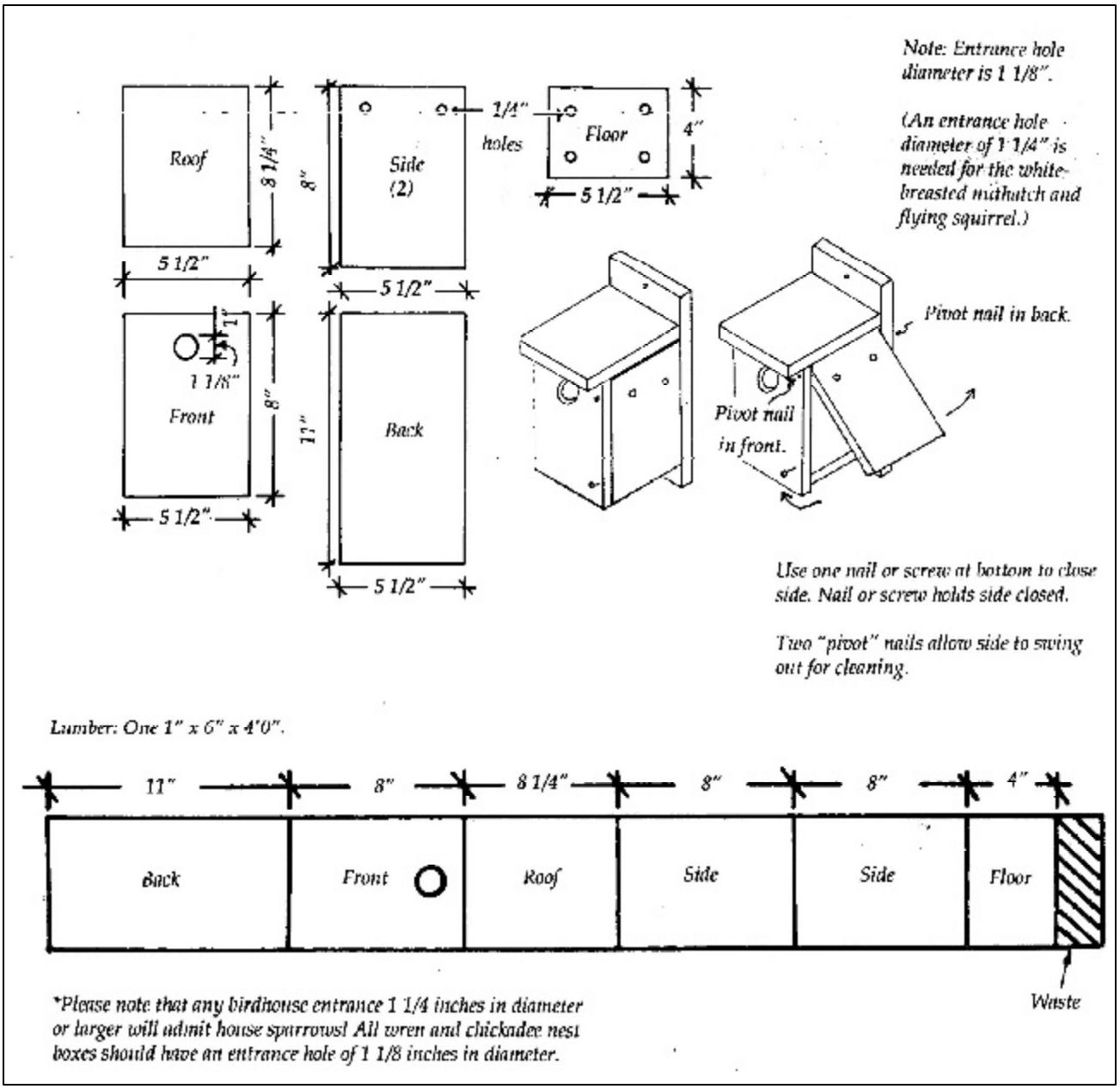
Nesting baskets, cylinders, and culverts

Nesting baskets and tubs (both metal and fiberglass) are used by ducks (primarily mallards) and geese. Mallard nest baskets should be installed over water at least ten feet from the land. Baskets or tubs attached to wood or metal supports should be at least three feet above the surface of the water to prevent flooding. Straw, hay, or grass nesting material should be replaced annually. About ten drainage holes must be punched into the bottom of the tub. A 6x4-inch escape notch should be cut out of the side of the tub to allow goslings and ducklings to exit. The tub may be painted a natural earth tone (brown, gray, or dark green). If the tub is attached to a floating platform, the platform must be anchored to the bottom at opposite

C. Rewa

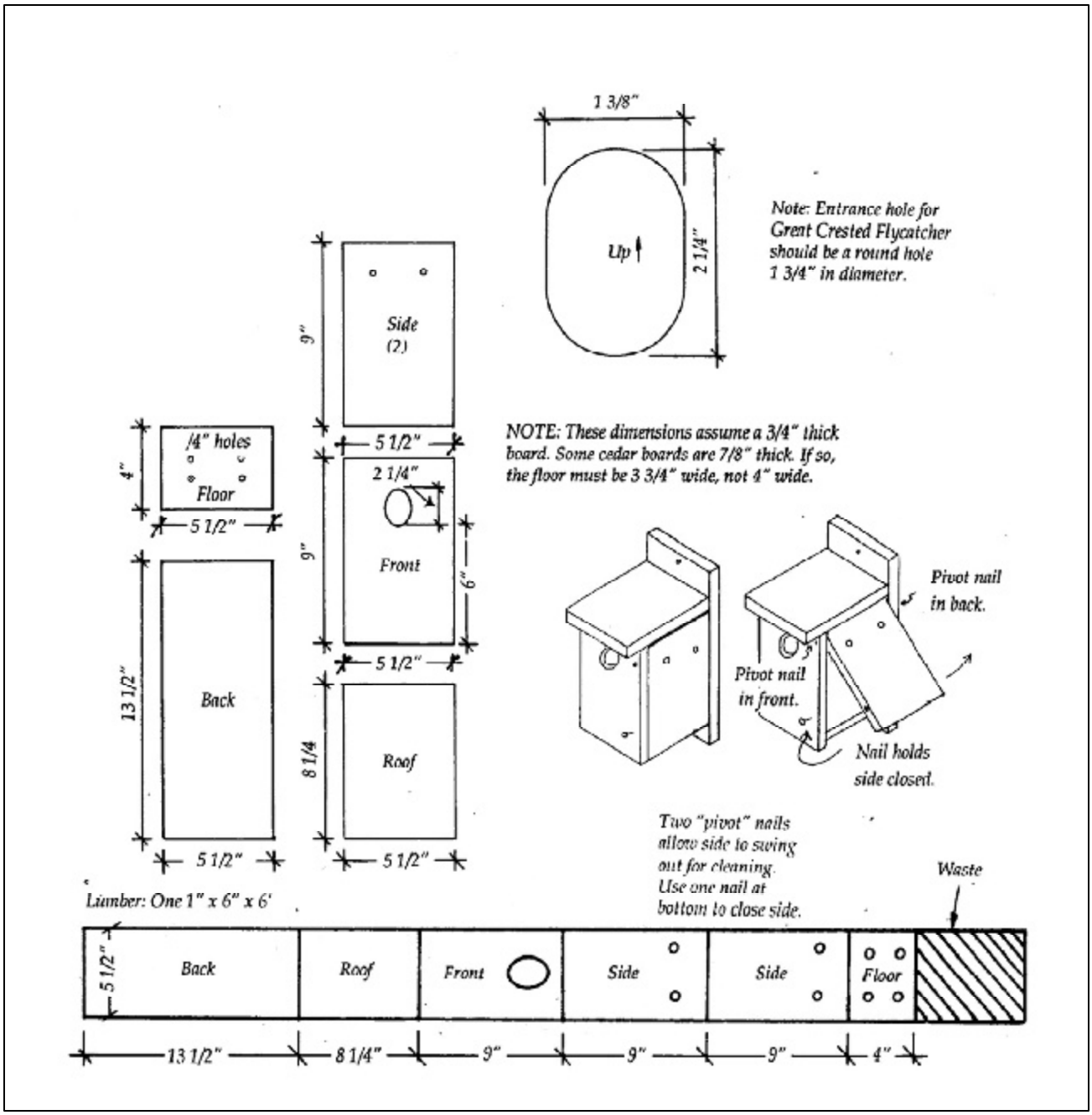
Baskets provide nesting sites attractive to waterfowl.

Nest box diagram for black-capped chickadee, house wren, prothonotary warbler, white-breasted nuthatch, flying squirrel, deer mouse and white-footed mouse.



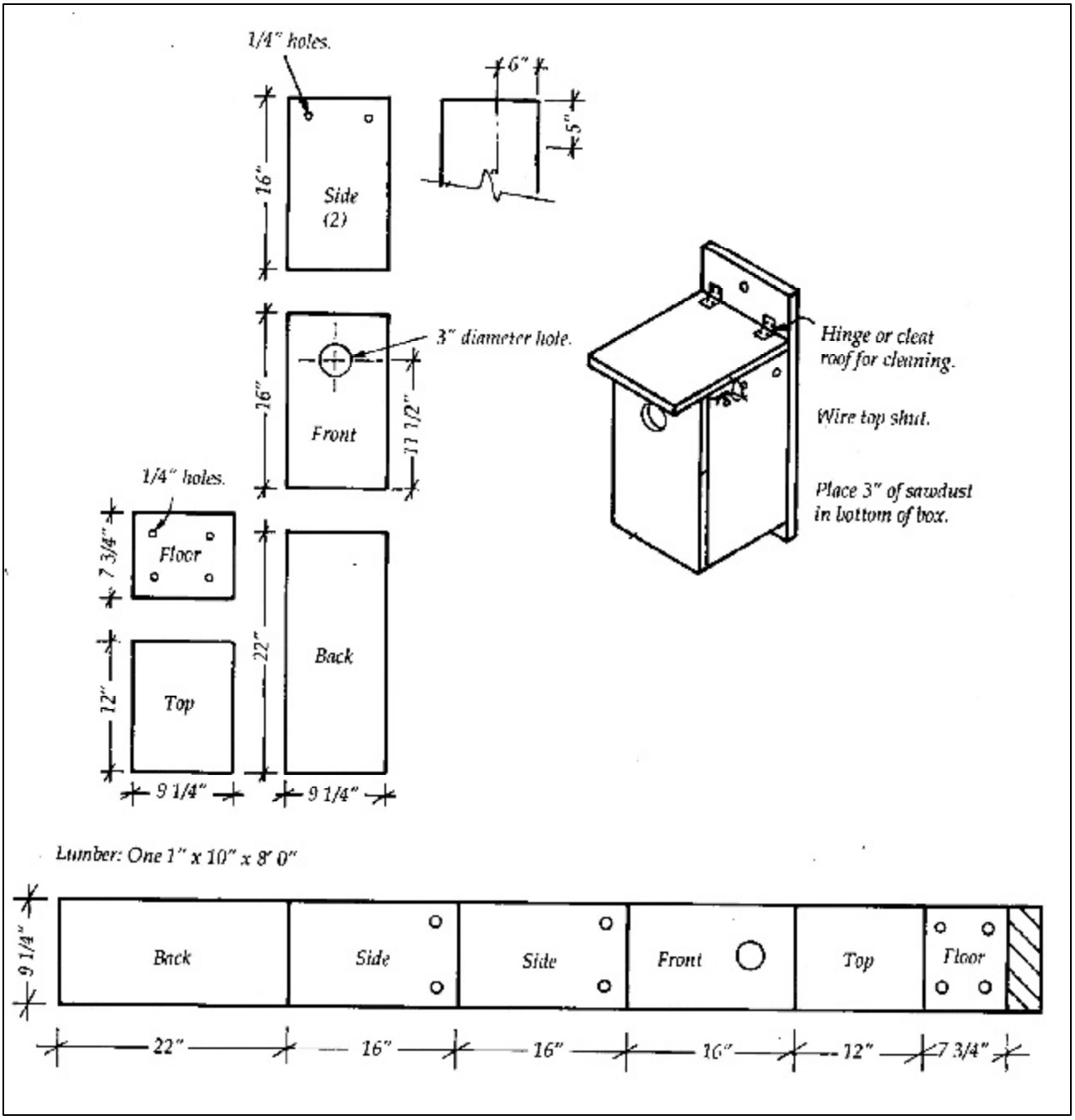
Minnesota Department of Natural Resources

Nest box diagram for eastern bluebird, great-crested flycatcher, and tree swallow.



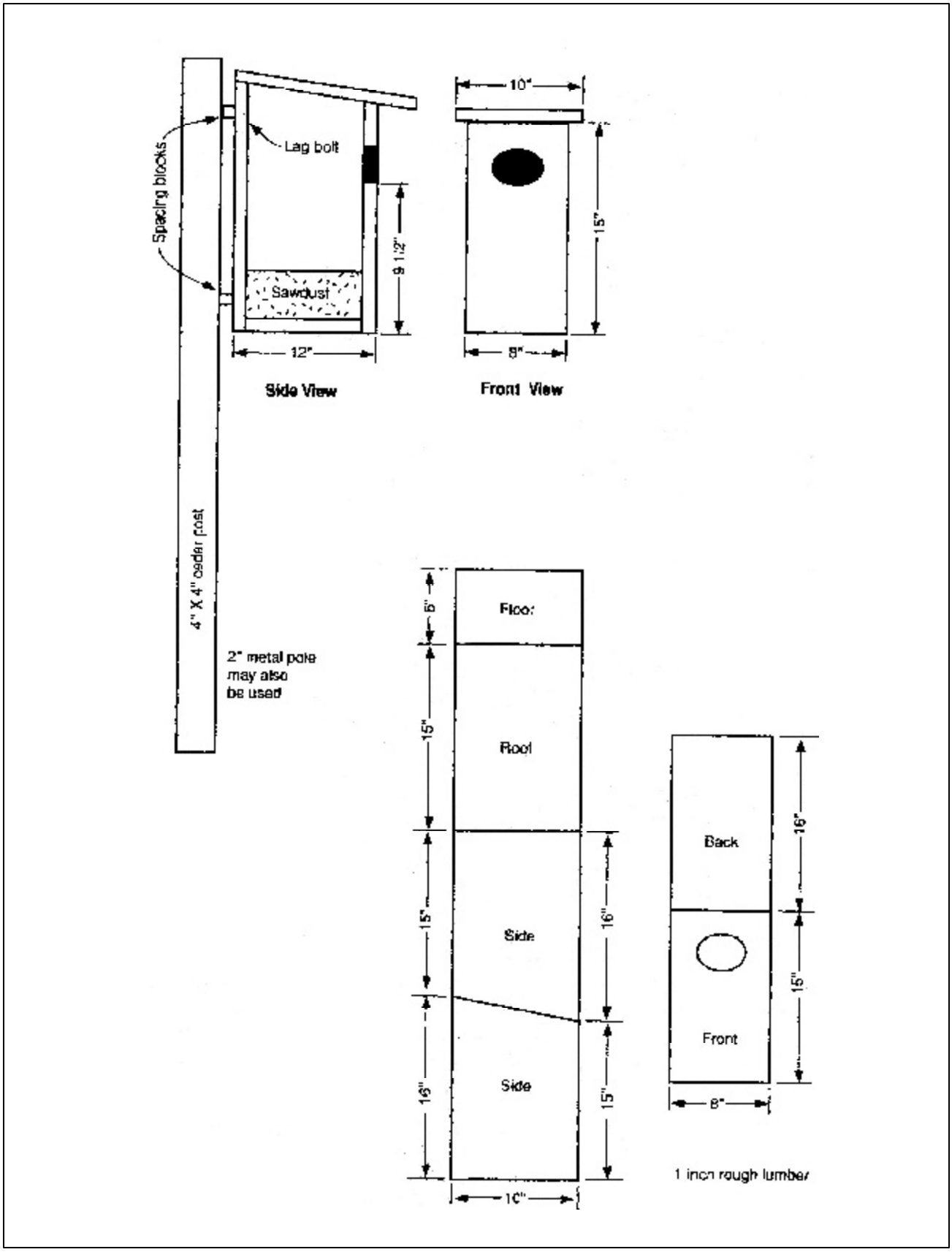
Minnesota Department of Natural Resources

Nest box diagram for American kestrel, boreal owl, northern saw-whet owl, screech owl, fox squirrel, gray squirrel and red squirrel.

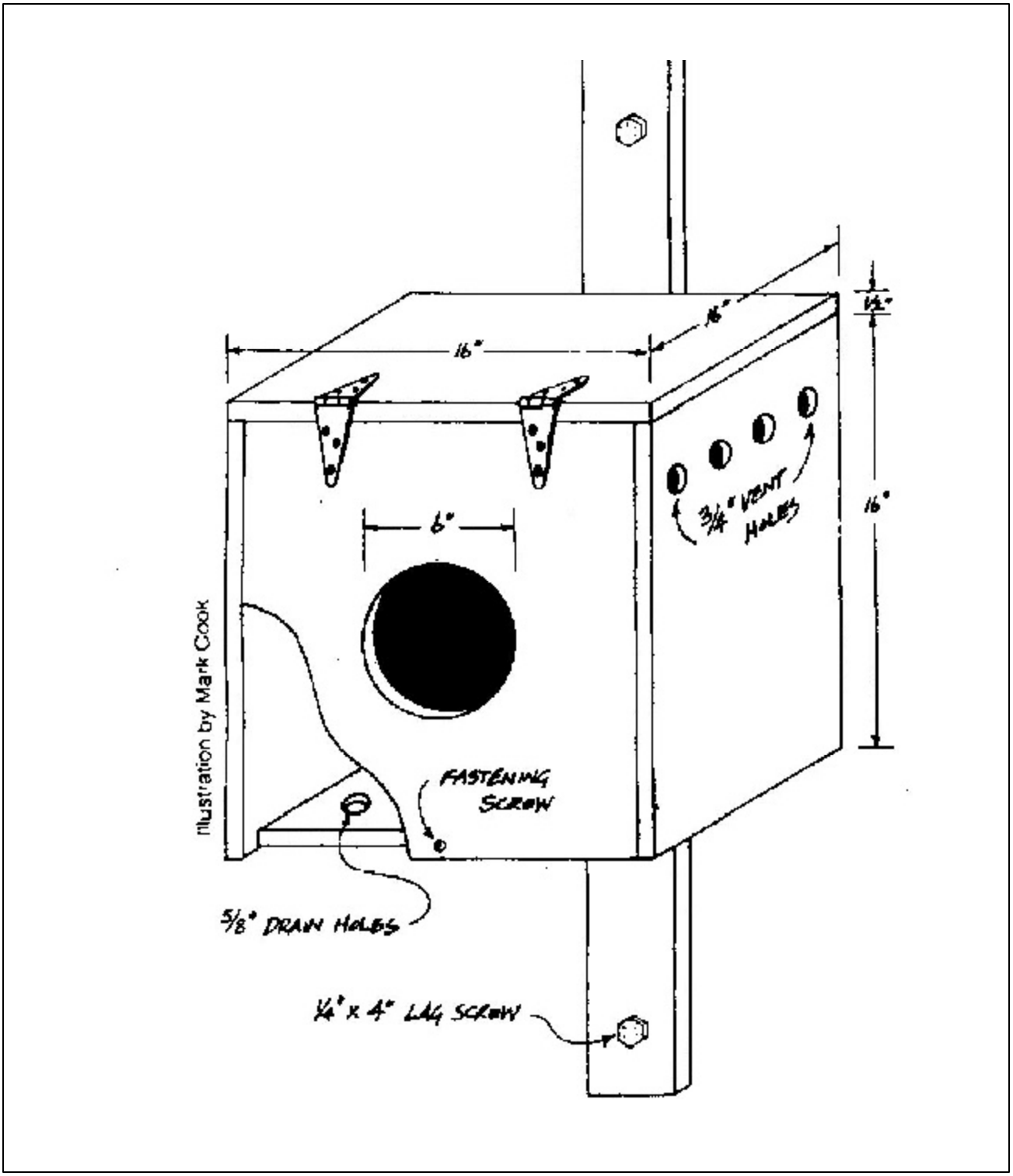


Minnesota Department of Natural Resources

Wood duck nest box diagram.

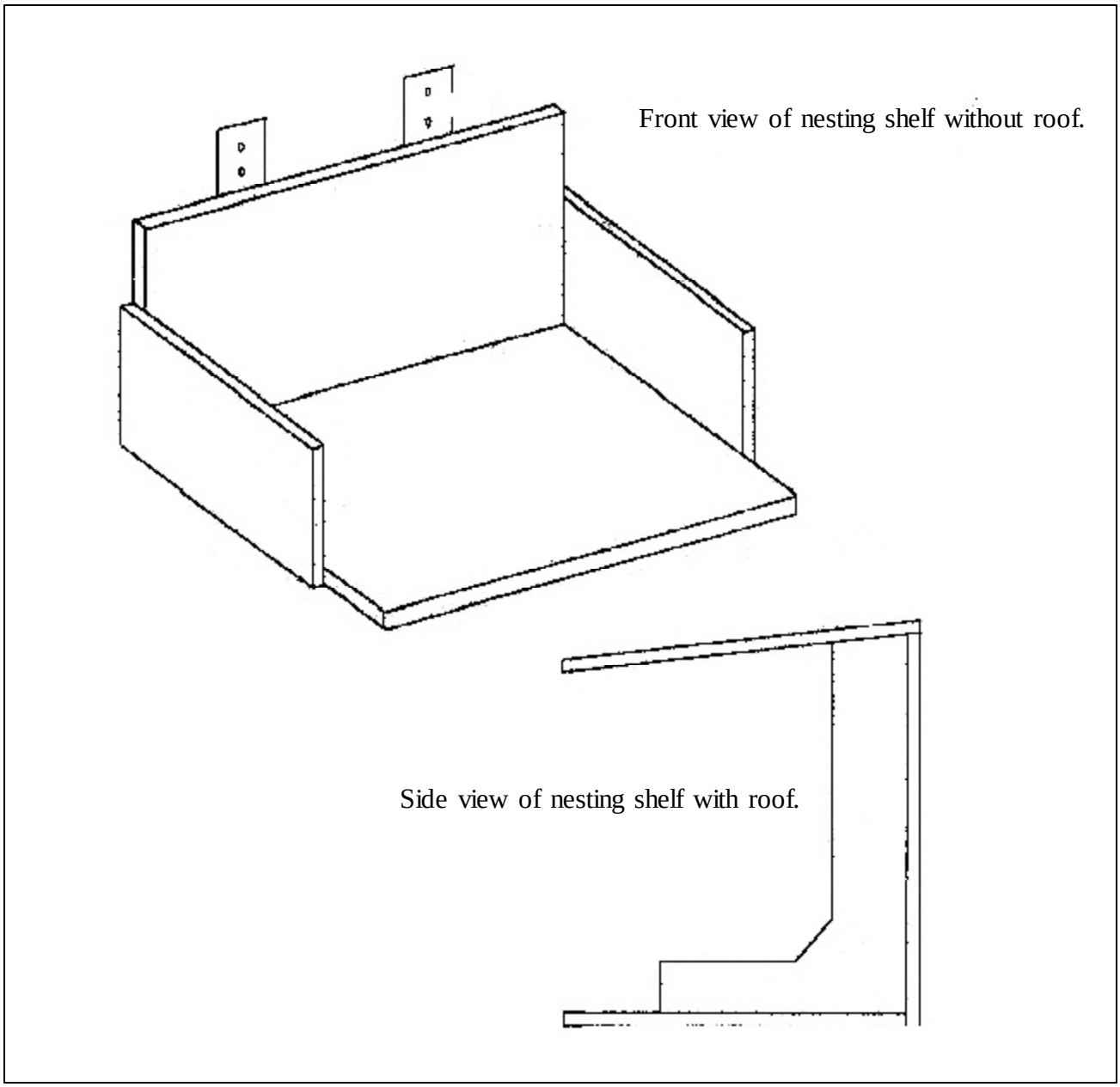


One type of barn owl nest box.



A barn owl nest box based on design in T. Hoffman, Using Barn Owls for Rodent Control (see on-line references). The 24-inch cube requires 1 1/2 sheets of 1/2-inch plywood.

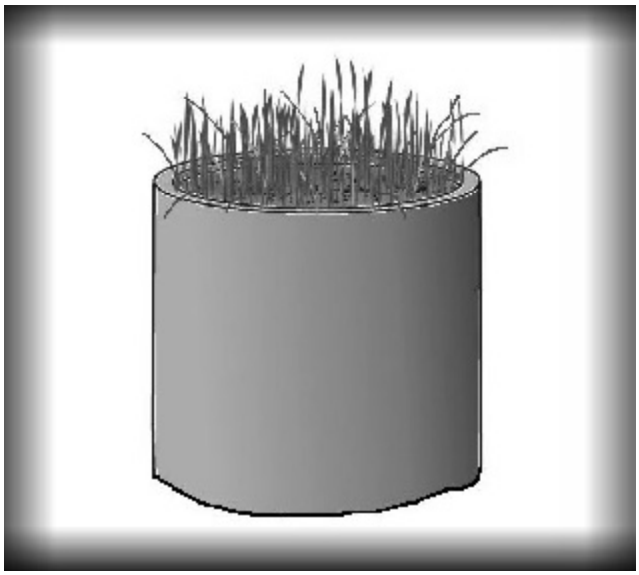
Nesting shelf diagrams for American robin, eastern phoebe, and barn swallow.



Nesting shelf dimensions and mounting height.

Bird Bird species	Floor dimensions (in.)	Front height (in.)	Mounting height (ft.)
American robin	6x8	8	6 to 15
Eastern phoebe	6x6	6	8 to 12
Barn swallow	6x6	6	8 to 12

Place shelf on side of building with vertical or horizontal brackets.



Concrete waterfowl nesting culvert.

C. Rewa

Waterfowl nesting cylinder, or "hen house."

ends in two to four feet of water. Floating structures and nesting baskets should be installed in areas where view of other similar structures is obstructed.

Hen houses, or nesting cylinders, are suitable nest sites for waterfowl species that favor overhead nesting cover. The house is basically a 3-ft. long cylinder made of rolled fencing wire and hay, dried grass or other vegetation. Cylinders can be mounted on wooden boards attached to poles protruding from the water. Pipes or poles supporting the hen house should extend at least three feet above the surface of the water to prevent flooding.

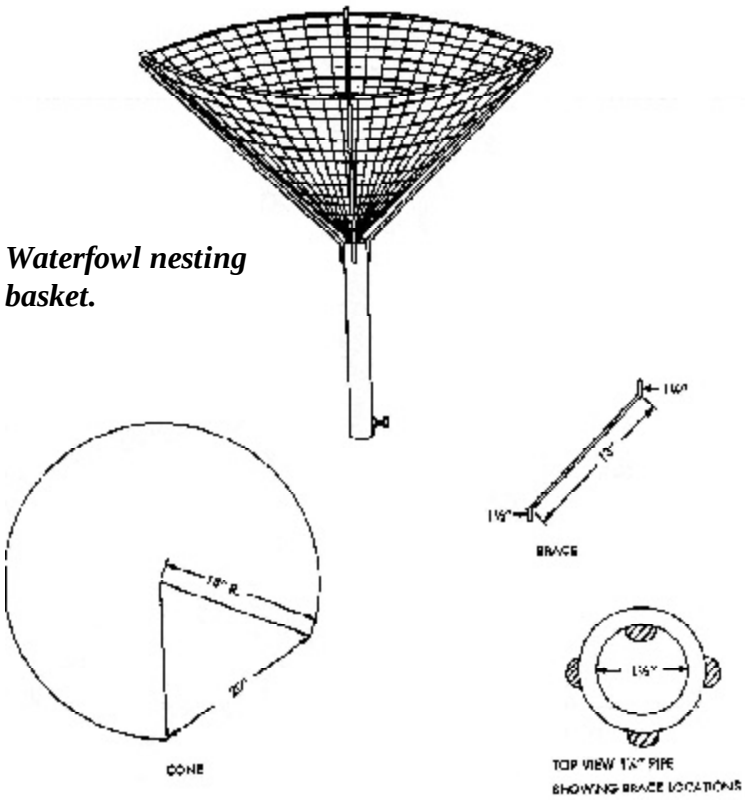
Basic designs for nesting baskets and cylinders are provided on page 21.

Concrete culverts can be used to make suitable nesting structures for some ducks and geese. To construct a nesting structure, the culvert is be set on end and filled with soil. Vegetation preferred by the target species should be planted in the top layer of soil. Culverts require little annual maintenance and are usually installed in about 18 inches of water along shorelines of lakes, ponds, and wetlands. The culvert should extend far enough above the water to prevent flooding or easy predator access. It may take one or two years before there is adequate vegetation cover to attract nesting waterfowl.

Bat box

Forty percent of bat species in the United States are rapidly declining or endangered because of habitat loss and destruction of roosts and hibernacula. Bats are nocturnal mammals that depend on roosts in natural tree cavities, caves, hollow trees and sloughing tree bark, and man-made structures such as attics, mines, and bridges. Daytime roosts are used for migrating

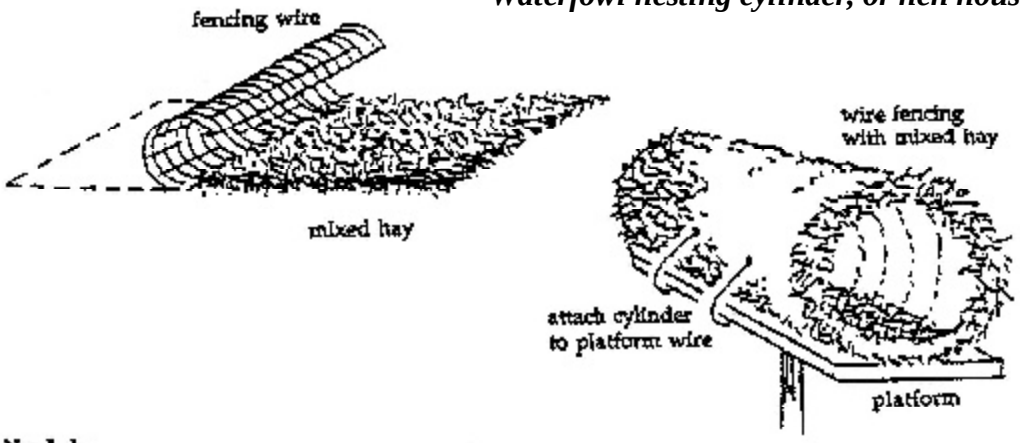
C. Rewa



Waterfowl nesting basket.

Add straw or hay nesting material before the nesting season.

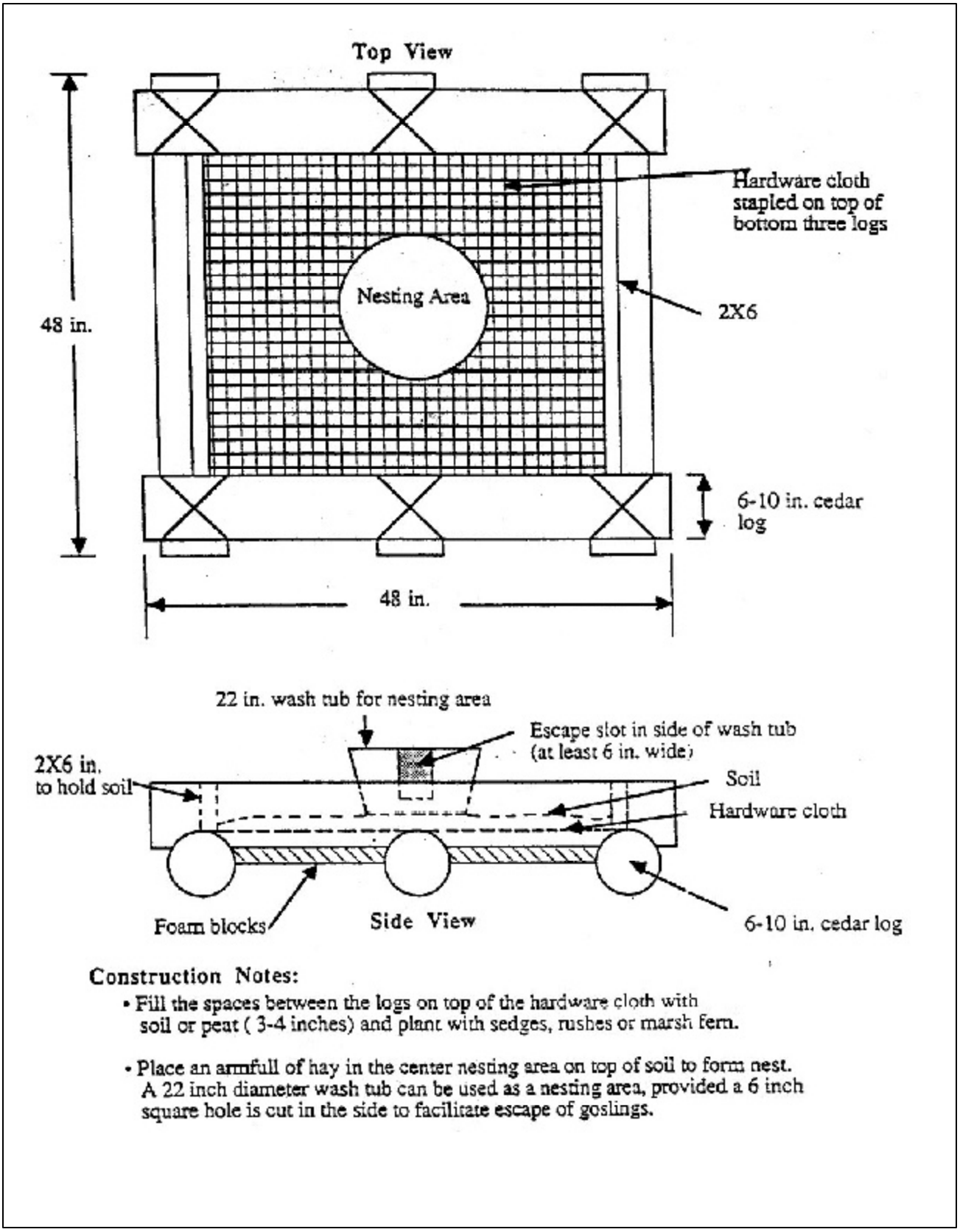
Waterfowl nesting cylinder, or hen house.



Materials Needed:

- 7 foot piece of 2" x2" mesh-welded plastic coated garden fencing. 36" wide.
- 1" x 6" x 3 ft. treated board.
- Pipe flange attached to the bottom center of the board which is driven into the marsh to stand 3 feet above the water.
- 4' x 1" steel pipe screwed into the flange.
- Marsh hay. If marsh hay is not available when rolling the wire into a cylinder, use 'ditch grass' or 'horse hay' such as a timothy orchard grass mixture. DO NOT USE STRAW.
- When wire is rolled, a cylinder which is 36" long by approximately 12" in diameter should be produced.

Floating platform diagram for common loon, Canada goose, and other waterfowl.



Construction Notes:

- Fill the spaces between the logs on top of the hardware cloth with soil or peat (3-4 inches) and plant with sedges, rushes or marsh fern.
- Place an armfull of hay in the center nesting area on top of soil to form nest. A 22 inch diameter wash tub can be used as a nesting area, provided a 6 inch square hole is cut in the side to facilitate escape of goslings.

C. Rewa

Osprey nesting platform.

and bachelor colonies, as well as summer maternity (or nursery) colonies. Artificial roosting structures, referred to as bat houses or bat boxes, can serve as effective roosts and nursery areas. Pairing two or more bat houses back-to-back or on the same building provides a variety of temperatures for different roosting needs. Pivot-pole systems are the easiest method to raise or lower single or paired boxes for maintenance.

Diagrams for building bat houses are provided on page 26 and 27. For additional information on bat biology, conservation, and research, see Fish and Wildlife Habitat Management Leaflet No. 5, *Bats,* or go to Bat Conservation International's website at *www.batcon.org*.

Osprey Nesting Platforms

Ospreys need nesting platforms placed over or close to a good quality water source that supports an abundant fish, the main component of the osprey diet. Platforms should be placed in areas free from human activity such as along secluded wetlands and river segments. Platforms should rise above the elevation of surrounding vegetation and landscape features. Osprey platforms should be located at least 1,000 feet apart and away from nests and perches of other large raptors. Pressure treated wood posts should be at least 25 feet tall. Some sticks should be placed on the platform to simulate previous use by ospreys.

Artificial burrows

Artificial burrows are used by a variety of ground-dwelling animals. Most artificial burrows are built of plywood and buried at least six inches below the ground surface. For a more natural appearance, a small mound of soil should be built up around the entrance hole to simulate natural excavation by some other animal. Artificial burrows are generally constructed of wood. Plastic tubing at least eight inches in diameter can also be used. The burrow should be placed on a relatively high, well-drained location and checked annually for repairs.

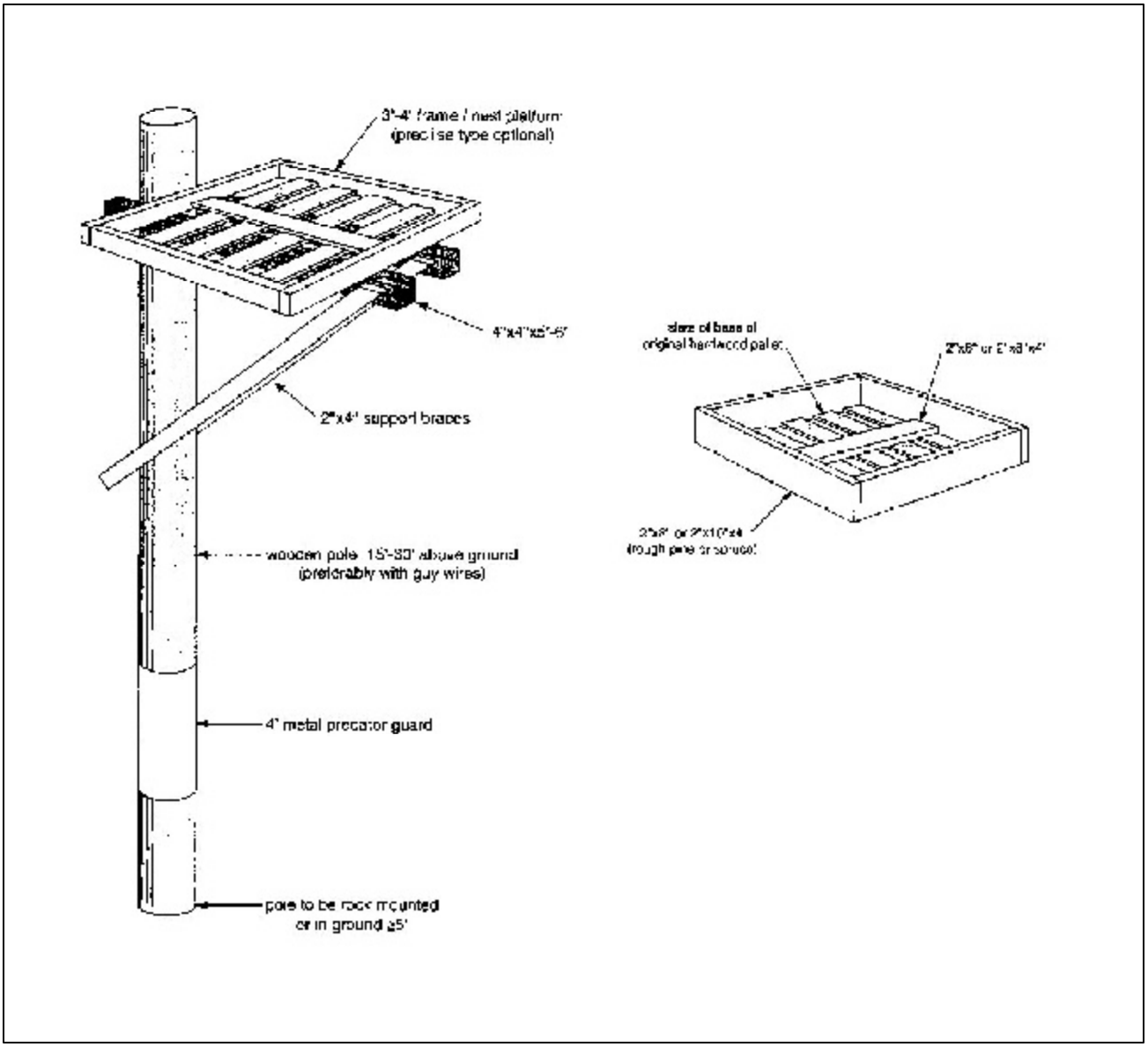
Burrowing owl.—Short grass prairies with good visibility are the preferred habitats of burrowing owls. Ungrazed mixed grass prairies are also used for nesting. The owls inhabit burrows abandoned by ground squirrels, prairie dogs, foxes, coyotes, and badgers. Since much of the burrowing owl's natural habitat has been lost to farming and ranching, artificial nesting burrows can help stabilize declining populations.

U.S. Fish and Wildlife Service

Burrowing owls.

Unimin-Emmett

Osprey nesting platform diagram.



Bat Conservation International

Bat Box Placement

Install bat houses two to six weeks before spring or before bats are evicted from an attic, barn, etc. Bat boxes should be installed on a 4x4- or 4x6-inch pressure-treated wooden post or a metal pole with an inside diameter greater than two inches (for stability). Boxes should be installed in open woodlots, old orchards, farmlands, or backyards within one-quarter mile of a lake, pond, stream, or wetland.

Bat houses placed on poles, under building overhangs or on the side of buildings are occupied more successfully than those boxes mounted on trees. The bottom of the house should be 12 to 15 feet above the ground and located in ample sunlight. Northern and eastern bat boxes should receive at least eight hours of direct sunlight per day and face south or southeast for the maximum amount of solar radiation. Warmer climates should receive six or more hours of direct sunlight and face east or southeast. In the hottest climates, four or five hours is acceptable.

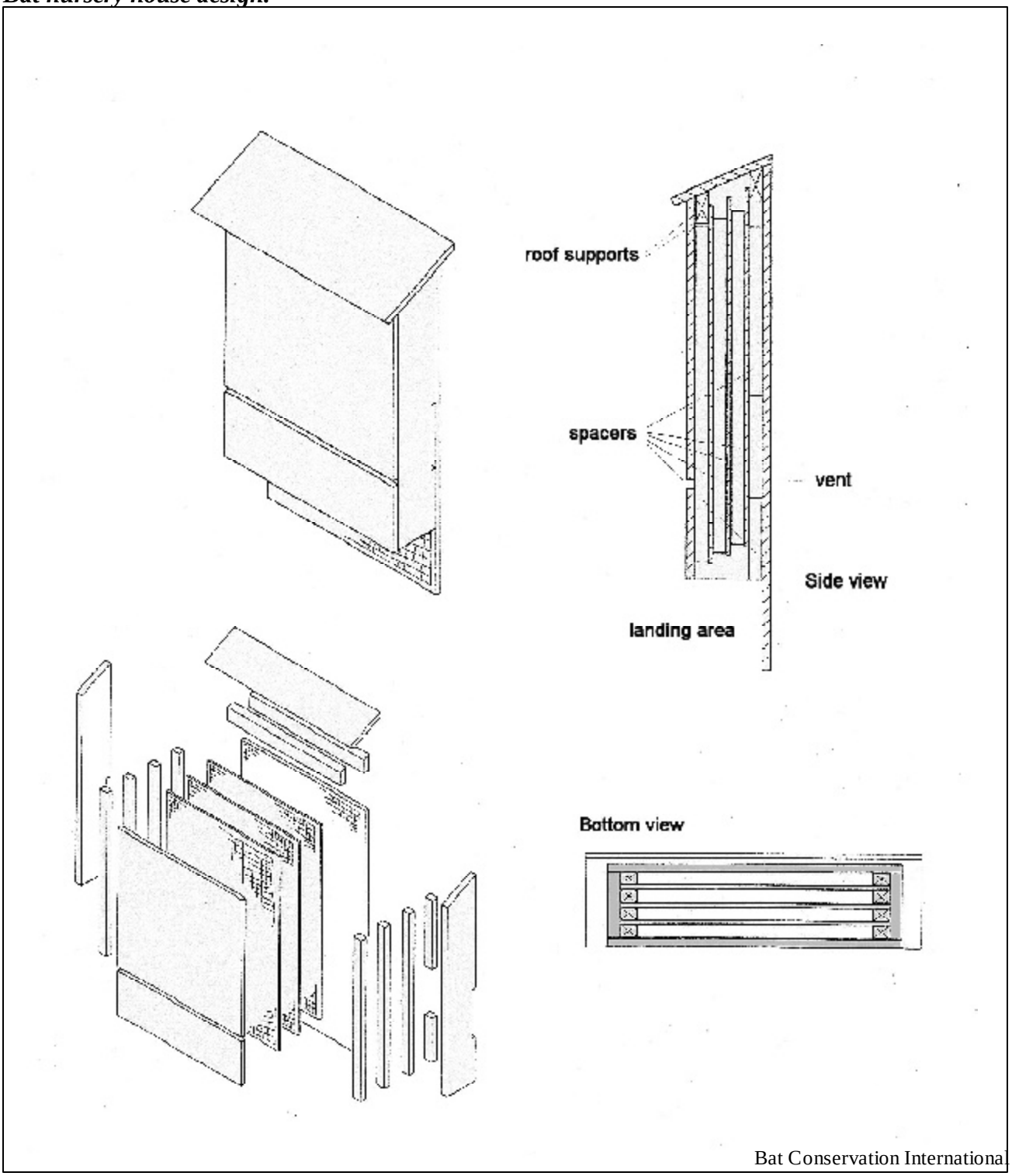
Basics of Bat House Design

Most bat houses, or bat boxes, are made of wood. Typically exterior-grade plywood that has not been pressure-treated is used. Listed below are some basic guidelines for building bat boxes. For more detailed information, contact Bat Conservation International (BCI) or visit their website at http://www.batcon.org.

- Internal roosting partitions should be properly spaced, 3/4 to 1 inch apart for bat species in the U.S., to conserve heat.
- Internal roosting partitions should be roughened with a saw or chisel to create footholds for bats. Use 1/8- to ¼-inch plastic mesh as a substitute.
- For boxes in regions where average July temperatures exceed 85 degrees Fahrenheit, include vents six inches from the bottom of the box. Front vents should be as long as the box is wide; side vents should be 6x1/2 inch.
- A partial bottom can be added to boxes in colder, northern climates to increase the internal temperature of the box. The bottom should be angled at 45 degrees or greater to allow guano to fall out of the box. Attach the bottom with rust-proof hinges and secure with a hook-and-eye latch for easy maintenance.
- Apply three layers of a dark colored exterior paint to the outside of the bat house; dark brown or black for boxes in the north and east, medium to light brown for boxes in the south and southwest. An aluminum roof may need to be installed (for shade) over boxes in regions with high summer temperatures.
- All exterior surfaces should be caulked and sealed to prevent heat loss from inside the box and prevent precipitation from leaking into the box.
- Perform routine, annual maintenance on the bat box such as caulking, painting, and general repairs.

Bat Conservation International

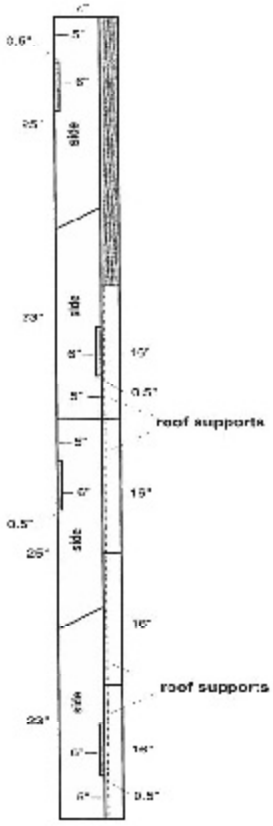
Bat nursery house design.



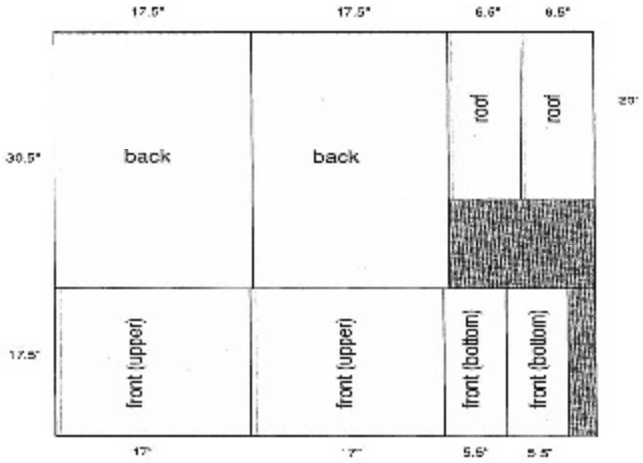
Bat Conservation International

1. Measure and mark all wood as per cutting diagrams on page 27. Cut out all parts.
2. Cut six pieces of netting14"x21.". Staple to partitions.
3. Screw back to sides, caulking first. Be sure top angles match.
4. Cut a piece of netting16"x30" and staple to inside surface of back. Be sure netting lies flat and does not pucker.
5. Construct house as per drawings above. Place spacers on partitions, screw top front piece to sides, then screw bottom front piece to sides to create a 1/2" vent between the two pieces. Attach supports, attach roof.
6. Caulk between roof and sides, sides and front pieces, and sides and back pieces to seal the nursery house tight.

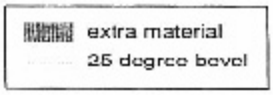
Bat nursery house sawing diagrams.

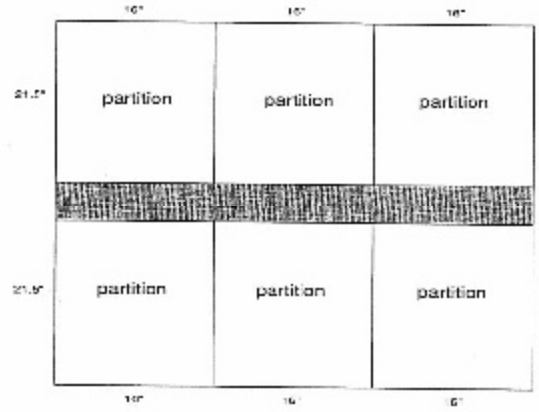


1" x 6" x 8' sheeting

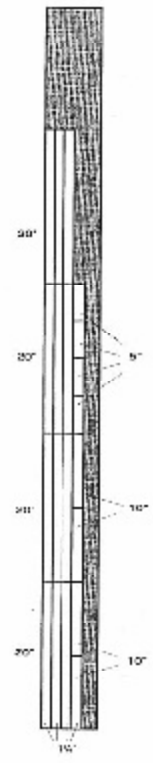


4' x 4' x 1/2" plywood





4' x 4' x 1/4" plywood



spacers:
5" spacers = back bottom
10" spacers = back top
20" spacers = others

1" x 6" x 8' sheeting

Bat Box Monitoring

Bat boxes should be checked at least twice a month in the summer with a flashlight in daylight hours to count adult bats and young. Boxes should be checked at least once during the fall and once during the winter to check for migrating and overwintering bats. Bats are sensitive to excessive human disturbance. For large colonies, count the bats as they emerge from the box at dusk.

To determine if a box contains a nursery colony (late May through June), check the box 45 minutes after sundown after the adults have left to feed. The young are pink and flightless and cling to the insides of the box.

Bat Conservation International

Monitoring bat boxes during daylight hours minimizes disturbance to roosting bats.

Landowner Assistance

There are a variety of private and public organizations that provide technical and/or financial assistance to landowners and managers that want to enhance existing wildlife habitats by erecting artificial nesting structures. Local chapters of ornithological societies, such as local Audubon chapters or birding clubs, can help landowners construct and install the appropriate nesting structures. State wildlife agencies can also help landowners identify wildlife needs and assess available habitat. Local hardware stores, home improvement stores, lumberyards, or pipe manufacturers may be willing to donate materials needed to construct a large quantity of nesting structures. Boy Scout and Girl Scout troops may wish to help land managers build and install artificial nesting structures. Local utility companies may also be willing to assist landowners erect raptor and heron platforms or other tall, hard to install nest structures.

There are numerous groups and organizations that supply information about the biology of specific species, as well as detailed instructions for building nesting structures to attract the desired species.

Conclusion

Artificial nesting structures are not meant to replace suitable habitat, but rather to enhance existing habitat and increase the nesting success of a particular species. Basic habitat management techniques for improving habitat for a variety of wildlife species and groups are provided in other habitat management leaflets in this series. These leaflets contain information about specific species that use artificial nesting structures, such as the wood duck (*No. 1*), eastern bluebird, (*No. 2*), and American kestrel, (*No. 3*). These leaflets are available at www.ms.nrcs.usda.gov/whmi and at www.wildlifehc.org.

Landowners and managers must be patient when attempting to attract wildlife to artificial nesting structures. It can take a year or two for the desired species to take notice of new nesting structures. Human activities that disturb nesting activities should be restricted in the vicinity of structures during the breeding season.

Quality of construction is important. The type of materials used, entrance hole dimensions (if applicable), attachments, and predator guards contribute to the ef-

Groups and organizations that design artificial nesting structures for specific wildlife species.

Group name	Contact information	Website address
Bat Conservation International (BCI)	P.O. Box 162603 Austin, Texas 78716-2603 tel: 512-327-9721 fax: 512-327-9724	www.batcon.org
Purple Martin Conservation Association (PMCA)	Edinboro University of Pennsylvania Edinboro, Pennsylvania 16444 tel: 814-734-4420	www.purplemartin.org
North American Bluebird Society (NABS)	P.O. Box 74 Darlington, Wisconsin 53530-0074	www.nabluebirdsociety.org
The Eagle Institute	P.O. Box 182 Barryville, New York 12719 tel: 914-557-6162	www.eagleinstitute.org
National Audubon Society	700 Broadway New York, New York tel: 212-979-3000 fax: 212-979-3188	www.audubon.org

fectiveness and longevity of the structure and the reproductive success of the targeted wildlife species. By considering the biology and habitat requirements of the desired species, landowners and managers can maximize the benefits of using artificial nesting structures for wildlife.

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The mission of the Wildlife Habitat Council is to increase the amount of quality wildlife habitat on corporate, private, and public land. WHC engages corporations, public agencies, and private, non-profit organizations on a voluntary basis as one team for the recovery, development, and preservation of wildlife habitat worldwide.

www.wildlifehc.org

Primary author: Holly L. May, Wildlife Habitat Council. Reviewers: Sheryl Ducummon, Bat Conservation International; Rob Pauline, Wildlife Habitat Council; Charlie Rewa, NRCS Wildlife Habitat Management Institute; and Tina Phillips, Cornell Laboratory of Ornithology.