
The Great Trinity Forest
Management Plan
Volume 12
Grasslands

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Volume 12

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<u>Great Trinity Forest Management Plan</u>

Grasslands

An Assessment of the use of Seeding, Mowing and Burning in the Restoration of an Oldfield to Tallgrass Prairie in Lewisville, Texas Continued

APPENDIX C

SHOOT COUNTS COVERAGE FOR C3 GRASS, C4 GRASS, EXOTIC AND ANNUAL PLANT GUILDS FOR ALL SUB-REPLICATES FOR ALL YEARS

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	1	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	1	0	0	0	0	0	0	2
96	F	1	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	1	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	65	96	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	1	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1
96	F	1	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	10	18	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	1	6	None	C	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	6
96	F	1	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	1	8	None	C	0	0	0	0	0	0	5	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	1	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	2	1	Seed	C	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	8
96	F	2	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	F	2	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	2	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	2
96	F	2	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	1	0	0	0	0	0	0	1
96	F	2	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	1
96	F	2	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	4	0	0	0	0	0	0	0
96	F	2	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	1
96	F	2	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	4
96	F	3	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	3	2	Seed	C	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
96	F	3	3	Seed	C	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	6
96	F	3	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	3	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	64	0	0	0	0	0	2	0	0	0	0	0	0	0
96	F	3	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	3	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	5	0	0	0	0	0	0	3
96	F	3	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
96	F	3	9	Seed	C	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	1	0	0	0
96	F	4	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	3	0	0	0	0	0	0	0
96	F	4	2	None	C	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0
96	F	4	3	None	C	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	4	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	128	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	4	5	None	C	0	0	0	0	0	0	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	5	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	5	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
96	F	5	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	1	0	0	0	0	0	0	7
96	F	5	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	5	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	1	0	0	0	0	0	0
96	F	5	6	Seed	C	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0
96	F	5	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	3
96	F	5	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
96	F	5	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	7
96	F	6	1	None	C	0	0	0	0	0	0	2	0	0	0	0	0	15	0	0	0	0	0	0	5	0	0	0	0	0	0	4
96	F	6	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0
96	F	6	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
96	F	6	4	None	C	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
96	F	6	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	5
96	F	6	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	6
96	F	6	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	21

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	6	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3
96	F	6	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	0	0	0	0	1	0	0	0	0	0	0	8
96	F	7	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	96	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	7	2	Seed	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	7	3	Seed	C	0	0	0	2	0	0	75	0	0	0	0	0	0	70	0	3	5	0	0	0	0	0	0	0	0	0	2
96	F	7	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	F	7	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	0	0	0	0	0	0	0	0	0	0
96	F	7	6	Seed	C	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
96	F	7	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	160	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	7	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	53	2	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	7	9	Seed	C	0	0	0	0	0	0	12	0	0	0	0	0	6	10	0	2	0	0	0	0	0	0	0	0	0	0	0
96	F	8	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
96	F	8	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	7	10	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	8	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	8	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
96	F	8	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	7
96	F	8	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	88	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	8	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	8	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
96	F	8	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	9
96	F	9	1	None	C	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
96	F	9	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	F	9	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	294	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	9	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	12

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	9	5	None	C	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
96	F	9	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	9	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	9	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	0	0	0	0	3	0	0	0	0	0	0	0
96	F	9	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	1
96	F	10	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	10	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	10	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	10	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	113	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	10	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	4	0	0	0	0	0	0	0	0	0	0	3
96	F	10	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0
96	F	10	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	10	8	None	C	0	0	0	0	0	0	5	0	0	0	0	0	0	64	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	10	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	11	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	11	2	Seed	C	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	F	11	3	Seed	C	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0
96	F	11	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	11	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	12	0	0	0	0	0	0	0	0	0	0	0
96	F	11	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	11	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	102	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	11	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	16	0	0	0	0	0	0	0	0	0	0	0
96	F	11	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	119	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	12	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	12	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	F	12	3	Seed	C	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
96	F	12	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
96	F	12	5	Seed	C	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	12	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	12	7	Seed	C	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	12	8	Seed	C	0	0	0	0	0	0	65	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	F	12	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	F	13	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	13	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	122	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	13	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	6
96	F	13	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	F	13	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	1	0	0	0	0	0	0
96	F	13	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	13	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	13	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	0	0	0	0	0	0	0
96	F	13	9	None	C	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	14	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	3
96	F	14	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
96	F	14	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	27	48	0	0	0	0	0	3	0	0	0	0	0	0	0
96	F	14	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	4	0	0	0	0	0	0	0
96	F	14	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0
96	F	14	6	Seed	C	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	F	14	7	Seed	C	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	14	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	3
96	F	14	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0
96	F	15	1	None	C	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
96	F	15	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	3
96	F	15	3	None	C	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
96	F	15	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
96	F	15	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	F	16	1	None	C	0	0	0	0	0	0	10	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	16	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	17	9	0	0	0	0	0	1	0	0	0	0	0	0	0
96	F	16	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	3	0	0	0	0	0	0	0
96	F	16	4	None	C	0	0	0	0	0	0	8	0	0	0	0	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	16	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	16	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
96	F	16	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	16	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	143	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	16	9	None	C	0	0	0	0	0	0	100	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	17	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	17	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	F	17	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	F	17	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	17	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	55	15	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	17	6	None	C	0	0	0	0	0	0	24	0	0	0	0	0	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	F	17	7	None	C	0	0	0	0	0	0	14	0	0	0	0	0	26	10	0	1	0	0	0	0	0	0	0	0	0	0	0
96	F	17	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	17	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	18	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	F	18	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	1	0	0	0	0	0	0	0
96	F	18	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
96	F	18	4	None	C	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	18	5	None	C	0	0	0	0	0	0	29	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	18	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	18	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0
96	F	18	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	F	18	9	None	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	F	19	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	5	0	0	0	0	0	0	2
96	F	19	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	11	0	0	0	0	0	0	0	0	0	0	1
96	F	19	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	F	19	4	Seed	C	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
96	F	19	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	19	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	19	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0
96	F	19	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0
96	F	19	9	Seed	C	0	0	0	0	0	0	20	0	0	0	0	0	15	0	0	1	0	0	0	1	0	0	0	3	0	0	3
96	F	20	1	Seed	C	0	0	0	0	0	0	36	0	0	0	0	0	0	24	0	0	3	0	0	3	0	0	0	0	0	0	2
96	F	20	2	Seed	C	0	0	0	0	0	0	10	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	1
96	F	20	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	8	45	0	2	0	0	0	2	0	0	0	0	0	0	5
96	F	20	4	Seed	C	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	3	0	0	0	4	0	0	0	0	0	0	0
96	F	20	5	Seed	C	0	0	0	0	0	0	0	0	1	0	0	0	0	15	0	13	0	0	0	0	0	0	0	0	0	0	0

180

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	20	6	Seed	C	0	0	0	0	0	0	6	0	0	0	0	0	0	3	0	1	0	0	0	4	0	0	0	1	0	0	6
96	F	20	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0
96	F	20	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	3	0	0	0	0	0	0	0
96	F	20	9	Seed	C	0	0	0	0	21	0	6	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	1
96	F	21	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	9	0	0	0	0	0	0	0
96	F	21	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	2	0	0	0	0	0	0	2
96	F	21	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
96	F	21	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	0	0	0	0	0	1
96	F	21	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	1	0	0	0	0	0	0	0
96	F	21	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	4
96	F	21	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
96	F	21	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	21	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	83	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	22	1	None	C	0	0	0	0	0	0	6	0	0	0	0	0	13	16	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	22	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	F	22	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	22	4	None	C	0	0	0	0	0	0	25	0	0	0	0	0	70	0	0	0	0	0	0	2	0	0	0	0	0	0	0
96	F	22	5	None	C	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	22	6	None	C	0	0	0	0	0	0	1	0	6	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	22	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	F	22	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0
96	F	22	9	None	C	0	0	0	0	0	0	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	23	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
96	F	23	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	23	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	F	23	4	None	C	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
96	F	23	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	F	23	6	None	C	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	F	23	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
96	F	23	8	None	C	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	F	23	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	24	1	Seed	C	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	9	2	0	0	0	0	0	0	0	0	0	0
96	F	24	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	F	24	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	15	0	0	0	0	0	0	0	0	0	0
96	F	24	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	3	0	0	0	0	0	0	0	0	0	0
96	F	24	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
96	F	24	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	5	0	0	0	0	0	0	0	0	0	0
96	F	24	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
96	F	24	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	F	24	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	25	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	3	0	0	0	3	0	0	0	0	0	0	0
96	F	25	2	None	C	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	5	0	0	2	0	0	0	0	0	0	3
96	F	25	3	None	C	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	16
96	F	25	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	F	25	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	1
96	F	25	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	6	0	0	0	0	0	0	0
96	F	25	7	None	C	0	0	0	8	0	0	29	0	0	0	0	0	22	36	0	0	0	0	0	2	0	0	0	0	0	0	2
96	F	25	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	25	9	None	C	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	26	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	50	17	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	26	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	13
96	F	26	3	None	C	0	0	0	0	0	0	0	0	1	0	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	26	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	88	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	26	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	8	5	0	2	0	0	0	0	0	0	0	0	0	0	0
96	F	26	6	None	C	0	0	0	0	0	0	4	0	0	0	0	0	0	42	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	26	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	26	8	None	C	0	0	0	0	0	0	16	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	26	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	F	27	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	27	2	Seed	C	0	0	0	0	0	0	22	0	1	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	27	3	Seed	C	0	0	0	0	21	0	13	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	27	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	18	50	0	0	0	0	0	0	0	0	0	0	0	0	1
96	F	27	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	53	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	F	27	6	Seed	C	0	0	0	0	0	0	32	0	0	0	0	0	19	0	0	0	0	0	0	4	0	0	0	0	0	0	0
96	F	27	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	50	35	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	27	8	Seed	C	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	7	1	0	0	2	0	0	6
96	F	27	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	93	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	28	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0
96	F	28	2	Seed	C	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
96	F	28	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	28	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	1	0	0	0	0	0	0	0
96	F	28	5	Seed	C	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	28	6	Seed	C	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	F	28	7	Seed	C	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	28	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	90	6	0	15	0	0	0	0	0	0	0	0	0	0	0
96	F	28	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	F	29	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
96	F	29	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
96	F	29	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	F	29	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
96	F	29	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	F	29	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
96	F	29	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	2	0	0	0	0	0	0	0	0
96	F	29	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0
96	F	29	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	30	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
96	F	30	2	None	C	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	F	30	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	F	30	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	3	0	0	0	0	0	0	0	0
96	F	30	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
96	F	30	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	2
96	F	30	7	None	C	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	30	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	30	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	2
96	F	31	1	Seed	C	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	16
96	F	31	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	31	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	0	1	0	0	0
96	F	31	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	9
96	F	31	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0
96	F	31	6	Seed	C	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	F	31	7	Seed	C	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	10
96	F	31	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	2	0	0	0	0	0	0	0
96	F	31	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	F	32	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	F	32	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	F	32	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	4	0	0	0	0	0	0	16
96	F	32	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	11	0	0	0	0	0	0	2
96	F	32	5	None	C	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
96	F	32	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	6	0	0	0	0	0	0	0
96	F	32	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	F	32	8	None	C	0	0	0	0	0	0	20	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	32	9	None	C	0	0	0	0	0	0	86	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	33	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0	0	0	8
96	F	33	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	F	33	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	92	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	33	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	136	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	33	5	Seed	C	0	0	0	0	0	0	25	0	0	0	0	0	0	128	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	33	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	64	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	33	7	Seed	C	0	0	0	0	0	0	7	0	0	0	0	0	23	5	0	0	0	0	0	2	0	0	0	0	0	0	0
96	F	33	8	Seed	C	0	0	0	0	0	0	30	0	0	0	0	0	47	4	0	0	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	33	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	3	0	0	0	0	0	0	3
96	F	34	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
96	F	34	2	Seed	C	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
96	F	34	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	2
96	F	34	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	1	0	0	0
96	F	34	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
96	F	34	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
96	F	34	7	Seed	C	0	0	0	0	0	89	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	34	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	34	9	Seed	C	0	0	0	0	0	3	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	1
96	F	35	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	3	0	0	0	0	0	0	0	0	0	3
96	F	35	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
96	F	35	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	3	0	0	0	0	0	0	0	0	0	4
96	F	35	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	F	35	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
96	F	35	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	F	35	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
96	F	35	8	Seed	C	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
96	F	35	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	3	0	0	0	0	0	0	1
96	F	36	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0
96	F	36	2	None	C	0	0	0	0	0	22	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	3
96	F	36	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	F	36	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	1
96	F	36	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	36	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0
96	F	36	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	1	0	0	0	0	0	0	2
96	F	36	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	F	36	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	42	6	0	1	0	0	0	0	0	0	0	0	0	0	3
96	F	37	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	1	0	0	0	0	0	0	1
96	F	37	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	F	37	3	Seed	C	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
96	F	37	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	F	37	5	Seed	C	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	7
96	F	37	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	37	7	Seed	C	0	0	0	0	0	0	15	0	0	0	0	0	52	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	F	37	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	37	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
96	F	38	1	Seed	C	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	2
96	F	38	2	Seed	C	0	0	0	0	0	0	30	0	0	0	0	0	21	0	0	0	0	0	0	6	0	0	0	0	0	0	3
96	F	38	3	Seed	C	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	F	38	4	Seed	C	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1
96	F	38	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	38	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
96	F	38	7	Seed	C	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	11	0	0	0	2	0	0	0	0	0	0	0
96	F	38	8	Seed	C	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	3	0	0	0	4	0	0	0	0	0	0	1
96	F	38	9	Seed	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
96	F	39	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	39	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	60	17	0	0	0	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	F	39	3	None	C	0	0	0	0	0	0	5	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	39	4	None	C	0	0	0	0	0	0	8	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	39	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	39	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	F	39	7	None	C	0	0	0	0	0	0	1	0	0	0	0	0	35	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	F	39	8	None	C	0	0	0	0	0	0	49	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	F	39	9	None	C	0	0	0	0	0	0	22	0	0	0	0	0	7	0	0	0	0	0	0	3	0	0	0	0	0	0	1
97	F	1	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0
97	F	1	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	1	0	0	1	0	0	0	0	2
97	F	1	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	1	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0	1	0	0	0	0	0	0	0	0	0	0	0
97	F	1	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	15	8	0	0	0	0	0	0	0	0	0	0	0	0	1
97	F	1	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	135	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	1	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	1	8	None	C	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
97	F	1	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	2	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0	0	0	0	2	0	0	0	0	0
97	F	2	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	2
97	F	2	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	85
97	F	2	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0	0	0	20
97	F	2	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	3	0	0	0	0	1
97	F	2	6	Seed	C	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	F	2	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	4
97	F	2	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	2	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	3	0	0	0	0	4
97	F	3	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	3	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
97	F	3	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	10	0	0	0	0	0	0	0	0	0	0	1
97	F	3	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0
97	F	3	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
97	F	3	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	2
97	F	3	7	Seed	C	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
97	F	3	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
97	F	3	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	14
97	F	4	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	8	0	0	0	0	0	14	0	0	0	0	0
97	F	4	2	None	C	0	0	0	0	0	4	0	0	0	0	0	0	0	36	0	2	0	0	0	0	0	3	0	0	0	0	0
97	F	4	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	0	0	0	0	7
97	F	4	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	190	0	0	0	0	0	0	1	0	0	0	0	0	0
97	F	4	5	None	C	0	0	0	0	0	0	14	0	0	0	0	0	0	1	0	0	0	0	0	0	0	8	0	0	0	0	4
97	F	5	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	5	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	1	2	0	0	0	0	1
97	F	5	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	1	0	0	0	0	0
97	F	5	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	5	5	Seed	C	0	0	0	0	0	0	0	0	0	0	10	0	18	0	0	0	1	0	0	0	0	0	0	0	0	0	0
97	F	5	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	1	0	0	0	0	0	1	0	0	0	0	2
97	F	5	7	Seed	C	0	0	0	0	0	0	2	0	0	0	6	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	6
97	F	5	8	Seed	C	0	0	0	2	0	0	4	0	0	0	0	0	0	5	0	0	0	0	0	0	0	2	0	0	0	0	7
97	F	5	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	2	0	0	0	0	0	13

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	6	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2
97	F	6	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
97	F	6	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	6	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	F	6	5	None	C	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0
97	F	6	6	None	C	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0
97	F	6	7	None	C	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	6	8	None	C	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
97	F	6	9	None	C	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0
97	F	7	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	7	0	0	0	0	0
97	F	7	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	9	0	0	0	0	0	4	0	0	0	0	0
97	F	7	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	79	0	0	0	0	0	0	0	1	2	0	0	0	0	0
97	F	7	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0
97	F	7	5	Seed	C	0	0	0	0	0	0	2	0	0	0	0	0	9	0	0	3	0	0	0	0	0	9	0	0	0	0	0
97	F	7	6	Seed	C	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0
97	F	7	7	Seed	C	0	0	0	0	0	0	3	0	0	0	0	0	0	16	0	3	3	0	0	0	0	1	0	0	0	0	0
97	F	7	8	Seed	C	0	0	0	0	0	0	1	0	0	0	0	0	0	11	0	0	0	0	0	0	0	8	0	0	0	0	0
97	F	7	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	8	0	0	0	0	0	12	0	0	0	0	0
97	F	8	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2
97	F	8	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	5
97	F	8	3	None	C	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	2
97	F	8	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	4	0	0	0	0	0
97	F	8	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0	0	0	0	0	0	0	0
97	F	8	6	None	C	0	0	0	0	0	6	0	0	0	0	0	0	0	1	0	1	12	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	8	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	1
97	F	8	8	None	C	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	6
97	F	8	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	2	0	0	0	0	0	0	1	0	0	0
97	F	9	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	7
97	F	9	2	None	C	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
97	F	9	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
97	F	9	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
97	F	9	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
97	F	9	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0
97	F	9	7	None	C	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0
97	F	9	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	2	0	0	0	0	0
97	F	9	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	3
97	F	10	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	10	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	10	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	F	10	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	10	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	10	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	10	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	0	0	1	0	0	5
97	F	10	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	10	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	11	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
97	F	11	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	11	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GALpul	HELmax	XANdra
97	F	11	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	80	0	6	0	0	0	0	0	0	0	0	0	0	0
97	F	11	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	11	0	0	0	0	0
97	F	11	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	1	0	0	0
97	F	11	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	115	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	11	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	7	0	0	0	0	0
97	F	11	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
97	F	12	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0
97	F	12	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	1	0	0	0	0	0
97	F	12	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	4	0	0	0	0	0
97	F	12	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
97	F	12	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	12	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	12	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	12	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	7	0	0	0	0	0
97	F	12	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	1	0	0	0	0	0	0	0	0	0	0	0
97	F	13	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
97	F	13	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	F	13	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1
97	F	13	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
97	F	13	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	2	0	0	0	0	5
97	F	13	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	5
97	F	13	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	3	1	0	0	0	0	0
97	F	13	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	13	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	4	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	14	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	0	0	0	0	0
97	F	14	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	4	0	0	0	0	5
97	F	14	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0	0	0	0	0	0
97	F	14	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
97	F	14	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0
97	F	14	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	31
97	F	14	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
97	F	14	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	5
97	F	14	9	Seed	C	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	3
97	F	15	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0	0	0	0	4	0	0	0	0	0
97	F	15	2	None	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	10	0	0	0	2	0	5	0	0	0	0	1
97	F	15	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	13	4	0	0	0	0	0	1	0	8	0	0	0	0	0
97	F	15	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	1
97	F	15	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	3	1	4	0	0	0	0	1
97	F	16	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0
97	F	16	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	16	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	4	0	0	0	0	0	3	0	0	0	0	0
97	F	16	4	None	C	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
97	F	16	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	3	0	0	0	0	0
97	F	16	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	3	0	0	0	0	0	3	0	0	0	0	0
97	F	16	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	6	0	0	0	0	0
97	F	16	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	F	16	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0
97	F	17	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	1	1	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	17	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	4	0	0	0	0	0
97	F	17	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	85	0	1	0	0	0	0	0	1	0	0	0	0	0
97	F	17	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	8	0	0	0	0	0
97	F	17	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	17	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	136	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	17	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	39	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	17	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	1	0	0	0	0	0	4	0	0	0	0	0
97	F	17	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	54	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	18	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0
97	F	18	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	1	0	0	0	0	0	0
97	F	18	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0
97	F	18	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
97	F	18	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
97	F	18	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	3	0	0	0	0	0
97	F	18	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	0	0	0	0	0
97	F	18	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	F	18	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
97	F	19	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	F	19	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	F	19	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	F	19	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0
97	F	19	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
97	F	19	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0
97	F	19	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	6	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	19	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0
97	F	19	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	1	0	0	0
97	F	20	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	20	2	Seed	C	0	0	0	0	0	0	10	0	0	0	0	0	0	0	7	0	0	0	0	0	1	4	0	0	0	0	0
97	F	20	3	Seed	C	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
97	F	20	4	Seed	C	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
97	F	20	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0
97	F	20	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	9	0	0	0	0	0
97	F	20	7	Seed	C	0	0	0	0	0	0	350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	F	20	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	9	1	5	0	0	0	0	0
97	F	20	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	19	0	0	0	0	0
97	F	21	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0
97	F	21	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	2	0	0	0	0	0	0	0
97	F	21	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	1
97	F	21	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	3
97	F	21	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	3
97	F	21	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
97	F	21	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	8	0	0	0	0	0
97	F	21	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	2
97	F	21	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	12	0	0	0	0	0
97	F	22	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
97	F	22	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
97	F	22	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0
97	F	22	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	22	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0
97	F	22	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0
97	F	22	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	6	0	0	0	0	0
97	F	22	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0
97	F	22	9	None	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0
97	F	23	1	None	C	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0
97	F	23	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
97	F	23	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	3	0	0	0	0	0
97	F	23	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
97	F	23	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0	0
97	F	23	6	None	C	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0
97	F	23	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0	0
97	F	23	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
97	F	23	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	0	0	0	0	0	1	0	0	0	0	0
97	F	24	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
97	F	24	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
97	F	24	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
97	F	24	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	24	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	1	3	0	0	0	0	0
97	F	24	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	1	0	0	0	0	0
97	F	24	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
97	F	24	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	24	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	1	0	0	0	0	0	0	0	0	0	0
97	F	25	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	25	2	None	C	0	0	0	0	0	0	1	0	0	0	0	0	0	28	0	4	0	0	0	0	0	0	0	0	0	0	0
97	F	25	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	21
97	F	25	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
97	F	25	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38
97	F	25	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	6	0	0	0	0	0
97	F	25	7	None	C	0	0	0	0	4	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	6	0	0	0	0	4
97	F	25	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	25	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
97	F	26	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	10
97	F	26	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
97	F	26	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	26	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	1	0	0	0
97	F	26	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	26	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	1	0	0	0	0	0
97	F	26	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	26	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	26	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	27	1	Seed	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	11
97	F	27	2	Seed	C	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
97	F	27	3	Seed	C	0	0	0	0	0	0	4	0	0	0	0	0	40	0	0	0	0	0	0	2	0	1	0	0	0	0	1
97	F	27	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	1	0	0	3	0	1	0	0	0	0	3
97	F	27	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	7	2	0	0	0	0	0	0	0	0	0	0
97	F	28	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	28	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	28	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0
97	F	28	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
97	F	28	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	F	28	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
97	F	28	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
97	F	28	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	F	28	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	4	0	0	0	0	0
97	F	29	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
97	F	29	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0
97	F	29	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	F	29	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
97	F	29	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	1	0	0	0
97	F	29	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
97	F	29	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	29	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	F	29	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	1	0	0	0	0	0	0
97	F	30	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	1	0	0	0	0	0
97	F	30	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	F	30	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	24
97	F	30	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	30	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	1	0	0	0	0	0
97	F	30	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	2	0	0	0	0	0
97	F	30	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
97	F	30	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	30	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	3
97	F	31	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	5	0	4	0	0	0	0	0
97	F	31	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	2	0	0	0	0	2
97	F	31	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	13	3	8	0	0	0	0	9	0	0	0	0	0	0	0
97	F	31	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	1	0	2	0	0	0	0	2
97	F	31	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	1	1	0	0	0	0	0
97	F	31	6	Seed	C	0	0	0	35	0	0	1	0	0	0	0	0	15	7	0	0	0	0	0	0	0	2	0	0	0	0	4
97	F	31	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	10	0	0	0	0	0
97	F	31	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	4	0	3	0	0	0	0	0
97	F	31	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	1	8	0	0	0	0	0
97	F	32	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0	1	0	0	0	0	1
97	F	32	2	None	C	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1
97	F	32	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	6
97	F	32	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	8	0	12	0	0	0	0	0
97	F	32	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	2	1	0	0	0	0	4
97	F	32	6	None	C	0	0	0	10	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	4	0	2	0	0	0	0	0
97	F	32	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	2	0	7	0	0	0	0	2
97	F	32	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	4	0	0	0	0	0
97	F	32	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	2	0	0	2	0	0	0	0	0	0	2
97	F	33	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	80	17	0	0	2	0	0	0	0	0	0	0	0	0	0
97	F	33	2	Seed	C	0	0	0	0	0	0	20	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	33	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	33	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	2
97	F	33	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	33	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	10	90	0	0	0	0	0	0	0	5	0	0	0	0	0
97	F	33	7	Seed	C	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	2	0	0	0	0	0	5	0	0	0	0	0
97	F	33	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	2
97	F	33	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	6	0	0	0	0	0
97	F	34	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	1	1	0	0	3	0	0	1
97	F	34	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	5	0	0	0	1	1	0	0	0	0	0	0
97	F	34	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
97	F	34	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	1	0	0	0	0	0	0	0
97	F	34	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0
97	F	34	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0
97	F	34	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
97	F	34	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0
97	F	34	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	1	0	0	0	0	0	0	0	0	0	0
97	F	35	1	Seed	C	0	0	0	0	0	0	0	0	1	0	0	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3
97	F	35	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	5
97	F	35	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	2	1	0	0	0	0	0	1
97	F	35	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	9	0	0	0	0	1
97	F	35	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	3	0	0	2
97	F	35	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	1	0	0	0	0	0
97	F	35	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	1	0	3	0	0	0
97	F	35	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	2	0	0	0	0	0	0	6
97	F	35	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	14	0	0	0	0	0
97	F	36	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	1	0	1	0	0	0
97	F	36	2	None	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	1	0	0	7

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	36	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	3
97	F	36	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	2	0	0	0	0	5
97	F	36	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	1	0	0	0	0	10
97	F	36	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	3
97	F	36	7	None	C	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
97	F	36	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	1	0	0	0	0	1
97	F	36	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	F	37	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	3
97	F	37	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	0	0	0	0	6
97	F	37	3	Seed	C	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	F	37	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	10	0	0	0	0	1
97	F	37	5	Seed	C	0	0	3	15	0	0	30	0	0	0	0	0	15	0	0	1	0	0	0	3	0	3	0	0	0	0	0
97	F	37	6	Seed	C	0	0	0	0	0	0	3	0	0	0	0	0	5	3	0	0	0	0	0	4	0	7	0	0	0	0	0
97	F	37	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	1	4	0	0	0	0	1
97	F	37	8	Seed	C	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	1
97	F	37	9	Seed	C	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	3
97	F	38	1	Seed	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	14	0	1	0	0	1	0	0	0	0	0	6
97	F	38	2	Seed	C	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	7	0	0	0	2	0	0	0	0	0	0	2
97	F	38	3	Seed	C	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
97	F	38	4	Seed	C	0	0	0	0	0	0	2	0	0	0	30	0	18	0	0	0	0	0	0	1	0	2	0	0	0	0	2
97	F	38	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	6	0	0	0	0	0
97	F	38	6	Seed	C	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	6	0	0	0	5	0	3	0	0	0	0	0
97	F	38	7	Seed	C	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	4
97	F	38	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	3	0	0	0	0	0	10	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	F	38	9	Seed	C	0	0	0	0	0	0	5	0	0	0	0	0	80	0	0	0	0	0	0	1	0	0	0	0	0	0	0
97	F	39	1	None	C	0	0	0	0	0	0	1	0	0	0	0	0	0	75	0	1	0	0	0	0	0	1	0	0	0	0	0
97	F	39	2	None	C	0	0	0	0	0	0	3	0	0	0	0	0	0	65	0	0	0	0	0	0	0	1	0	0	0	0	0
97	F	39	3	None	C	0	0	0	0	0	0	5	0	0	0	0	0	40	13	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	39	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	39	5	None	C	0	0	0	0	0	0	4	0	0	0	0	0	0	1	0	3	0	0	0	0	0	1	0	0	0	0	4
97	F	39	6	None	C	0	0	0	0	0	0	60	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	1
97	F	39	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	F	39	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	1	0	0	0	0	0
97	F	39	9	None	C	0	0	0	0	0	0	1	0	0	0	0	0	25	30	0	0	0	0	0	0	1	1	0	0	0	0	0
98	F	1	1	None	C	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	1	2	None	C	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
98	F	1	3	None	C	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	9
98	F	1	4	None	C	0	0	0	0	0	0	116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	1	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	1	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	156	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	1	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	17	35	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	1	8	None	C	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	1	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	2	1	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	13
98	F	2	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	6
98	F	2	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	2	4	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	7	12	0	1	0	0	0	0	0	0	0	0	0	0	1
98	F	2	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	1	0	0	0	0	0	0	4

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	2	6	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	17
98	F	2	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	4	0	0	0	0	0	0	5
98	F	2	8	Seed	M	0	0	0	0	0	0	0	0	2	0	0	0	17	0	0	0	0	0	0	2	0	0	0	0	0	0	0
98	F	2	9	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	19
98	F	3	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	12
98	F	3	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	3	3	Seed	C	0	0	0	0	2	0	0	0	0	0	0	0	110	0	0	0	0	0	0	1	0	0	0	0	0	0	11
98	F	3	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	78	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	3	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	2	0	0	0	0	0	0	0	4
98	F	3	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
98	F	3	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	6
98	F	3	8	Seed	C	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
98	F	3	9	Seed	C	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1
98	F	4	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	4	2	None	C	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
98	F	4	3	None	C	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
98	F	4	4	None	C	0	0	0	0	0	2	0	0	0	0	0	0	35	0	0	0	0	0	0	2	0	0	0	0	0	0	0
98	F	4	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	15	23	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	5	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	5	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	5	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	1	0	0	0	0	0	0	0	0	0	1
98	F	5	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	5	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	6	10	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	5	6	Seed	C	0	0	0	0	0	0	2	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	1

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	5	7	Seed	C	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
98	F	5	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	5	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	2	0	0	0	1	0	0	0	0	0	0
98	F	6	1	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
98	F	6	2	None	M	0	0	0	0	0	7	0	0	0	0	0	0	32	0	0	0	0	0	0	1	0	0	0	0	0	0	3
98	F	6	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	4
98	F	6	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	1
98	F	6	5	None	M	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4
98	F	6	6	None	M	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	6	7	None	M	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
98	F	6	8	None	M	0	0	0	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
98	F	6	9	None	M	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0
98	F	7	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	7	2	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	7	3	Seed	B	0	0	0	0	0	0	4	0	0	0	0	0	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	7	4	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
98	F	7	5	Seed	B	0	0	0	0	0	0	3	0	0	0	0	0	72	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	7	6	Seed	B	0	0	0	0	0	0	12	0	0	0	55	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
98	F	7	7	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	83	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	7	8	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	88	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	7	9	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	93	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	8	1	None	M	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
98	F	8	2	None	M	0	0	0	0	0	0	0	0	0	0	0	0	24	47	0	0	2	0	0	0	0	0	0	0	0	0	0
98	F	8	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	2	0	0	0	0	0	0	0	0	0	1

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	8	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	21	60	0	0	3	0	0	0	0	0	0	0	0	0	0
98	F	8	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	8	6	None	M	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	8	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	1
98	F	8	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	2	0	0	0	0	0	0	0	0	0	1
98	F	8	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	0	1	0	0	0	0	0	0	0	0	0	8
98	F	9	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	1
98	F	9	2	None	C	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	9	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	1
98	F	9	4	None	C	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	9	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	9	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1
98	F	9	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0
98	F	9	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
98	F	9	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1
98	F	10	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	10	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	10	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	10	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	7	0	0	0	0	0	0	0	0	0	0	0
98	F	10	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	10	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	130	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	10	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	85	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	10	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	10	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0

205

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	11	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	143	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	11	2	Seed	B	0	0	0	0	0	0	55	0	0	0	0	41	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	11	3	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	1	0	0	0	0	0	0	0	0	0
98	F	11	4	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	175	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	11	5	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	126	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	11	6	Seed	B	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
98	F	11	7	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	83	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	11	8	Seed	B	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
98	F	11	9	Seed	B	0	0	0	0	0	0	25	0	0	0	0	0	0	128	0	2	0	0	0	0	0	0	0	0	0	0	2
98	F	12	1	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	12	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0
98	F	12	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	12	4	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	75	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	12	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	12	6	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	F	12	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0
98	F	12	8	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	95	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	12	9	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0
98	F	13	1	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	13	2	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	13	3	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	13	4	None	B	0	0	0	0	0	0	0	0	0	0	0	0	77	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	13	5	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	13	6	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	13	7	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
98	F	13	8	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3
98	F	13	9	None	B	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	6	0	0	0	1	0	0	0	0	0	0	0
98	F	14	1	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	2	0	0	0	0	0	0	2
98	F	14	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	3
98	F	14	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	2	0	0	0	0	0	0	0
98	F	14	4	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	3	0	0	0	0	0	0	5
98	F	14	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	6
98	F	14	6	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
98	F	14	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	3
98	F	14	8	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	4
98	F	14	9	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	2	0	0	0	0	0	0	4
98	F	15	1	None	C	0	0	0	0	13	0	0	0	0	0	0	0	45	0	0	0	0	0	0	2	0	0	0	0	0	0	0
98	F	15	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4
98	F	15	3	None	C	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	15	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1
98	F	15	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	1
98	F	16	1	None	M	0	0	0	18	0	0	0	0	0	0	0	0	0	6	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	16	2	None	M	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	16	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	126	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	16	4	None	M	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
98	F	16	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	16	6	None	M	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	16	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	16	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	1	0	0	0
98	F	16	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	208	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	17	1	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	17	2	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	130	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	17	3	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	17	4	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	17	5	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	17	6	None	B	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	17	7	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	17	8	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
98	F	17	9	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	1	0	0	0	0	0	0
98	F	18	1	None	M	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	18	2	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	18	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	F	18	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
98	F	18	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	18	6	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	18	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	18	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	18	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
98	F	19	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	19	2	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	19	3	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	F	19	4	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	3	0	0	0	0	0	0	0	0	0

208

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	19	5	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	280	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	19	6	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	1	0	0	0	0	0	0	1
98	F	19	7	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	1
98	F	19	8	Seed	B	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	F	19	9	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1	0	0	0	0	0	1
98	F	20	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0	0	28
98	F	20	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	20	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	20	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	20	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	81	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	20	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4
98	F	20	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	1
98	F	20	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	120	18	0	0	0	0	0	0	3	0	0	0	0	0	0	0
98	F	20	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	1	0	0	0	0	0	0	0	0	0	0
98	F	21	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	21	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	21	3	None	C	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
98	F	21	4	None	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	21	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	2
98	F	21	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1
98	F	21	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	4
98	F	21	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	9
98	F	21	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	1
98	F	22	1	None	B	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	3

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	22	2	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	F	22	3	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	22	4	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	1	0	0	0	0	0	0	0
98	F	22	5	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0
98	F	22	6	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
98	F	22	7	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	22	8	None	B	0	0	0	0	0	0	8	0	0	0	0	0	18	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	22	9	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	23	1	None	M	0	0	0	0	0	0	0	0	0	0	0	0	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	23	2	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	23	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	1	0	0	0	0	1	0	0	0	0	0	0
98	F	23	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	23	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	23	6	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1	0	0	0
98	F	23	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	23	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0
98	F	23	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	F	24	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	F	24	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	24	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	24	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	24	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
98	F	24	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	24	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	1	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	24	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	24	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	25	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	16
98	F	25	2	None	C	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
98	F	25	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	25	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	25	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	158	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	25	6	None	C	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	25	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	25	8	None	C	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
98	F	25	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	26	1	None	M	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0	1
98	F	26	2	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	26	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	128	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	26	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	26	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	7	0	0	0	0	0	0	0	0	0	0	0
98	F	26	6	None	M	0	0	0	0	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	26	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	26	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	54	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	26	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	27	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	27	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	1	0	0	0	0	0	0	2
98	F	27	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	4
98	F	27	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	1	0	0	0	0	0	0	1

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	27	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	49	0	0	0	0	0	0	0	0	0	0	0	0	0	2
98	F	27	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	1	0	0	0	0	0	0	0	0	0	0
98	F	27	7	Seed	C	0	0	0	0	0	0	4	0	0	0	0	0	30	4	0	0	0	0	0	1	0	0	0	0	0	0	1
98	F	27	8	Seed	C	0	0	0	0	0	0	0	0	0	32	0	0	3	0	0	0	6	0	0	0	0	0	0	0	0	0	0
98	F	27	9	Seed	C	0	0	0	0	0	0	9	0	0	0	0	0	14	3	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	28	1	Seed	M	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	10
98	F	28	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	F	28	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	1
98	F	28	4	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	4	0	2	0	0	0	0	0
98	F	28	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	149	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	28	6	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	10	0	0	0	0	0	0	0	0	0	0	2
98	F	28	7	Seed	M	0	0	0	0	0	0	13	0	0	0	0	0	14	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	28	8	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	1	0	0	1	0	0	0	0	0
98	F	28	9	Seed	M	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0
98	F	29	1	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	29	2	None	B	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	F	29	3	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	29	4	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
98	F	29	5	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0
98	F	29	6	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
98	F	29	7	None	B	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	4	0	0	0	1	0	0	0	0	0	0	0
98	F	29	8	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	29	9	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	F	30	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	30	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
98	F	30	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
98	F	30	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	30	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	F	30	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	30	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	30	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	30	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	31	1	Seed	M	0	0	0	0	0	0	0	0	0	0	0	40	18	0	0	0	0	0	0	0	0	0	0	0	0	0	10
98	F	31	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	31	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
98	F	31	4	Seed	M	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
98	F	31	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	2
98	F	31	6	Seed	M	0	0	0	32	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	F	31	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
98	F	31	8	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2
98	F	31	9	Seed	M	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	3	0	0	0	1	0	0	0	0	0	0	1
98	F	32	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	2	0	0	0	0	0	0	5
98	F	32	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	2	0	0	0	0	0	0	5
98	F	32	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	32	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	10	0	0	0	0	0	0	0
98	F	32	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	32	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4
98	F	32	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	7

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	32	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
98	F	32	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	1
98	F	33	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	5	51	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	33	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	33	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	33	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	135	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	33	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	33	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	20	10	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	33	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	160	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	33	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	2	0	0	0	1	0	0	0	0	0	0	0
98	F	33	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	32	29	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	34	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	1	0	0	0	0	0	0
98	F	34	2	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	1	0	0	0	0	0	0	0
98	F	34	3	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
98	F	34	4	Seed	B	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	34	5	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	F	34	6	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
98	F	34	7	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	96	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	34	8	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	0
98	F	34	9	Seed	B	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	1
98	F	35	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	35	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	35	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	35	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	35	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	35	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	3
98	F	35	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0
98	F	35	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
98	F	35	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	36	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	1
98	F	36	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0
98	F	36	3	None	C	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	F	36	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	36	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
98	F	36	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
98	F	36	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	2	0	0	0	0	0	0	0
98	F	36	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
98	F	36	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	1
98	F	37	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	7	0	0	0	0	0	0	0
98	F	37	2	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
98	F	37	3	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	8
98	F	37	4	Seed	B	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
98	F	37	5	Seed	B	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	0	0	0	3	0	0	0	0	0	0	4
98	F	37	6	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2
98	F	37	7	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	37	8	Seed	B	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	37	9	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0
98	F	38	1	Seed	M	0	0	0	12	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	F	38	2	Seed	M	0	0	0	0	0	0	15	0	0	0	0	0	20	0	0	2	0	0	0	1	0	0	0	0	0	0	3
98	F	38	3	Seed	M	0	0	0	0	0	0	8	0	0	0	0	0	67	0	0	0	0	0	0	1	0	0	0	0	0	0	1
98	F	38	4	Seed	M	0	0	0	0	0	0	23	0	0	0	0	0	0	73	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	38	5	Seed	M	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	3
98	F	38	6	Seed	M	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	38	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	1
98	F	38	8	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
98	F	38	9	Seed	M	0	0	0	0	0	0	17	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
98	F	39	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	39	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	F	39	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	90	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	F	39	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	85	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	39	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	39	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	96	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	39	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0
98	F	39	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0	0	0	0	0	0	0	0	0	0	0	0	0
98	F	39	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	170	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	1	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	1	2	None	C	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
96	S	1	3	None	C	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	1	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
96	S	1	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	1	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	1	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	1	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	1	9	None	C	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	2	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1
96	S	2	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	3
96	S	2	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
96	S	2	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	5	20	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	2	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	1	0	0	0	0	0	0	9
96	S	2	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	78	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	S	2	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
96	S	2	8	Seed	C	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
96	S	2	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	1
96	S	3	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	8	0	0	0	0	0	0	2
96	S	3	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
96	S	3	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
96	S	3	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
96	S	3	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	S	3	6	Seed	C	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	3	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
96	S	3	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
96	S	3	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	7
96	S	4	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	44	0	0	0	0	0	1	0	0	0	0	0	0	0
96	S	4	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	4	3	None	C	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
96	S	4	4	None	C	0	0	53	0	0	5	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	4	5	None	C	0	0	10	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	5	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	1	0	0	0	0	0	0	6
96	S	5	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
96	S	5	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
96	S	5	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
96	S	5	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0
96	S	5	6	Seed	C	0	0	0	0	0	4	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
96	S	5	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	5	8	Seed	C	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	5	9	Seed	C	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	6	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
96	S	6	2	None	C	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	6	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	1	3
96	S	6	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0
96	S	6	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	6	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	2
96	S	6	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	6	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	12
96	S	6	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	16
96	S	7	1	Seed	C	0	0	0	0	0	0	54	0	0	0	0	0	0	40	0	3	0	0	0	0	0	0	0	0	0	0	0
96	S	7	2	Seed	C	0	0	0	0	0	0	3	0	0	0	0	0	0	8	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	7	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	7	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0
96	S	7	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	7	6	Seed	C	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	S	7	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	7	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	S	7	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	8	1	None	C	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	24
96	S	8	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
96	S	8	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
96	S	8	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
96	S	8	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	8	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	2
96	S	8	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	148	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	8	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
96	S	8	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
96	S	9	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	9	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
96	S	9	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	14
96	S	9	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	S	9	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	9	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	5
96	S	9	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
96	S	9	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	9	9	None	C	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	9
96	S	10	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	10	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	10	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	10	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	10	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	10	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	10	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	S	10	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	85	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	10	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	124	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	11	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	S	11	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	S	11	3	Seed	C	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	11	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	11	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	11	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	11	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	11	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	11	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	12	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
96	S	12	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	12	3	Seed	C	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
96	S	12	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	12	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	1	0	0	0	0	0	0	0
96	S	12	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	32	34	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	12	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	12	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	12	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	13	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	13	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	13	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	13	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	13	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	13	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	13	7	None	C	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	13	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	13	9	None	C	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	14	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	4
96	S	14	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	14	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
96	S	14	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	S	14	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	14	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	1	0	0	0	0	0	0
96	S	14	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
96	S	14	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	0
96	S	14	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	S	15	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	15	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0
96	S	15	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	15	4	None	C	0	0	0	0	0	0	1	0	0	0	0	0	64	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	S	15	5	None	C	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	16	1	None	C	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	16	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	16	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	16	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	16	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	16	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	16	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	16	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	16	9	None	C	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	17	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	17	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	17	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	7	0	0	0	0	0	0	0	0	0	0	0
96	S	17	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	17	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	17	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	S	17	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	17	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	17	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	18	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	18	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	18	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	18	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	18	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	18	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	18	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	18	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	18	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	19	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
96	S	19	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	1	0	0	0	0	0	0
96	S	19	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	S	19	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	1	0	0	0	0	0	0	0
96	S	19	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
96	S	19	6	Seed	C	0	0	0	0	0	0	17	0	0	0	0	0	0	6	0	9	0	0	0	0	0	0	0	0	0	0	0
96	S	19	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	19	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
96	S	19	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	20	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	2	0	0	0	0	0	0	0
96	S	20	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
96	S	20	3	Seed	C	0	0	0	0	0	0	1	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	2
96	S	20	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	3	1	0	0	0	0	0	1
96	S	20	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	S	20	6	Seed	C	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	7
96	S	20	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	51	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	20	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	S	20	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	21	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	21	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0
96	S	21	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	1

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	21	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	10
96	S	21	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	1	0	0	0	1	0	0	0	0	0	0	0
96	S	21	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0
96	S	21	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	5	0	0	0	0	0	0	0
96	S	21	8	None	C	0	0	0	0	0	0	34	0	0	0	0	0	22	1	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	21	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0
96	S	22	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	22	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	S	22	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	46	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	22	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	22	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	22	6	None	C	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	22	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
96	S	22	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	22	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	1	0	0	0	0	0	0	0
96	S	23	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
96	S	23	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	S	23	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	23	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	23	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	23	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	S	23	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	23	8	None	C	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	23	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	24	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	15	0	0	0	0	0	0	0	0	0	0
96	S	24	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
96	S	24	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	1	0	0	0	0	0	0	0	0	0	0
96	S	24	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	24	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	24	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	S	24	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
96	S	24	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	24	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	25	1	None	C	0	0	0	0	0	0	18	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	4
96	S	25	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	8	0	0	2	0	0	0	0	0	0	0
96	S	25	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	115	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	25	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2
96	S	25	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0
96	S	25	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	15
96	S	25	7	None	C	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	7	0	0	0	2	0	0	0	0	0	0	0
96	S	25	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
96	S	25	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	26	1	None	C	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	26	2	None	C	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	26	3	None	C	0	0	0	10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	1
96	S	26	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	26	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	26	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	104	0	0	0	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	26	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	26	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	1	0	0	0	0	0	0	3
96	S	26	9	None	C	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1
96	S	27	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	27	2	Seed	C	0	0	0	0	0	0	5	0	0	0	0	0	24	0	0	0	3	0	0	0	0	0	0	0	0	0	2
96	S	27	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	3	0	0	0	0
96	S	27	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	54	0	0	5	0	0	0	3	0	0	0	0	0	1	8
96	S	27	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	1	0	0	1	0	0	0	5
96	S	27	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	2	0	0	0	0	0	0	3
96	S	27	7	Seed	C	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1
96	S	27	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	1	0	1
96	S	27	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	28	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	S	28	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
96	S	28	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	28	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
96	S	28	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	28	6	Seed	C	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	28	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	28	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	28	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	29	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
96	S	29	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	12
96	S	29	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	29	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	29	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
96	S	29	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	S	29	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
96	S	29	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	S	29	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	30	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	2	0	0	0	0	0	0	0	0	0	0
96	S	30	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
96	S	30	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	5
96	S	30	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	2	0	0	0	0	0	0	0	0	0	0	1
96	S	30	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	30	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0
96	S	30	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	30	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2
96	S	30	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	S	31	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	1	0	0	0	0	0	0	2
96	S	31	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	13
96	S	31	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	5	0	0	0	0	0	0	0	0	0	0	0
96	S	31	4	Seed	C	0	0	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
96	S	31	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	3
96	S	31	6	Seed	C	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	S	31	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	7	0	0	0	0	0	0	0	0	0	0	2
96	S	31	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0
96	S	31	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	32	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
96	S	32	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	32	3	None	C	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
96	S	32	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	3	0
96	S	32	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	1
96	S	32	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0
96	S	32	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	5	1	0	0	0	0	2	1
96	S	32	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	S	32	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	33	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	5	0	0	2	0	0	1	0	0	0	0
96	S	33	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	33	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	3	0	0	0	0	0	0	5
96	S	33	4	Seed	C	0	0	0	0	0	0	21	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	33	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	34	8	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	33	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	33	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
96	S	33	8	Seed	C	0	0	0	0	0	0	4	0	0	0	0	0	12	20	0	0	0	0	0	1	0	0	0	0	0	0	0
96	S	33	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	5	0	0	0	0	0	0	0
96	S	34	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	3	0	0	0	0	0	0	0
96	S	34	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	34	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	34	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0
96	S	34	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
96	S	34	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	34	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	34	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
96	S	34	9	Seed	C	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	3
96	S	35	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
96	S	35	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	3
96	S	35	3	Seed	C	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
96	S	35	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
96	S	35	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
96	S	35	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	S	35	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	3
96	S	35	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1
96	S	35	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	19
96	S	36	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2
96	S	36	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	S	36	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	1
96	S	36	4	None	C	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2
96	S	36	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
96	S	36	6	None	C	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	36	7	None	C	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4
96	S	36	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
96	S	36	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0
96	S	37	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	37	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	5	0	0	0	0	0	0	0	0	0	0	0
96	S	37	3	Seed	C	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	10

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
96	S	37	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
96	S	37	5	Seed	C	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	8
96	S	37	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	37	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	S	37	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2
96	S	37	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3
96	S	38	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	38	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	1	0	0	0	1	0	0	0	0	0	0	0
96	S	38	3	Seed	C	0	0	0	0	0	0	33	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	2
96	S	38	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	38	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
96	S	38	6	Seed	C	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
96	S	38	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
96	S	38	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
96	S	38	9	Seed	C	0	0	0	0	0	0	51	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
96	S	39	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	39	2	None	C	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	39	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	10	8	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	39	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	39	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	104	0	0	1	0	0	0	0	0	0	0	0	0	0	0
96	S	39	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	39	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	39	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
96	S	39	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	130	0	0	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	1	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0
97	S	1	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	S	1	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	1	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	111	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	1	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	1	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	250	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	1	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	1	0	0	0	0	0	0	34
97	S	1	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	1	0	0	0	0	0	0	6
97	S	1	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0	1	0	0	0	0	0	0	1
97	S	2	1	Seed	C	0	0	0	0	0	20	0	0	0	0	0	3	0	0	1	0	0	0	3	0	0	0	0	0	0	0	3
97	S	2	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	3	5	0	0	0	0	0	0	0
97	S	2	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	4	0	0	0	0	0	0	12
97	S	2	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	10	2	0	0	0	0	0	25
97	S	2	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	2	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
97	S	2	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	17
97	S	2	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	0	0	0	0	5	0	2
97	S	2	9	Seed	C	0	0	0	0	0	5	0	0	0	0	0	0	8	0	0	2	0	0	0	0	0	0	0	0	0	0	5
97	S	3	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
97	S	3	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
97	S	3	3	Seed	C	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	23
97	S	3	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
97	S	3	5	Seed	C	0	0	0	0	0	0	0	0	1	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	17
97	S	3	6	Seed	C	0	0	0	0	14	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	3	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	3
97	S	3	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	1	0	0	0	0	10
97	S	3	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	4	1	None	C	0	0	0	0	0	0	1	0	0	0	0	0	0	12	0	1	0	0	0	0	1	0	0	0	0	0	0
97	S	4	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	2	0	0	0	0	0	3	0	0	0	0	15
97	S	4	3	None	C	0	0	0	0	0	0	2	0	0	0	0	0	3	0	0	1	0	0	0	2	0	1	0	0	0	0	10
97	S	4	4	None	C	0	0	0	0	0	0	0	0	1	0	0	0	0	10	0	1	3	0	0	0	0	3	0	0	0	0	1
97	S	4	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	2	0	0	2	0	0	0	0	0
97	S	5	1	Seed	C	0	0	0	0	0	4	0	0	0	0	0	0	12	0	0	1	0	0	0	0	0	8	0	0	0	0	0
97	S	5	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	2	10	0	0	0	0	0	0	0	0	3	0	0	0	0	0
97	S	5	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	27	0	0	0	0	0
97	S	5	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	2	1	0	0	0	0	0
97	S	5	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	1	0	0	0	1	0	0
97	S	5	6	Seed	C	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
97	S	5	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
97	S	5	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	4	0	0	0	3
97	S	5	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	8
97	S	6	1	None	C	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
97	S	6	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	17
97	S	6	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	6
97	S	6	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	6	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	14
97	S	6	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	6	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	17

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	6	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	9
97	S	6	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
97	S	7	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	15	2	1	0	0	0	0	1	1	0	0	0	0	0
97	S	7	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
97	S	7	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	2	0	0	0	0	0	0	0	0	0	7
97	S	7	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0
97	S	7	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	11	0	5	0	0	0	0	0	0	0	0
97	S	7	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	1
97	S	7	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	2
97	S	7	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0
97	S	7	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	28	1	0	2	0	0	0	0	0	0	0	0	0	0
97	S	8	1	None	C	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
97	S	8	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	8	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	0	0	0	0	0
97	S	8	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	15	0
97	S	8	5	None	C	0	0	0	0	0	0	5	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	1	0
97	S	8	6	None	C	0	0	0	0	0	0	8	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0
97	S	8	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	3	0	0	0	1	0	0	0	0	0
97	S	8	8	None	C	0	0	0	0	0	0	45	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	8	9	None	C	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0
97	S	9	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88	0	0	0	0	0	0	0	0	0	0	0	0
97	S	9	2	None	C	0	0	0	0	0	3	0	0	0	0	0	0	20	0	0	0	0	0	0	3	0	1	0	0	0	0	0
97	S	9	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	1	0	0	0	2	0	0	0	0	2	0	0
97	S	9	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	3	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	9	5	None	C	0	0	0	120	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	2	0	2	0	0	0	0	0
97	S	9	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	20	0	8	0	0	0	0	0	0	0	0	0	0	0	0
97	S	9	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	3	0	0	0	2	0	0	0	0	0	0	0
97	S	9	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	9	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0
97	S	10	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	10	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	10	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	10	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	1	0	0	0	0	0	0
97	S	10	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	10	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	10	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	10	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	12	7	0	2	0	0	0	0	1	0	0	0	0	0	0
97	S	10	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	11	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	4	0	0	0	0	0
97	S	11	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	5	0	0	0	0	0	9	0	0	0	0	0
97	S	11	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	3	0	0	0	0	0
97	S	11	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	10	0	0	0	0	0
97	S	11	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	0	0	0	0	0	3	0	0	0	0	0
97	S	11	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	6	4	0	0	0	0
97	S	11	7	Seed	C	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	11	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	11	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	2	0	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	12	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
97	S	12	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	12	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	5	0	0	0	0	0
97	S	12	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	1	0	0	0	0	0
97	S	12	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	12	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	4	0	0	0	0	0	4	0	0	0	0	0
97	S	12	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	15	0	0	0	0	0
97	S	12	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	2	0	0	0	0	0
97	S	12	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	20	0	0	0	0	0
97	S	13	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	4	0	0	0	0	0	0	42
97	S	13	2	None	C	0	0	8	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	13	3	None	C	0	0	1	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	108
97	S	13	4	None	C	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	13	5	None	C	0	0	1	1	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
97	S	13	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
97	S	13	7	None	C	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
97	S	13	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	13	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	14	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	1
97	S	14	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	1	0	0	0	0	4
97	S	14	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	43
97	S	14	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0
97	S	14	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	14	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
97	S	14	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	1	4	0	0	0	0	0	0	0	0	0	0
97	S	14	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	3	0	0
97	S	14	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	15	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	S	15	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0
97	S	15	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	4	0	0	0	2	0	0	0	0	0	0	6
97	S	15	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	3
97	S	15	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	1	0	0	0	6	0	0	0	0	0	0	4
97	S	16	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	11
97	S	16	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0
97	S	16	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	16	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0
97	S	16	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	16	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	7	0	0	0	0	0
97	S	16	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	16	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
97	S	16	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	17	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0
97	S	17	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2
97	S	17	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	17	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	14	0	0	0	0	0
97	S	17	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	5	0	0	0	0	0
97	S	17	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	17	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	98	0	0	0	0	0	0	0	0	0	0	0	0	6
97	S	17	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	1	0	0	0	0	0
97	S	17	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	1	4	0	0	0	0	0
97	S	18	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	6
97	S	18	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	2
97	S	18	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	S	18	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	S	18	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	18	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	S	18	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	4
97	S	18	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	18	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	1	0	0	0	0	0
97	S	19	1	Seed	C	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	4	0	0	0	0	1	3	0	0	0	0	0
97	S	19	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	4	0	0	0	0	8
97	S	19	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	12	0	0	0	0	0
97	S	19	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	5	0	0	1	0	0
97	S	19	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	1	0	0	0	0	0
97	S	19	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
97	S	19	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	15	0	0	0	0	0
97	S	19	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
97	S	19	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	20	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	S	20	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	1	0	0	0	2	0	0	0	0	0	0	0
97	S	20	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	4	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	20	4	Seed	C	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	33
97	S	20	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	9
97	S	20	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	1	0	0	0	0	0	0	10
97	S	20	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	1	0	0	0	0	0	0	0
97	S	20	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
97	S	20	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	21	1	None	C	0	0	0	0	0	0	13	0	0	0	0	0	10	0	3	2	4	0	0	0	0	0	0	0	0	0	0
97	S	21	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	30	12	4	0	0	0	0	3	0	0	0	0	0	0	0
97	S	21	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	21	4	None	C	0	0	6	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	8	0	0	0	0	0	0	0
97	S	21	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	8	0	0	0	0	0	0	0
97	S	21	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	S	21	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	23	9	0	0	0	0	0	4	0	0	0	0	0	0	0
97	S	21	8	None	C	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	6
97	S	21	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	22	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	1	0	0	0	0	0	1	0	0	0	0	0
97	S	22	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0	0
97	S	22	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0
97	S	22	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	3	0	0	0	0	0
97	S	22	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
97	S	22	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	6	0	0	0	0	0
97	S	22	7	None	C	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
97	S	22	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
97	S	22	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	23	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
97	S	23	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
97	S	23	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	0	0	0	0	0
97	S	23	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	S	23	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0
97	S	23	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0
97	S	23	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	3	0	0	0	0	0
97	S	23	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	S	23	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	3	0	0	0	0	1	1	0	0	0	0	0
97	S	24	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	0	0	1	7	0	0	0	0	0
97	S	24	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
97	S	24	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	1
97	S	24	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	17	0	0	0	0	0
97	S	24	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0
97	S	24	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	3	0	0	0	0	0
97	S	24	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	1	0	0	0	0	0	0
97	S	24	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	1
97	S	24	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	1	0	0	0	0	0	2
97	S	25	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	25	2	None	C	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	11
97	S	25	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	65	0	0	3	0	0	0	0	0	0	0	0	0	0
97	S	25	4	None	C	0	0	14	0	0	0	0	0	0	0	0	0	45	0	0	0	1	0	0	2	0	0	0	0	0	0	0
97	S	25	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	130	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	25	6	None	C	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	3	0	0	6	0	4	0	0	0	0	32

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	25	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	1	0	7	0	0	0	0	0
97	S	25	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	10
97	S	25	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0
97	S	26	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	26	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	26	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	26	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	26	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	6	8	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	26	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	26	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	26	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	26	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	27	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	27	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	1	0	0	0	0	0	0
97	S	27	3	Seed	C	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	6
97	S	27	4	Seed	C	0	25	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	27	5	Seed	C	0	20	0	0	0	0	0	0	0	0	0	0	15	0	0	0	1	0	0	0	4	0	0	0	0	0	0
97	S	28	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0	0	0	0	0
97	S	28	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
97	S	28	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
97	S	28	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	2
97	S	28	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
97	S	28	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	0
97	S	28	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	72	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	28	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
97	S	28	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	S	29	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	S	29	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
97	S	29	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	1
97	S	29	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
97	S	29	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
97	S	29	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	4
97	S	29	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2
97	S	29	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	2	0	1	0	0	0	0	0	0
97	S	29	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
97	S	30	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	S	30	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	2	0	2	0	0	0	0	0
97	S	30	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	1	0	0	0	0	0	0
97	S	30	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
97	S	30	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	1	0	0	0	0	1
97	S	30	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	2	0	0	2	0	0	0	0	0	0	0	9
97	S	30	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	2
97	S	30	8	None	C	0	0	80	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
97	S	30	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	2
97	S	31	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	4	1	1	0	0	0	0	0
97	S	31	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	12	0	0	1	0	0
97	S	31	3	Seed	C	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	2	0	0	0	2	0	13	0	0	0	0	0
97	S	31	4	Seed	C	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	18

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	31	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0
97	S	31	6	Seed	C	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	3	1	0	0	0	0	0	11
97	S	31	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0
97	S	31	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	2	0	0	0	0	0
97	S	31	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	4	0	0	0	0	0
97	S	32	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2
97	S	32	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	5	0	0	0	2	0	0	0	0	0	0	0
97	S	32	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
97	S	32	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	10	6	0	0	0	0	0	1	0	6	0	0	0	0	4
97	S	32	5	None	C	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
97	S	32	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	6	0	0	0	0	0
97	S	32	7	None	C	0	0	0	10	0	0	0	0	0	0	0	0	30	22	0	0	0	0	0	0	1	3	0	0	0	0	0
97	S	32	8	None	C	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	3	0	4	0	0	0	0	4
97	S	32	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	33	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	3	0	0	0	0	0	0	0	0	0	0
97	S	33	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	9	38	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	33	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	15
97	S	33	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	33	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	1	0	0	0	0	0	0	0	0	0	0	0
97	S	33	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	33	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	33	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	7	0	0	0	0	0	0	5
97	S	33	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	51	0	2	0	0	0	0	0	0	0	0	0	0	1
97	S	34	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	12	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	34	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	1	0	0	0	0	0	0
97	S	34	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0
97	S	34	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	1	0	0
97	S	34	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0
97	S	34	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
97	S	34	7	Seed	C	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0	0	7
97	S	34	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
97	S	34	9	Seed	C	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	8	0	0	0	3	0	0	0	0	0	0	3
97	S	35	1	Seed	C	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	0	1	0	1
97	S	35	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	1	0	0
97	S	35	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	1	0	0
97	S	35	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	2
97	S	35	5	Seed	C	0	0	0	0	0	0	15	0	0	0	0	0	8	0	0	4	0	1	3	0	1	0	0	0	0	0	2
97	S	35	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	7
97	S	35	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0	0	0	0	4
97	S	35	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	35	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	10
97	S	36	1	None	C	0	0	8	35	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	1
97	S	36	2	None	C	0	0	0	0	0	0	2	0	0	0	0	0	6	0	0	0	0	1	0	6	0	3	0	0	0	0	7
97	S	36	3	None	C	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	12	1	0	0	0	0	0	15
97	S	36	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	36	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	4	0	0	0	0	1	0	0	0	0	0	5
97	S	36	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	8
97	S	36	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	3	0	6

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	36	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	2	0	0	0	0	3
97	S	36	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	5
97	S	37	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
97	S	37	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	8	0	0	0	0	0	5	0	0	0	0	0
97	S	37	3	Seed	C	0	0	25	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	3
97	S	37	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
97	S	37	5	Seed	C	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
97	S	37	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
97	S	37	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
97	S	37	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	2	0	0	0	0	0
97	S	37	9	Seed	C	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0
97	S	38	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0	1	0	0	0	0	13
97	S	38	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	0	0	0	0	1	0	0	0	0	0	2
97	S	38	3	Seed	C	0	0	0	0	0	0	15	0	0	0	0	0	0	0	1	0	0	0	0	0	0	7	0	0	0	0	8
97	S	38	4	Seed	C	0	0	20	0	0	0	6	0	0	0	0	0	75	0	0	0	0	0	0	3	0	0	0	0	0	0	0
97	S	38	5	Seed	C	0	0	0	0	0	0	6	0	0	0	0	0	30	0	0	0	0	0	0	0	0	2	0	0	0	0	0
97	S	38	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
97	S	38	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
97	S	38	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	14	0	3
97	S	38	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0
97	S	39	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	39	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	1	0	0	0	0	0	2
97	S	39	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	39	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	50	25	0	0	0	0	0	0	0	0	0	0	0	0	0

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
97	S	39	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	1	0	0	0	0	0	0	0
97	S	39	6	None	C	0	2	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	39	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
97	S	39	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	5	0	0	0	0	0	0	0	0	0	0	0
97	S	39	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
98	S	1	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	S	1	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	7	0	0	0	0	0	0	0	0	0	0	3
98	S	1	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	98	0	4	0	0	0	0	0	0	0	0	0	0	0
98	S	1	4	None	C	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	1	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	89	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	1	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	175	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	1	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	120	0	3	0	0	0	0	0	0	0	0	0	0	0
98	S	1	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	1	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	8	0	0	0	0	0	0	0	0	0	0	0
98	S	2	1	Seed	M	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	3	0	33
98	S	2	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	13	0	15
98	S	2	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	1	0	0	0	0	0	16
98	S	2	4	Seed	M	0	0	0	0	0	0	0	0	0	0	70	0	3	0	0	0	0	0	0	3	0	0	0	0	0	0	17
98	S	2	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	1	0	0	0	0	0	16
98	S	2	6	Seed	M	0	0	0	0	0	0	0	0	0	0	0	5	23	0	0	0	0	0	0	1	0	0	0	0	0	0	24
98	S	2	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	1	0	0	0	0	6
98	S	2	8	Seed	M	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	3
98	S	2	9	Seed	M	0	0	0	0	0	0	0	8	0	0	0	0	0	30	0	0	0	0	0	5	1	0	0	0	0	0	15
98	S	3	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	3	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	4
98	S	3	3	Seed	C	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	1	0	6	0	0	0	0	4
98	S	3	4	Seed	C	0	0	0	0	0	0	0	0	0	0	2	0	0	5	0	0	0	0	0	4	0	0	0	0	0	0	9
98	S	3	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	3	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	1	0	2	1	0	0	0	0	0	4
98	S	3	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
98	S	3	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	2	0	0	0	0	0	0	28
98	S	3	9	Seed	C	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
98	S	4	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	4	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	4	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
98	S	4	4	None	C	3	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	2	0	0	1	0	0	0	0	0	0	1
98	S	4	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
98	S	5	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	72	0	2	0	0	0	0	0	0	0	0	0	0	0	0
98	S	5	2	Seed	C	0	0	0	0	0	35	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	1
98	S	5	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	105	0	0	1	0	0	0	0	0	0	0	0	0	0
98	S	5	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	3	0	0	0	0	1
98	S	5	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	53	0	0	3	0	0	0	0	0	0	0	0	0	0
98	S	5	6	Seed	C	1	0	0	0	0	0	0	0	0	0	0	0	0	13	0	4	0	0	0	7	0	3	0	0	0	0	4
98	S	5	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	48	0	18	0	0	0	0	0	0	0	0	0	0	0
98	S	5	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	2	0	0	0	0	0
98	S	5	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	6	1	None	M	0	0	0	0	35	0	0	0	0	0	0	0	11	0	0	0	0	0	0	2	0	6	0	0	0	0	30
98	S	6	2	None	M	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	0	2	0	0	0	0	1	0	0	0	0	7

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Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	6	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	0	0
98	S	6	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	7	0	0	0	0	0
98	S	6	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	4	0	0	0	0	0	2	0	0	0	0	0
98	S	6	6	None	M	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	16	0	0	0	0	0
98	S	6	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0	0	0	0	0	2	0	3	0	0	0	0	0
98	S	6	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	2	3	0	3	0	0	0	0	10
98	S	6	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	5	0	0	0	0	0	0	0	0	0	0	0
98	S	7	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	1	0	0	0	0	0
98	S	7	2	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	7	3	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	46	20	0	0	0	0	0	0	0	2	0	0	0	0	0
98	S	7	4	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	1	0	0	0	1	0	0	0	0	0	0
98	S	7	5	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	8	0	0	0	0	0	0	0	0	4	0	0
98	S	7	6	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	1	2	0	0	0	0	0
98	S	7	7	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	4	0	0	0	0	0	0	0	0	0	0	0
98	S	7	8	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	7	9	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	1	0	0	0	0	0	0
98	S	8	1	None	M	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	12	2
98	S	8	2	None	M	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	8	3	None	M	0	0	0	0	0	35	0	0	0	0	0	0	23	2	0	5	0	0	0	0	0	1	0	0	0	16	0
98	S	8	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
98	S	8	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	12	0
98	S	8	6	None	M	0	0	0	0	0	0	0	0	0	0	0	0	4	15	0	0	0	0	0	0	0	0	0	0	0	0	34
98	S	8	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	8	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	1	0	0	0	0	0	0

247

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	8	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	44	0	0	0	0	0	0	0	0	0	0	0	6	5
98	S	9	1	None	C	0	1	0	0	0	0	0	0	0	0	0	0	14	0	9	0	4	0	0	1	0	0	0	0	0	0	6
98	S	9	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	5	0	0	2	0	0	0	0	0	0	0
98	S	9	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	1	0	0	1	0	3	0	0	0	0	0
98	S	9	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	S	9	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	2	0	0	5	0	0	0	0	0	0	2
98	S	9	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	57	0	2	0	0	0	0	1	0	10	0	0	0	0	0
98	S	9	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85	8	1	0	0	0	0	0	0	0	0	0	0
98	S	9	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	78	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	S	9	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	7	0	0	1	0	0	0	0	0	0	1
98	S	10	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	S	10	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	2	0	0	0	0	0	0	0	0
98	S	10	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	5	0	0	0	0	0	0	0	0	0	0	0
98	S	10	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	1	0	0	0	0	0	0	0	0	0	0	0
98	S	10	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	10	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	2
98	S	10	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	S	10	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	10	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	11	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	11	2	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	11	3	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	11	4	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	11	5	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	11	6	Seed	B	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	11	7	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	8	0	0	0	0	0	0	0	0	0	0	0
98	S	11	8	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	11	9	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	20	5	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	12	1	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	S	12	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	S	12	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
98	S	12	4	Seed	M	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0
98	S	12	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	S	12	6	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0
98	S	12	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0
98	S	12	8	Seed	M	0	0	0	0	0	0	0	0	0	0	0	33	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0
98	S	12	9	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	S	13	1	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	S	13	2	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	13	3	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	S	13	4	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	S	13	5	None	B	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	13	6	None	B	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	15	0	0	0	0	0	0	0	0	0	0	0
98	S	13	7	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
98	S	13	8	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	13	9	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
98	S	14	1	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	1	0	0	0	0	0	0
98	S	14	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	25	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	14	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	S	14	4	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0	0	0
98	S	14	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	65	0	0	3	1	0	0	0	3	0	0	0	0	0	0	0
98	S	14	6	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	4	0	0	0	0	0	0	0
98	S	14	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
98	S	14	8	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	180	0	0	0	0	0	0	0	0	1	0	0	0	0	0
98	S	14	9	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	15	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	2	0	0	0	0	0	0	4
98	S	15	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	4	0	0	0	2	0	0	0	0	0	0	5
98	S	15	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	S	15	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0
98	S	15	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
98	S	16	1	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	1	0	0	0	0	0	0	0	5
98	S	16	2	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	3	0	0	0	0	0	0	0	0
98	S	16	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
98	S	16	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	16	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	S	16	6	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	49	0	0	0	0	0	1	0	0	0	0	0	0	0
98	S	16	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	68	0	1	0	0	0	0	0	0	0	0	0	0	0
98	S	16	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	1	0	0	0	0	0	1	0	0	0	0	0
98	S	16	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	S	17	1	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	S	17	2	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0
98	S	17	3	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	17	4	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0
98	S	17	5	None	B	0	0	0	0	0	0	0	0	0	0	0	0	22	45	0	7	0	0	0	0	0	0	0	0	0	0	0
98	S	17	6	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	2	0	0	0	0	0	0
98	S	17	7	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	2	0
98	S	17	8	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
98	S	17	9	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
98	S	18	1	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	9	0	0	0	0	0
98	S	18	2	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
98	S	18	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	10	0	0	0	0	0
98	S	18	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	S	18	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	3	0	0	0	0	0
98	S	18	6	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	0	0	0
98	S	18	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	S	18	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	2
98	S	18	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	3	0	0	0	0	0
98	S	19	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	2	0	0	0	1	0	4	0	0	2	0	2
98	S	19	2	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	1	0	0	0	2	0	0	0	0	0
98	S	19	3	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0
98	S	19	4	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0	0
98	S	19	5	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
98	S	19	6	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	21	1	0	0	0	0	0	0	0	0	0	0
98	S	19	7	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	60	0	5	0	0	0	3	1	0	1	0	0	0	0
98	S	19	8	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	1	0	0	0	0	0	0	0	0	0	2
98	S	19	9	Seed	B	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	12	0	0	0	1	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	20	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	6	0	0	0	0	0	0	1
98	S	20	2	Seed	C	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	0
98	S	20	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	2	0	0	0	0	0	0	6
98	S	20	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	180	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	20	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	3	0	0	0	2	0	0	0	0	0	0	0
98	S	20	6	Seed	C	0	0	0	0	0	0	0	0	2	0	0	7	0	0	0	6	0	0	0	4	0	0	0	0	0	0	0
98	S	20	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	20	8	Seed	C	0	0	0	0	0	0	0	0	0	0	3	9	0	4	0	14	0	0	0	0	0	0	0	0	0	0	3
98	S	20	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	1	0	0	0	0	0	0	0	0	0	0	10
98	S	21	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	21	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
98	S	21	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	3
98	S	21	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	4	0	0	0	0	0	0	8
98	S	21	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	2	0	0	0	0	0	0	0
98	S	21	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	S	21	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	95	0	0	0	0	0	0	1	0	0	0	0	0	0	3
98	S	21	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	4
98	S	21	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	22	1	None	B	0	0	0	0	0	0	12	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	22	2	None	B	20	0	0	0	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0	1	0	0	0	0	1	0	0
98	S	22	3	None	B	0	0	0	0	0	0	0	0	0	0	0	0	190	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	22	4	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
98	S	22	5	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	S	22	6	None	B	1	0	0	0	0	0	0	0	0	0	0	0	45	0	0	1	0	0	0	1	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	22	7	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
98	S	22	8	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	1	0	0	0	0	0	0	0
98	S	22	9	None	B	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	23	1	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	S	23	2	None	M	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	S	23	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
98	S	23	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	S	23	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	5	0	0	0	0	0	0	0	1	0	0	0
98	S	23	6	None	M	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	1
98	S	23	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0
98	S	23	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	3	0	0	0	1	0	0	0	0	0	0	0
98	S	23	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	S	24	1	Seed	C	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
98	S	24	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1
98	S	24	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	1	0	0	1	3
98	S	24	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	6	0	0	0	0	0	0	3	0	0	0	0
98	S	24	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	1	0	3	0	0	0	0
98	S	24	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	S	24	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
98	S	24	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	1	0	0	0	0
98	S	24	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	9	0	0	0	0	0	0	0	0	0	0	0
98	S	25	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1
98	S	25	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	2	0	0	0	1	0	0	0	0	0	0	12
98	S	25	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	3	0	2

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	25	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	1	0	0	0	0	0	0	0
98	S	25	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1	0	0	0	0	0	0	0	0	0	0
98	S	25	6	None	C	0	0	0	0	0	0	5	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	3
98	S	25	7	None	C	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	3	0	0	0	0	0	0	0	0	0	0
98	S	25	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	130	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	25	9	None	C	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	7
98	S	26	1	None	M	0	0	0	0	0	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	0	0	0	0	0	0	1
98	S	26	2	None	M	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	11	0	0	0	0	0	0	0	0	0	0	4
98	S	26	3	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0
98	S	26	4	None	M	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	S	26	5	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0
98	S	26	6	None	M	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	8
98	S	26	7	None	M	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	S	26	8	None	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0
98	S	26	9	None	M	0	0	0	0	0	0	0	0	0	0	0	0	45	0	5	2	0	0	0	0	0	2	0	0	0	0	2
98	S	27	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	26	8	0	0	0	0	0	1	0	0	0	0	0	0	0
98	S	27	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	2	0	0	0	0	0	1	0	0	0	0	0
98	S	27	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	27	4	Seed	C	0	0	0	8	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	27	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	86	0	0	0	0	0	0	1	0	1	0	0	0	0	1
98	S	27	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	3	42	0	0	0	0	0	0	2	0	0	1	0	0	1	0
98	S	27	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	S	27	8	Seed	C	0	0	0	0	0	0	0	0	0	0	8	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	1
98	S	27	9	Seed	C	0	0	0	0	0	0	0	0	0	0	12	0	45	0	0	0	0	0	0	0	0	2	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	28	1	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	1	0	0	0
98	S	28	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	2	0	0	0	0	0	0	0	2
98	S	28	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	6	0	0	1	0	0
98	S	28	4	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	11	0	1	0	0	0	0	0	0	0	0	0
98	S	28	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	S	28	6	Seed	M	0	0	0	0	0	0	70	0	0	0	0	0	0	0	0	12	0	0	0	0	0	2	0	0	0	0	0
98	S	28	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	3	0	0	0	0	0	0	0	0	0	0	0
98	S	28	8	Seed	M	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	4
98	S	28	9	Seed	M	0	0	0	0	0	0	70	0	0	0	0	0	14	18	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	29	1	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	S	29	2	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	S	29	3	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	1	0	0	0	0	0	0	0	0
98	S	29	4	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
98	S	29	5	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	S	29	6	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0	0	0	0	0	0
98	S	29	7	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	1	0	0	0	0	0	0
98	S	29	8	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	1	0	0	0	0	0	0
98	S	29	9	None	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
98	S	30	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	30	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	S	30	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	1	0	0	0	0	0	0	0	0	0	0	5
98	S	30	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	9
98	S	30	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	S	30	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	30	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
98	S	30	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	S	30	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	29
98	S	31	1	Seed	M	0	0	0	0	0	0	0	0	0	0	0	65	0	0	0	0	0	0	0	1	0	0	0	0	0	0	41
98	S	31	2	Seed	M	0	0	0	0	45	0	0	0	0	0	0	23	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
98	S	31	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
98	S	31	4	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	11
98	S	31	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	1	0	0	0	0	0	0	20
98	S	31	6	Seed	M	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	3
98	S	31	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53
98	S	31	8	Seed	M	0	0	0	0	0	0	0	0	0	0	22	0	0	31	5	0	0	0	0	1	0	0	0	0	0	1	2
98	S	31	9	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	3	0	0	0	0	0	0	0	0	0	0	12
98	S	32	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	S	32	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	32	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	0	0	0	0	0
98	S	32	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
98	S	32	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
98	S	32	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	16	0	0	0	0	0	0	1
98	S	32	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	10
98	S	32	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	4	0	0	0	0	0	0	0
98	S	32	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
98	S	33	1	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	18	12	0	0	0	0	0	1	0	0	0	0	0	0	3
98	S	33	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	6	0	0	0	0	0	0	3
98	S	33	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	1

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	33	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	30	20	0	2	0	0	0	0	0	0	0	0	0	0	0
98	S	33	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	33	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	1	0	0	0	0	0	0	0	0	0	0	0
98	S	33	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	33	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	S	33	9	Seed	C	0	0	0	0	0	0	8	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	34	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	S	34	2	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	67	0	0	0	0	0	0	1	2	0	0	0	0	0	0
98	S	34	3	Seed	B	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	S	34	4	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	S	34	5	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	S	34	6	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0
98	S	34	7	Seed	B	0	0	0	0	0	0	0	0	0	0	12	20	0	0	0	9	0	0	0	0	0	0	0	0	0	0	1
98	S	34	8	Seed	B	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	18	2	0	0	0	0	0	0	0	0	1	0
98	S	34	9	Seed	B	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	8	0	0	0	2	0	0	0	0	0	3	0
98	S	35	1	Seed	C	0	0	0	96	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
98	S	35	2	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	1	0	0	0	0	0	1	0	5
98	S	35	3	Seed	C	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	6	0	0	0	0	0	0	0	0	0	0	2
98	S	35	4	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0
98	S	35	5	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	13
98	S	35	6	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	0	0	0	0	4
98	S	35	7	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
98	S	35	8	Seed	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	13	0	0	0	0	1	0	0	0	0	0	4
98	S	35	9	Seed	C	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	2	0	0	0	0	1	5	0	0	0	0	3

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	36	1	None	C	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	1
98	S	36	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	7
98	S	36	3	None	C	0	0	0	3	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	4
98	S	36	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
98	S	36	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	2
98	S	36	6	None	C	0	0	0	0	0	0	15	0	0	0	0	0	6	0	0	0	0	0	0	1	0	0	0	0	0	0	0
98	S	36	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	10
98	S	36	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	1	0	0	0	0	0	0	10
98	S	36	9	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	5
98	S	37	1	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	4	0	0	0	0	0	0	0	0	0	0	0
98	S	37	2	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	11
98	S	37	3	Seed	B	0	0	0	0	0	0	0	0	0	0	5	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	4
98	S	37	4	Seed	B	0	0	0	0	0	0	0	0	0	0	0	7	0	38	0	0	0	0	0	2	0	0	0	0	0	0	3
98	S	37	5	Seed	B	0	0	0	0	0	0	9	0	0	0	0	0	0	6	0	0	0	0	0	1	0	0	0	0	0	0	12
98	S	37	6	Seed	B	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	1	0	0	0	0	0	0	9
98	S	37	7	Seed	B	0	0	0	0	0	0	0	0	0	0	0	9	47	0	2	4	0	0	0	0	0	0	0	0	0	0	0
98	S	37	8	Seed	B	0	0	0	14	0	0	0	0	0	0	5	0	10	0	0	0	0	0	0	0	0	2	0	0	0	0	7
98	S	37	9	Seed	B	0	0	0	0	0	0	34	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	1	0	1
98	S	38	1	Seed	M	0	0	0	0	0	0	0	0	2	0	0	0	60	0	0	0	0	0	0	2	0	0	0	0	0	0	0
98	S	38	2	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	4
98	S	38	3	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0
98	S	38	4	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	S	38	5	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	5
98	S	38	6	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	7	0	0	0	0	0	0	0

Year	Season	Plot	sub	Seed?	Treatme	DICsp	ELYsp	STIsp	ARIsp	ANDglo	ANDvir	BOTsac	BOUcur	PANcap	PANvir	SCHsco	SOGnut	SPOsp	BOTisc	BROjap	SORhal	AMBart	HELann	ASTun	CROmo	EUPbic	AGAhet	VERbip	ERYlea	GAIpul	HELmax	XANdra
98	S	38	7	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
98	S	38	8	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	9	0	0	0	0	0	0	0
98	S	38	9	Seed	M	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	1
98	S	39	1	None	C	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	39	2	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	39	3	None	C	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	39	4	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	110	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	39	5	None	C	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	39	6	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	39	7	None	C	0	0	0	0	0	0	0	0	0	0	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	39	8	None	C	0	0	0	0	0	0	0	0	0	0	0	0	0	130	0	0	0	0	0	0	0	0	0	0	0	0	0
98	S	39	9	None	C	0	0	0	15	0	0	0	0	0	0	0	0	30	0	0	2	0	0	0	0	0	0	0	0	0	0	5

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Great Trinity Forest Management Plan

Grasslands

Seeding Rangeland

E-53

Seeding Rangeland

Tommy G. Welch, Barron S. Rector and James S. Alderson*

Soil and water conservation, high quality forage production for livestock and wildlife, revegetation of deteriorated rangeland and old cropland and obtaining a sustainable level of forage production are management goals which keep landowners and researchers investigating new and old plant materials for range seeding. Although production on some land may be improved by grazing management alone, most land requires grazing management, brush and weed control and/or seeding to restore production potential. This publication has been prepared to serve as a guide for seeding Texas rangelands.

The most common objective of rangeland seeding is to alter vegetation composition. This usually is done because of a need for more or higher quality forage. Occasionally a better seasonal balance of forage supply is needed. Other objectives met by altering vegetation composition through rangeland seeding include soil stabilization, improved water infiltration, improved vegetation ground cover for reduced water runoff, return to a prairie-like vegetation and improved wildlife habitats.

WHEN TO SEED

Since seeding rangeland is expensive and the risk of failure is always present, carefully consider seeding or allowing natural revegetation. When the management objective is to improve range condition, evaluate the quantity and distribution of current desirable plants. If desirable plants make up less than 10 to 15 percent of the vegetation, seeding probably is necessary. If desirable plants are uniformly distributed and make up more than 10 to 15 percent of the vegetation, use grazing management to improve range condition.

Often, however, another management decision dictates the necessity for seeding. For example, seeding usually is necessary following a brush control method, such as rootplowing, that destroys the existing turf. Also, when a better seasonal balance of forage supply is desired, seeding usually is required because the species needed to extend the period of green forage are not present. These plants often are introduced species and are seeded in pure stands.

In addition, seeding usually is the most effective way to establish desirable vegetation on abandoned cropland, since natural revegetation processes may take 50 to 100 years on land barren from farming. On other bare areas, such as newly constructed dams and newly laid pipelines, seeding to establish a plant cover often is necessary to prevent wind and water erosion.

WHERE TO SEED

Seed only those sites having sufficient potential to insure reasonable chances of success. First, survey the area to determine if there is a mixture of range sites or if one predominates; then, decide whether the sites are suitable for seeding. If the area is a mixture of sites, expend the most effort on ones with the best chance for success. Select seeding sites so the area can be incorporated into the overall ranch management.

Sites with sufficient soil depth for adequate root development and water storage or sites that can be modified mechanically to accomplish a greater effective soil depth usually are suitable. However, avoid barren, rocky sites, which have greater temperature extremes at the soil surface and are more droughty than sites with soil and litter on the surface. Low soil moisture and wide temperature extremes can kill plant seedlings.

Although the amount of precipitation received on an area cannot be controlled, select sites that receive runoff water, thereby increasing the amount of moisture available. However, do not disturb steep, potentially erosive areas.

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WHAT TO SEED

Plants selected for seeding depend on management objectives. For example, plants to improve range condition are different from those selected to stabilize a disturbed area or to extend the grazing season. However, regardless of management objective, select only species of plants that are adapted to the soil, climate and topography of the area to be seeded. If possible, choose plants that: (1) establish easily, (2) are palatable to animals that will graze the seeded area, (3) are relatively productive, (4) withstand invasion by undesirable plants, (5) withstand moderate grazing, (6) prevent erosion under moderate grazing and (7) are available at a moderate price.

Usually, plants best adapted to an area are native ones growing in the area, so it is important to determine the original source of seeds of native species. When available, use certified named varieties. Generally, seed of native species should originate from local sources or from within 200 miles north or south and 100 miles east or west of the area to be seeded. Recommended species and varieties for the various resource areas and soil groups are shown in Table 1. Consult local Soil Conservation Service personnel for information on seeding specific range sites, because some species are adapted to only certain range sites within a resource area.

Often, mixtures of native and/or introduced species are seeded on rangeland, partly as an attempt to simulate natural conditions. Using a mixture is helpful because all areas have variations in soil, moisture and slope, and each species in the mixture is adapted better than other species to certain site characteristics. For instance, variation in rooting habits of species in the mixture allows for more efficient use of moisture and nutrients from the various soil depths. Also, the mixture usually extends the grazing season because each species varies slightly in its period of lush growth and dormancy. Finally, a mixture provides a varied diet that often is more desirable to animals.

Under certain conditions, a pure stand of a single species is more desirable. Species low in palatability and needing special management, or species requiring intensive management, should be planted alone. In addition, many introduced species are easier to manage when planted in a pure stand.

Use seed of known quality. Know the germination and purity of the seed, since seeding rates are based on pure live seed.

HOW TO SEED

Seedbed Preparation

An ideal seedbed is firm below seeding depth, free from live, resident plant competition and has moderate amounts of mulch or plant residue on the soil surface. A major purpose of seedbed preparation is to reduce existing plant competition.

Plowing is the most common method of preparing a seedbed. A variety of plowing methods is available. The method selected depends on the type of vegetation to be controlled and the level of financial resources available. On abandoned cropland use a moldboard, offset disk or one-way. On a brush infested area, consider rootplowing.

Herbicides also may be used to control existing vegetation. After applying the herbicide, drill seeds of desired plants directly into the dead vegetative cover. Although this method of seedbed preparation seldom is used, it offers possibilities where wind erosion occurs.

In areas where wind or excessive heat is a problem, protect clean-tilled soil with a crop or dead litter crop. Sorghums, small grains and other cool season annual grasses make an excellent dead litter mulch. To prevent seed production in sorghum, plant it late in the growing season or harvest it, leaving the stubble for mulch. Small grains also may be used as a cover crop. After establishing the cover crop, drill or broadcast seeds of desired species into the stubble or mulch.

In some areas seedbeds have been successfully prepared by burning. For example, prescribed burning may reduce competition from certain perennial plants, allowing subsequently seeded species to establish more easily. Following a wildfire, seeding may be necessary to restore the area's productivity.

On abandoned cropland, an ideal seedbed may be prepared without undue expense, but on rangeland, the ideal seedbed is a goal seldom attained because expenses exceed expected returns. Even though preparing an ideal seedbed may not be economically feasible, prepare the best seedbed that available resources allow. On some brush-infested rangeland, rootplowing, followed by roller chopping, raking or chaining, is an acceptable method of seedbed preparation. Roller chopping usually is conducted before seeding. On potentially productive sites the expense of rootplowing, raking and plowing with an offset disk may be justified. In addition, smooth seedbeds allow for harvesting seed, and the income from seed sales could pay for seedbed preparation costs.

Timing

Choosing the correct time to seed is very important. Try to seed at the beginning of a period that will provide the best growing conditions (favorable temperatures and good soil moisture). In most cases, achieve the greatest success by seeding just before the season of expected high rainfall. Most parts of Texas receive significant rainfall in early to mid-spring; in those areas, warm season plants may be seeded successfully during late winter to early spring. The Trans-Pecos region usually receives its precipitation during mid to late summer, so seeding in midsummer may be best. In the more southern areas of the state where a rainfall peak occurs in the fall, seeding in late summer or early fall may allow seedlings time to become established before the winter season. In terms of temperature, many cool season plants may be seeded either in the spring or early fall, though late summer or fall normally is best because young seedlings may not tolerate hot, dry summers. On the other hand, warm season plants grow best if seeded in the spring.

Seeding Methods

The two most common methods of seeding rangeland are drill and broadcast. Drill methods place the seed in the soil; broadcast methods place the seed on the soil's surface.

Drilling is a superior method because the drill places the seed in the soil, thus improving the probability of seedling establishment. Use drills on old fields and on areas where a smooth seedbed has been prepared. A good drill has the following:

- Double disk opener to provide a trench with minimum soil movement.
- Depth bands for proper depth control.
- Packing mechanism to place seed more firmly in contact with soil.
- Seed boxes with agitators to keep seed mixed and prevent fluffy seed from lodging in box, separate boxes for large and small seed, divided or partitioned boxes to keep seed feeding to individual metering devices and a good metering device to control the amount of seed to be planted.

Since most drills are not sturdy enough to be used on rough rangeland, broadcast seeding often is used instead. However, broadcast seeding has limitations because seed are poorly covered with soil and stand establishment often is slower.

Broadcast the seed by aerial or ground application. Ground application includes broadcasting by hand, rotary spreader, with airstream or exhaust or seeder boxes of the fertilizer-spreader type. Aerial application is popular because it is faster. Aircraft must be equipped with a spreader and a positive, power-driven seed metering device.

Broadcast seeding seldom is effective without some soil disturbance before the seeding operation. Be sure to distribute seed uniformly. Small, slick seed lend themselves to broadcast seeding much better than fluffy seed, since small seed are easier to broadcast and are covered by natural sloughing of the soil.

Broadcast seeding is more successful if the seed are broadcast on loose, rough soil, where natural sloughing and settling will cover the seed, or when seeding is followed by harrowing, chaining or cultipacking. If the seedbed consists of large clods of soil, seed may be buried too deeply.

Seeding Rate

The quantity of seed to apply per acre depends upon the species, method of seeding and potential site productivity. Seeding rates usually are based on pounds of pure live seed (PLS) per acre. PLS is the percentage of the bulk seed material that is live seed. This is determined by multiplying percentage germination by percentage purity of the lot of seed. When hard seed are involved, PLS = (percent germination + percent hard seed) x percent purity.

Recommended seeding rates usually call for 20 live seed per square foot. The number of seed per pound varies with species. Table 1 gives the number of seed per pound and recommended seeding rates for species used in Texas.

Seeding Depth

Optimum seeding depth is roughly proportional to seed size. Since smaller seeds have a smaller quantity of stored energy, do not seed them as deeply as larger seed. As a rule, plant seed at a depth four to seven times the diameter of the seed. When using a mixture of small and large seed, determine the planting depth by the diameter of smallest seed. In most rangeland seedings, plant the seed about 1/4 to 1/2 inch deep but not deeper than 3/4 inch. Plantings can be deeper in light, sandy soils than in heavier, clay soils.

MANAGEMENT AFTER SEEDING

Protect a newly seeded area from grazing until plants are established. Some species establish sooner than others, but in general, plants should be well-rooted before grazing to prevent pulling up the seedlings. Length of deferment from grazing varies. In exceptionally good growing conditions, deferment through one growing season may be sufficient. During periods of harsh growing conditions, however, 2 or 3 years of deferment may be necessary. Grazing during dormant periods may help improve the stand by scattering and trampling seed into the soil. After plants are established, practice good grazing management to maintain the seeded stand.

Because seeded areas usually receive some type of soil disturbance, weeds or weedy species often become abundant during the growing season following seeding. Weed control measures such as mowing, shredding or use of herbicides may be necessary during the first growing season to allow seeded species to become established. Most grass seedlings can tolerate a herbicide application after the seedlings have reached the fourth leaf stage.

Table 1. Seed characteristics, seeding rates and adaptations of species used for seeding Texas rangeland.

Name	Variety[1]	Seeds per lb	Seeding rate[2] lb PLS per acre: Normal rows (40 in)	Seeding rate[2] lb PLS per acre: Drill (20 in or less) or broadcast	Ratings of adaptation[3] Tolerance: Drought	Cold	Salt	Soil: Sandy	Loam	Clay	Native (N) or Introduced (I)	4 Season of growth	Regional adaptation[5]: Coast Saline Prairie	Coast Prairie	East Texas Timberlands	Claypan Area	Blackland Prairie	East Cross Timbers	West Cross Timbers	Grand Prairie	North Central Prairies	Central Basin	Edwards Plateau	Northern Rio Grande Plain	Western Rio Grande Plain	Central Rio Grande Plain	Lower Rio Grande Valley	Rolling Plains	High Plains	Trans-Pecos	6 Minimum rainfall (inches)
Alkali sacaton (*Sporobolus airoides*)		1,750,000	0.4	1.0	2	1	1	3	2	1	N	W											X	X	X	X	X	X	X	X	10
	Saltalk				2	1	1	3	2	1	N	W				X		X	X		X							X	X		10
	Salado				1	1	1	3	2	1	N	W												X	X	X	X			X	10
Angleton bluestem (*Dichanthium aristatum*)		500,000	0.4	1.0	2	3	2	3	3	1	I	W		X																	30
Big bluestem[7] (*Andropogon gerardii*)		130,000	2.0	6.0	2	1	2	2	1	2	N	W	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	25
Black grama (*Bouteloua eriopoda*)	Nogal	1,335,000	0.5	1.5	1	2	3	1	1	3	N	W																	X	X	10
Blue grama (*Bouteloua gracilis*)		711,000 (spikelet)	0.5	1.5	1	1	2	2	1	1	N	W																X	X	X	10
	Lovington				1	1	2	2	1	1	N	W																X	X	X	10
	Hachita				1	1	2	2	1	1	N	W																X	X	X	10
Blue panicgrass (*Panicum antidotale*)		657,000	0.8	2.0	2	3	2	2	1	1	I	W									X	X	X	X	X	X	X	X	X	X	20
Boer lovegrass (*Eragrostis chloromelas*)		2,922,000	0.8	1.5	1	2	2	1	1	1	I	W																		X	10
	Catalina				1	2	2	1	1	1	I	W																		X	10
Buffelgrass (*Cenchrus ciliare*)	Common	225,000 bur or 867,000 grain	1.0	2.0	1	3	3	2	1	2	I	W												X	X	X	X				16
	Higgins[8]		0.5	1.5	1	3	3	2	1	2	I	W												X	X	X	X				16
	Nueces				1	3	3	2	1	2	I	W												X	X	X	X				16
	Llano				1	3	3	2	1	2	I	W												X	X	X	X				16
Buffalograss (*Buchloe dactyloides*)		42,000 bur or 275,000 grain	5.0	16.0	1	1	2	3	1	1	N	W					X	X	X	X	X	X	X					X	X		15
	Texoka		---	3.0	1	1	2	3	1	1	N	W					X	X	X	X	X	X	X					X	X		15
California cottontop (*Digitaria californica*)		1,092,000	0.4	1.2	2	2	2	2	1	2	N	W									X		X	X	X	X	X	X	X	X	15
Caucasian bluestem (*Bothriochloa caucasica*)		860,000	0.5	1.2	2	2	2	2	1	1	I	W				X	X	X	X	X	X	X	X					X	X		18
Common reed[9] (*Phragmites australis*)	Shoreline	Rhizomes 12 to 18 in long	1 to 1 1/2 rhizomes per foot of row		3	1	2	1	1	1	N	W	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	30
Eastern gamagrass (*Tripsacum dactyloides*)		7,200	10.0	20.0	1	1	3	2	1	1	N	W	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	20
	Pete	7,500	8.0	15.0	1	1	3	2	1	1	N	W		X	X	X	X	X	X				X	X	X	X	X	X			20
	Iuka	5,500-7,500	8.0	15.0	1	1	3	2	1	1	N	W		X	X	X	X	X	X				X	X	X	X	X	X			20
Engelmanndaisy (*Engelmannia pinnatifida*)	Eldorado	58,500	5.0	15.0	1	1	3	2	1	3	N	C				X	X	X	X	X	X	X	X	X		X	X	X	X		16
Gordo bluestem (*Dichanthium aristatum*)		500,000	0.5	1.2	2	2	2	3	2	1	I	W		X			X							X		X	X				25

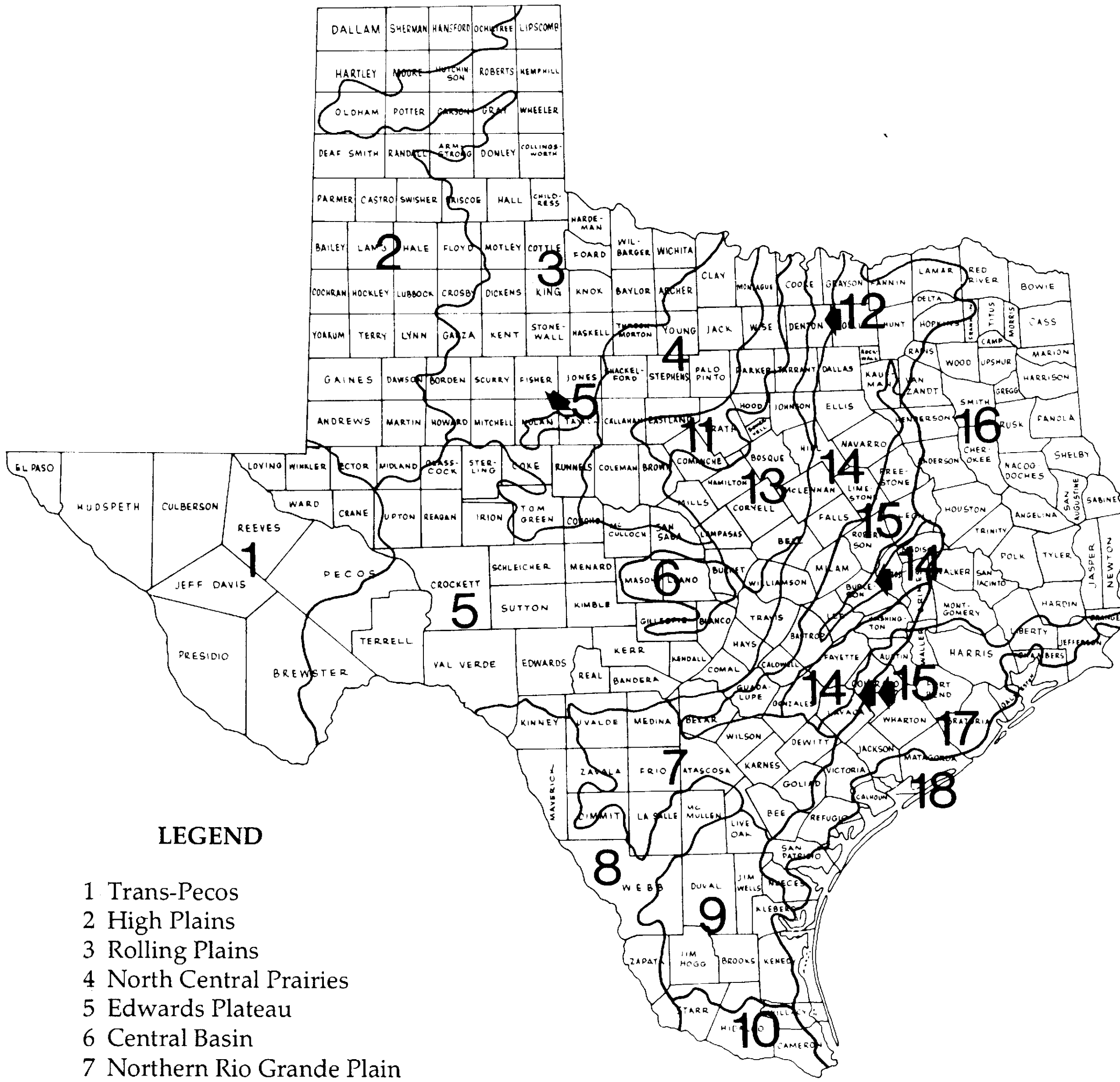
Green sprangletop (*Leptochloa dubia*)		538,000	0.7	1.7	1	1	2	1	1	2	N	W						X	X	X	X	X	X	X	X	X	X	X	X	X	10
	Van Horn	538,000			1	1	2	1	1	2	N	W						X	X	X	X	X	X	X	X	X	X	X	X	X	10
Illinois bundleflower (*Desmanthus illinoensis*)	Sabine	64,000	4.5	13.5	1	1	3	2	1	1	N	W		X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		16
Indiangrass[7] (*Sorghastrum nutans*)		170,000	1.5	4.5	3	1	2	1	1	2	N	W		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		16
	Cheyenne				3	1	2	1	1	2	N	W						X	X	X	X							X	X		16
	Lometa				3	1	2	1	1	2	N	W		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			22
King Ranch bluestem (*Bothriochloa ischaemum* var. *songarica*)		835,000	0.5	1.2	1	1	2	3	1	1	I	W		X		X	X	X	X	X	X	X	X	X	X	X	X	X			20
Kleberg bluestem (*Dichanthium annulatum*)		800,000	0.5	1.2	1	2	2	2	1	1	I	W		X		X	X			X		X	X	X	X	X	X				20
Kleingrass (*Panicum coloratum*)	Selection 75	500,000	0.5	1.5	2	3	2	2	1	1	I	W		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		20
	Verde	450,000	0.6	1.7	2	3	2	2	1	1	I	W		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		20
Lehmann lovegrass (*Eragrostis lehmanniana*)		4,245,000	0.5	1.5	1	3	2	1	1	2	I	W											X	X	X	X	X		X	X	10
(*E. lehmanniana* x *E. trichophora*)	Cochise				1	3	2	1	1	2	I	W											X	X	X	X	X		X	X	10
Little bluestem (*Schizachyrium scoparium*)		255,000	1.2	3.4	2	1	3	1	1	1	N	W		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	20
	Pastura				2	1	3	1	1	1	N	W																	X		16
	Cimarron				2	1	3	1	1	1	N	W																X	X		16
Maximilian sunflower (*Helianthus maximiliana*)	Aztec	320,000	---	0.25-1.0[10]	2	1	3	1	1	1	N	W		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		18
Medio bluestem (*Dichanthium aristatum*)		500,000	0.4	1.0	2	3	2	3	3	1	I	W	X				X							X	X	X	X				25
Old World bluestem (*Dichanthium* spp - *Bothriochloa* spp blend)	T-587	854,000	0.5	1.2	1	2	2	2	1	1	I	W		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	14
Plains bristlegrass (*Setaria leucopila*)		293,000	1.0	3.0	1	1	2	1	1	1	N	W				X					X	X	X	X	X	X	X	X	X	X	12
Rhodesgrass (*Chloris gayana*)	Bell	1,405,000 (spikelet)	0.4	1.0	2	3	1	2	1	1	I	W	X	X										X	X	X	X				20
Sand bluestem (*Andropogon gerardii* var. *paucipilus*)		125,000	2.0	6.0	2	1	3	1	2	3	N	W						X	X	X	X							X	X		18
	Woodward				2	1	3	1	2	3	N	W						X	X	X	X							X	X		18
	Elida				2	1	3	1	2	3	N	W																X	X		14
Sand dropseed (*Sporobolus cryptandrus*)		1,750,000	0.4	1.0	1	1	3	1	2	3	N	W	X	X	X	X	X	X	X	X	X	X	X		X						10

[1]Named varieties are adapted to regions checked. If a named variety is not listed, seed used should have a local origin or be from within 200 miles north or south and 100 miles east or west of site to be seeded. This is particularly important for widely adapted species.
[2]PLS = pure live seed = (percent germination + hard seed) x percent purity.
[3]Symbols for adaptation: 1 = good; 2 = fair; 3 = poor.
[4]Symbols: W = warm season; C = cool season.
[5]Land resource areas are shown in Figure 1. Consult local Soil Conservation Service personnel for information for seeding specific range sites because some species are adapted to only part of a resource area and/or to only certain range sites within a resource area.
[6]Extra moisture from runoff may substitute for rainfall. Figure 2 shows the average annual precipitation in Texas.
[7]These tallgrass species occur in resource areas listed. However, seed only on sites with high soil moisture potential such as bottomland range sites in the lower rainfall areas of the state.
[8]Higgins is better adapted to clay soil than other varieties. Nueces and Llano are more cold tolerant than Common and Higgins.
[9]Common reed is used at waterline on farm ponds and watershed dams for stabilization. When used at waterline, use anywhere in the state regardless of quantity of rainfall.
[10]Low rate for range seedings. High rate for wildlife block seedings.

Table 1. Seed characteristics, seeding rates and adaptations of species used for seeding Texas rangeland (concluded).

Name	Variety[1]	Seeds per lb	Seeding rate[2] lb PLS per acre: Normal rows (40 in)	Seeding rate[2] lb PLS per acre: Drill (20 in or less) or broadcast	Ratings of adaptation[3] Tolerance: Drought	Tolerance: Cold	Tolerance: Salt	Soil: Sandy	Soil: Loam	Soil: Clay	Native (N) or Introduced (I)	4 Season of growth	Regional adaptation[5]: Coast Saline Prairie	Coast Prairie	East Texas Timberlands	Claypan Area	Blackland Prairie	East Cross Timbers	West Cross Timbers	Grand Prairie	North Central Prairies	Central Basin	Edwards Plateau	Northern Rio Grande Plain	Western Rio Grande Plain	Central Rio Grande Plain	Lower Rio Grande Valley	Rolling Plains	High Plains	Trans-Pecos	6 Minimum rainfall (inches)
Sand lovegrass		1,300,000	0.5	1.5	1	1	3	1	2	3	N	W						X	X	X	X							X	X		18
(*Eragrostis trichodes*)	Mason	2,000,000			1	2	3	1	2	3	N	W						X	X	X	X	X	X	X	X			X	X		18
Sideoats grama		143,000	1.5	4.5	2	1	2	2	1	1	N	W				X	X	X	X	X	X	X	X	X	X	X		X	X	X	14
(*Bouteloua curtipendula*)	Haskell	(spikelet)			2	1	2	2	1	1	N	W			X	X	X	X	X	X	X	X	X	X	X	X		X	X		14
	Premier				2	1	2	2	1	1	N	W											X					X	X	X	14
	El Reno				2	1	2	2	1	1	N	W						X	X	X	X		X					X	X		14
	Niner				2	1	2	2	1	1	N	W											X					X	X	X	14
	Vaughn				2	1	2	2	1	1	N	W																	X		14
	Uvalde				2	1	2	2	1	1	N	W										X	X	X	X						18
Sorghum almum (*Sorghum almum*)		90,000	---	2.0 15.0[11]	2	2	2	2	1	1	I	W		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	18
Switchgrass[7]		389,000	1.2	3.5	2	1	2	1	1	1	N	W		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	20
(*Panicum virgatum*)	Alamo	427,365	0.8	2.0	2	1	2	1	1	1	N	W		X	X	X	X	X	X	X	X	X		X				X			25
	Blackwell	389,000	1.2	3.5	2	1	2	1	1	2	N	W					X	X	X	X	X							X	X		20
	Caddo	389,000	1.2	3.5	2	1	2	1	1	2	N	W					X	X	X	X	X							X	X		20
	Grenville	389,000	1.2	3.5	2	1	2	1	1	2	N	W																X	X		20
	Kanlow[12]	389,000	1.2	3.5	3	1	2	1	1	1	N	W					X	X	X	X	X							X	X		25
Weeping lovegrass		1,500,000	0.5	1.5	2	2	2	1	1	1	I	W			X	X	X	X	X	X	X			X				X	X		16
(*Eragrostis curvula*)	Ermelo				2	2	2	1	1	1	I	W			X	X	X	X	X	X	X			X				X	X		16
	Morpa				2	2	2	1	1	1	I	W			X	X	X	X	X	X	X			X				X	X		16
	Renner				2	2	2	1	1	1	I	W			X	X	X	X	X	X	X			X				X	X		16
Western wheatgrass		110,000	2.4	7.0	2	1	1	3	1	1	N	C																X	X		16
(*Agropyron smithii*)	Amba				2	1	1	3	1	1	N	C																	X		16
	Barton				2	1	1	3	1	1	N	C																	X		16
Wilman lovegrass (*Eragrostis superba*)	Palar	1,103,000	0.5	1.5	1	3	2	1	1	2	I	W										X	X	X	X	X				X	10
Yellow bluestem	Plains	830,000	0.6	1.8	2	1	2	2	1	2	I	W			X	X	X	X	X	X	X							X	X		18
(*Bothriochloa ischaemum*	Ganada				2	1	2	2	1	2	I	W																X	X	X	10
var. *ischaemum*)	WW Spar				2	1	2	2	1	2	I	W			X	X	X	X	X	X	X							X	X		18
	WW Iron-master[13]				2	1	2	2	1	2	I	W			X	X	X	X	X	X	X								X	X	18

[11]Low rate is for seeding with rangeland mixture
[12]Adapted to lowlands receiving extra moisture from rainfall
[13]Use only if iron is deficient in the soil



LEGEND

1 Trans-Pecos
2 High Plains
3 Rolling Plains
4 North Central Prairies
5 Edwards Plateau
6 Central Basin
7 Northern Rio Grande Plain
8 Western Rio Grande Plain
9 Central Rio Grande Plain
10 Lower Rio Grande Valley
11 West Cross Timbers
12 East Cross Timbers
13 Grand Prairie
14 Blackland Prairie
15 Claypan Area
16 East Texas Timberlands
17 Coast Prairie
18 Coast Saline Prairies

Figure 1. Land resource areas.

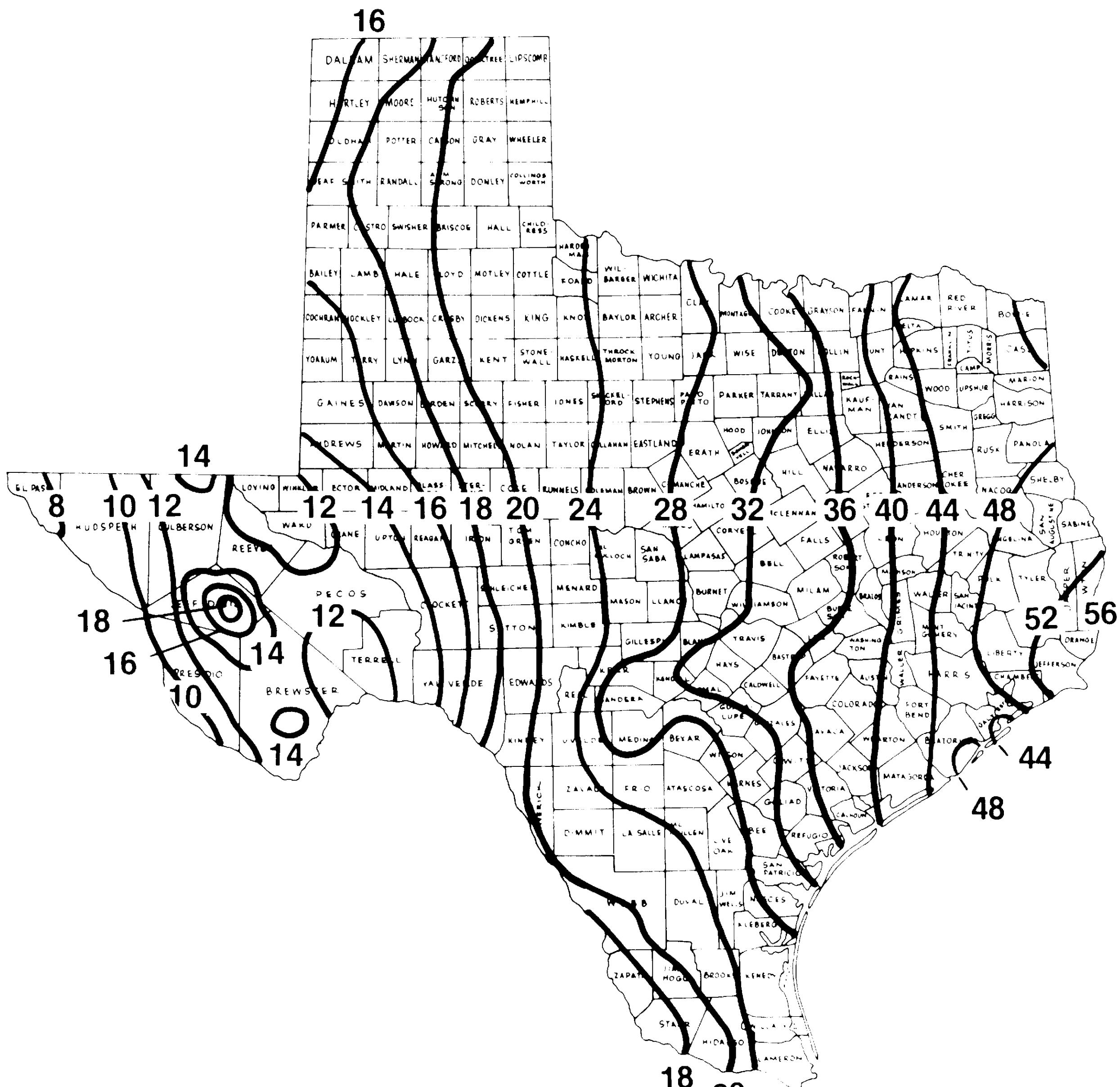


Figure 2. Mean annual total precipitation in Texas.

SUMMARY

For a successful seeding:

- Select proper site
- Select proper plant species
- Prepare adequate seedbed
- Plant during correct season
- Plant correct quantity of seed
- Plant seed at proper depth
- Allow seeded plants to establish
- Practice proper grazing management

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12M—4-93, Revision RS 4

Great Trinity Forest Management Plan

Grasslands

Rangeland Risk Management for Texans: Seeding Rangeland

E-117
10-00

Texas Agricultural Extension Service
THE TEXAS A&M UNIVERSITY SYSTEM

Seeding Rangeland

Barron S. Rector
Associate Professor and Extension Range Specialist, The Texas A&M University System

Sustaining natural resources and productive environments, such as Texas rangelands, requires skilled, science-based management. Range seeding is a management tool that can help you develop, alter and improve the range ecosystem. Range seeding is expensive and there is always some risk of failure. In many cases, though, seeding may be the most practical and environmentally sound practice for restoring rangelands and missing ecosystem functions.

The objective of range seeding is usually to alter the composition of vegetation so that the productivity of the land, especially its livestock grazing capacity, will increase. Restoring the production potential of deteriorated rangeland is attractive to ranchers whose operations are not profitable. However, seeding is not a cure for bad management or a substitute for good management. Managers must assess the causes of rangeland deterioration and address them. Seeding alone will not solve problems that previous management has created, nor is seeding always profitable in terms of forage produced.

Sometimes the objective of seeding is to revegetate barren or abandoned croplands, revegetate land after a prescribed fire, create a better seasonal balance in the forage supply, improve the quality and quantity of forage, reestablish native plants, or establish ground cover to prevent soil erosion and water runoff. Seeding can be a good tool for achieving these objectives.

What does a successful seeding look like? There are various opinions. The seeding rate for native grasses is 20 live seed planted per square foot, with a goal (when the objective is range improvement and land restoration) of two established plants per square foot, or 10 percent. Purchase seed on a pure live seed (PSL) basis. Some people may define a successful seeding as simply the introduction of a new plant species. Others may expect a successful seeding to resemble a planted row crop field. Whatever your expectation, there is a good chance that the seeded area will not look quite as you envisioned, at least not right away. Managers need patience, because grass seed may germinate over several years. Native grasses such as big bluestem may require 3 years or longer to become fully established.

Requirements for Successful Seeding

The greatest risk in range seeding lies in our inability to predict rainfall and other conditions at planting and during the establishment period. The chance of success decreases dramatically the farther west and north you go, because of low rainfall. You can expect a high rate of success where annual rainfall exceeds 35 inches, but in the Trans Pecos region of Texas seeding may be successful only one year in five. There are other risks associated with the planting process and the selection of seed. A complete discussion of rangeland seeding can be found in Extension publication B-1379, “Seeding Rangeland.”

1) **Deciding to seed.**
Determining whether rangeland can be restored by natural means or will require seeding is a matter of judgement. Improved management alone, particularly with livestock grazing, can restore some depleted ranges. Generally, if more than 10 percent of the vegetation is desirable native species, a manager can rely on natural succession. But the manager must understand the cause or causes of range deterioration and know how to manage the land during the natural revegetation process. Seeding may be the best tool if not enough desirable native plants remain on the land. Allowing natural processes to occur may be cheaper than seeding, but it will likely take many years for deteriorated grazing or farming lands to recover. The outcome is also uncertain because the vegetative mix is unpredictable. The fact is, abused lands may never return to their historical state because of soil loss and other conditions. We often have to accept what we get and adjust our management to actual conditions. We do not have enough money to change nature.

2) **Grass mixture versus monoculture.**
Because many landowners have one goal in mind, they do not always consider the effects land management practices may have on other aspects of the ecosystem. Loss of vegetation diversity will lead to a loss of wildlife diversity and threaten the sustainability of natural ecological functions. Planting a monoculture, or single species, can fragment wildlife habitat. It may be easier to plant and manage just one or a few plant species; it may even be easier in the short term to manage livestock with a monoculture. However, when a mixture of plants is seeded the benefits are better ground cover, a more varied diet for animals, and less risk in getting a stand established if the soil is heterogeneous. A diverse plant community is much more resilient to drought, insects and diseases than a monoculture. Planting a mixture of grasses and other kinds of plants gives the manager greater flexibility in using the land.

3) **Moisture.**
Successful seeding requires planning. To capitalize on moisture cycles, seeding should take place when the soil contains enough moisture for seeds to germinate

and plants to become established. For native, warm-season, perennial grasses, the best planting time usually is March and early April. Plans for seeding should be canceled if there is insufficient moisture in the soil at planting or if the long-range forecast is for inadequate rainfall. Seedling grasses need 29 to 30 days of appropriate temperature and moisture to establish good root systems and store nutrients so that they can survive the next dry period or dormant season.

4) **Seed selection.**
Finding appropriate seed is sometimes difficult. Seeds are not available for all species and varieties of native plants. If you plant varieties not adapted to your area, your risk of failure will be much greater. Non-adapted varieties may not perform satisfactorily, may go dormant earlier, green up later, and be more prone to damage from frost, drought or extremely wet weather. If you plan to plant native grasses, be sure to select seed varieties that originated no more than 200 miles north or south and 100 miles east or west of your area. Ask your seed dealer about the origin of seed.

5) **Native versus non-native plants.**
Native plants are usually preferable to non-native plants. Introduced plant species often become invasive weeds that compete with native plants. Planting non-native species increases the risk associated with rangeland seeding, especially if the manager does not understand the properties of the plants. Many of the introduced grasses on rangelands today were selected for their resistance to overgrazing, but are extremely competitive with native plants and have become pests. Examples include Johnsongrass, perennial ryegrass, Bahiagrass, common bermudagrass, King Ranch bluestem, Old World bluestem, medusahead, cheatgrass and Caucasian bluestem. Similar results have occurred with introduced forbs, legumes and trees such as Kudzu, Chinese tallowtree, kochia, Korean lespedeza, yellow sweetclover, Russian olive, lantana and salt cedar.

6) **Planting method.**
Because it is important that seeds have good contact with the soil, drilling seed is the most successful planting method. If drilling is not practical, soil/seed contact can be improved by disturbing the soil with roller chopping or “lite” raking before seed is broadcast. Seeding often follows brush control treatments, especially root plowing. The least successful planting method is aerial seeding, but it may be the only practical way of seeding large or rough areas. Native grass seeds are small and are generally planted from 1/8 to 1/4 inch deep. Planting seeds deeper makes it hard for seedlings to reach the surface and may result in a weak stand.

7) **Land preparation.**
If plowed sites are to be seeded, they should be given time to firm up before planting. Otherwise, the seedbed will not provide adequate soil/seed contact. Seeding in loose, air-filled soils may cause low seedling survival. If seeding is to be done in March or April, the seedbed should be prepared in late August or September to allow time for natural settling and firming of the soil.

8) **Weed control.**
When soil is disturbed for planting, it is natural for weeds to germinate and grow along with the native plants that were seeded. You can reduce the competition from weeds by disking between seeded rows or using herbicides to control them. There is less risk of injuring seedling grasses if chemicals are not used until young grasses reach the four- to six-leaf stage of growth.

Range seeding is risky. Plan accordingly and be prepared to adjust your management to prevent future crises. To get the most benefit from seeding you may need to shift your overall management of the land resource. Areas seeded with native grasses usually require better grazing management and at least a 1-year deferment from grazing during the establishment phase.

Other publications in this series:

L-5368, Making Better Decisions
L-5371, Common Grazing Management Mistakes
L-5377, Forage Quality and Quantity
L-5370, Drought
L-5369, Toxic Plants
L-5372, Types of Risk
L-5373, Will You Succeed as a Rangeland Manager?
L-5374, Rangeland Health and Sustainability
L-5375, Common Brush and Weed Management Mistakes

For further information:

B-1379, Seeding Rangeland, Texas Agricultural Extension Service.

For additional range management information see: http://texnat.tamu.edu

For additional risk management information see: http://trmep.tamu.edu

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1M, New

Great Trinity Forest Management Plan

Grasslands

Descriptions of Range and Pasture Plants

DESCRIPTIONS OF RANGE AND PASTURE PLANTS

B. J. Ragsdale and T. G. Welch*

THE MOST pronounced identifying characteristics for the 122 plants listed in RS 1.044 *Master Plant List for Texas Range and Pasture Plant Identification Contests* are described in this publication. Other sources should be used to acquaint contestants with more detailed individual characteristics that you use when training plant identification teams.

GRASSES

1. Alkali sacaton *(Sporobolus airoides)* This coarse-stemmed bunchgrass, 12 to 36 inches tall, grows in tough clumps with no rhizomes. The long, slender blades have hairs at the throat. The loosely flowered panicle is pyramid shaped. Spikelets are one-flowered on short pedicels. It grows in meadows and valleys, especially in alkaline soil. This grass, desirable to seed in salted-out sites, is relished by jackrabbits. It is adapted for vegetational areas 2, 6, 7, 8, 9 and 10 and is a perennial, warm, native grass that provides poor grazing for wildlife; fair grazing for livestock.

2. Bahiagrass *(Paspalum notatum)* This 8- to 16-inch tall bunchgrass with erect stems often has thick, scaly rhizomes. Leaves generally are hairless. Inflorescence usually has two spike-like branches, 1½ to 4½ inches long, paired at the tip of the stem, one slightly below the other. This grass grows in vegetational areas 1 and 2 in sites with adequate moisture and is a perennial, warm, introduced forage and hay grass that provides fair grazing for livestock but poor grazing for wildlife.

3. Barnyardgrass *(Echinochloa crusgalli* var. *crusgalli)* This 12- to 48-inch grass has stout stems that grow from a somewhat decumbent base. Leaf sheaths are smooth with long, flat blades. The 2- to 5-inch long panicle usually is erect, but can be nodding. The racemes usually spread with maturity. Spikelets may have long awns with each floret covered with short spines. Seeds furnish some food for ground birds. This invading plant seldom is grazed by any animal and grows mostly in moist, poorly drained regions of areas 1 through 10. An annual, warm, introduced grass, Barnyardgrass provides poor grazing for wildlife and livestock.

4. Beaked panicum *(Panicum anceps)* This 18- to 48-inch tall bunchgrass has stems growing from numerous scaly rhizomes. Sheaths are slightly hairy, with long leaves that are hairy on the upper part near the base. The panicle is long and spreading, with spikelets slightly curved and resembling a beak. This very palatable grass decreases with heavy grazing and grows mostly on sandy soils in areas 1, 2, 3 and 4. This perennial, warm native provides fair grazing for wildlife; good grazing for livestock.

5. Bermudagrass *(Cynodon dactylon)* This 4- to 12-inch tall, dark bluish-green sodgrass has rhizomes and stolons that take root at nodes. Internodes are flattened and the ligule is a conspicuous ring of white hairs. The inflorescence has three to six purple spikes, resembling a bird's foot. This common lawn and pasture grass of the South is adapted in areas 1 through 10 and is a perennial, warm, introduced grass that provides poor grazing for wildlife; good grazing for livestock.

6. Big bluestem *(Andropogon gerardii)* A 36- to 60-inch tall bunchgrass that grows from short rootstocks, big bluestem produces tall, slim culms. The lower sheaths and leaves usually are fuzzy and very hairy. Seedheads usually come out in three branches like a turkey foot. The ligule extends across the leaf collar. This grass, preferred by cattle, decreases with overgrazing, matures seed in fall and grows mostly in bottomland in areas 1 through 10. This perennial, warm native provides poor grazing for wildlife; good grazing for livestock.

7. Big cenchrus *(Cenchrus myosuroides)* This 36- to 60-inch tall bunchgrass has smooth stout stems growing from a decumbent base. The inflorescence is 2½ to 6 inches long with each spikelet as a one-flowered bur with the bristle united at the base. The outer bristles are shorter, the inner as long as the spikelet. It grows on a variety of soils from sands to clays and decreases with heavy grazing. This is a good grass for seeding old fields and denuded rangelands where cattle are to be grazed. The spiny spikelets will cling to wool and mohair. This perennial, warm, native grass is adapted in areas 2 and 6 and provides fair grazing for wildlife; good grazing for livestock.

8. Black grama *(Bouteloua eriopoda)* This 12- to 24-inch tall grass has weak, crooked, slender, woolly stems which often take root at the swollen fuzzy joints. The internodes usually are green during winter. The seedhead contains three to eight narrow spikes. Black grama is a good source of vitamin A during winter. This grass decreases with heavy grazing, grows on gravelly uplands in areas 7, 8, 9 and 10 and is a perennial, warm native that provides good grazing for wildlife and livestock.

9. Blue grama *(Bouteloua gracilis)* A 12- to 24-inch tall, tufted and erect grass, blue grama sometimes forms a sod. The inflorescence usually has two rooster comb-like spikes that curve downward when mature, with no

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stinger. Blue grama decreases with heavy grazing, grows on plains and hills in areas 7, 8, 9 and 10 and is a perennial, warm native that provides good grazing for wildlife and livestock.

10. Blue panicum *(Panicum antidotale)* This 48-to 54-inch tall bunchgrass has coarse stems growing from a dense crown of thick, short, bulbous rhizomes. The lower part of the stem has large nodes and internodes with branches coming from the nodes. Leaves are abundant, 7 to 12 inches long and flat with a heavy midrib on the lower side. Terminal panicles are long, loose, open and usually erect, but slightly drooping at maturity. The spikelets are greenish-yellow, very slick and shiny in appearance and are borne on the tip end of rather long seed branches. Most forage production is obtained when blue panicum is managed as a pasture plant. It grows on clay loam soils in areas 2 through 10 and is a perennial, warm, introduced grass that provides good grazing for wildlife and livestock. It can cause prussic acid poisoning in livestock at certain stages of growth.

11. Broomsedge bluestem *(Andropogon virginicus)* This 24- to 48-inch tall bunchgrass grows in small tufts with overlapping flattened sheaths, hairy along the margin of the upper blade surface toward the base. The upper two-thirds of the plant freely branches. Foliage is straw yellow when mature. Seedheads are partly enclosed in a sheath (spathe). Broomsedge bluestem is seldom grazed by any kind of animal. It grows mostly on upland woodland and invades overgrazed ranges in areas 1, 2, 3 and 6. This perennial, warm native provides poor grazing for wildlife and livestock.

12. Brownseed paspalum *(Paspalum plicatulum)* This 18- to 36-inch tall bunchgrass has purplish, compressed culms and sheaths. Spikelets are graygreen, turning dark brown and shiny when ripe. It resembles dallisgrass, but blades are narrower, racemes are shorter and fruit is not covered with silky hairs. It grows in savannahs in moist, sandy or clay soils in areas 1, 2, 3, 4 and 6 and is a perennial, warm native that provides fair grazing for wildlife and livestock.

13. Buffalograss *(Buchloe dactyloides)* This sod-forming grass grows 4 to 12 inches tall and has creeping surface runners that take root at the leafy nodes. The nodes are smooth and internodes are 2 to 2½ inches long, flattened and shorter than in common curlymesquite. Foliage turns reddish brown when frosted. Male and female plants grow in separate patches or colonies. Female plants bear seed in bur-like clusters among the leaves, while the male plants have a 2- or 3-spiked flag-like seedhead. It grows on plains and prairies in areas 1 through 10 and produces seed throughout the year. This perennial, warm native provides fair grazing for wildlife; good grazing for livestock.

14. Buffelgrass *(Cenchrus ciliaris)* This tufted buchgrass grows 20 to 40 inches tall with stems erect or spreading. The inflorescence is a dense, cylindrical panicle, 2 to 2½ inches long. Bristles of the "burs" are purplish and fused together at the base. Buffelgrass grows in areas 2, 3, 6, 7 and 10. It is a perennial, warm, introduced grass that provides good grazing for livestock; poor grazing for wildlife.

15. Burrograss *(Scleropogon brevifolius)* This 6- to 12-inch sodgrass grows from fuzzy, scaly rhizomes, but also with stolons that take root at nodes. Male and female plants grow in patches. The female resembles a threeawn and varies from pale green to reddish purple. The male has pale, overlapping, awnless spikelets. This grass, which increases on overstocked ranges and sterile soil, grows in semi-arid plains and valleys in areas 7, 8, 9 and 10. A perennial, warm, native grass, burrograss provides poor grazing for wildlife and livestock.

16. Bush muhly *(Muhlenbergia porteri)* This grass grows 6 to 24 inches tall, forming large bunches of tangled stems and leaves and growing most commonly under the protection of thorny brush. The mass of growth often resembles a bird's nest. Blades and stems are short and fine with the blades falling from the sheath after maturity. The inflorescence is 2 to 4 inches long, purplish to white, with single, short-awned florets borne on short pedicels. It decreases with heavy grazing and grows on hills, mesas and plains under protection of brushy plants in areas 6, 7, 8, 9 and 10. This perennial, warm native provides poor grazing for wildlife; good grazing for livestock.

17. California cottontop *(Digitaria californica)* This bunchgrass grows 12 to 48 inches tall, with hard, round stems growing from a knotty, swollen, felty, hairy base. The leaves are 3 to 5 inches long and flat; they do not clasp the stem firmly. The panicle is 2 to 5 inches long with white, purplish hairs exceeding the spikelets in length, giving the entire seedhead a cottony appearance. This grass, palatable throughout the year, is frequently overgrazed but responds readily to deferment. It grows on a wide variety of soils in areas 4 through 10. This perennial, warm, native grass provides fair grazing for wildlife; good grazing for livestock.

18. Canada wildrye *(Elymus canadensis)* This 24- to 48-inch tall bunchgrass has wide blades and an awned spike seedhead resembling wheat or barley which drops or nods when mature. Spikelets are in pairs, glumes are straight at the base and awns are more than twice as long as the lemma. Leaves are held to the stem by auricles. This perennial, cool, native grass grows in areas 2, 3, 7, 8, 9 and 10 and provides fair grazing for wildlife; good grazing for livestock.

19. Cane bluestem *(Bothriochloa barbinodis* var. *barbinodis)* This coarse bunchgrass grows 23 to 52 inches tall with stems that are usually erect, but sometimes bent at the base. Stem nodes are bearded. Panicles are narrow, contracted, dense, mostly 2½ to 5 inches long, often partially enclosed and with numerous branches, mostly 1½ to 3½ inches long. The lemma awn is ¾ to 1¼ inches long. Cane bluestem grows in areas 2, 5, 6, 7, 8, 9 and 10 and is a perennial, warm native that provides poor grazing for wildlife; fair grazing for livestock.

20. Common carpetgrass *(Axonopus affinis)* This sodgrass grows 12 to 30 inches tall, with flat stems and stolons and bearing flat, short, rounded blades. Plants take root at nodes. Seedheads of 2 or 3 racemes are formed on long, slender stems. Spikelets are fuzzy and not over 1/10 inch long. It grows best on bottomland soils and is managed as a pasture plant in areas 1, 2 and 3. It is a perennial, warm native which provides fair grazing for wildlife and livestock.

21. Common curlymesquite *(Hilaria belangeri)* This pale green, sodforming grass grows 4 to 10 inches tall with creeping surface runners which take root at the leafy nodes. The runners are long, wiry, rough-feeling and have hair at the nodes (buffalograss is smooth). Blades are densely tufted and curly. Foliage turns yellow when mature. The single spike-like seedhead is zig-zag when florets fall. It withstands heavy grazing but is not drouth resistant. This perennial, warm native grows on plains and prairies in areas 2 through 10 and provides poor grazing for wildlife; fair grazing for livestock.

22. Dallisgrass *(Paspalum dilatatum)* This tall bunchgrass grows 12 to 48 inches tall, erect or widely spreading, from a decumbent base with short, knotted rhizomes. Culms are knee-like at the base; nodes usually are dark and swollen. Blades are more than ½ inch wide. The long, extended, nodding panicles have three to five racemes, with long hairs at the axils. Spikelets are in pairs on short pedicels and look like four rows of seed. Seeds are covered with fine, silky hairs and resemble tomato seeds. Dallisgrass grows most abundantly in bottomland pastures that are properly managed in areas 1 through 4. This perennial, warm, introduced grass provides fair grazing for wildlife; good grazing for livestock.

23. Eastern gamagrass *(Tripsacum dactyloides)* This 36- to 72-inch tall bunchgrass has robust stems, flattened at the purplish base and growing from stout, scaly rhizomes resembling white grubs. Blades are ½ to 1 inch wide with rough or sharp margins. The inflorescence has one to three spikes, sometimes a foot long with male spikelets above and female spikelets below. Male spikelets grow in pairs, fitting into the hollows of the rachis. Female spikelets are oval and hard, breaking into boney joints at maturity. This grass is closely kin to corn, but has both male and female parts in the same spike. It grows in fertile bottomland soil, in swamps and along stream banks in areas 1, 2, 3, 4, 5, 7, 8, 9 and 10. It is a perennial, warm native that provides fair grazing for wildlife; good grazing for livestock.

24. Fall witchgrass *(Leptoloma cognatum)* This bunchgrass grows 12 to 30 inches tall with freely branching stems and felty pubsecence below. The short, rigid, flat blades have white edges with one edge often crinkled. The inflorescence resembles a lovegrass, but single, fuzzy seeds are borne at the end of short branches. The seedhead breaks off at maturity, forming tumbleweeds. It grows on dry, rocky or sandy soils in areas 1 through 10. It is a perennial, warm native that provides fair grazing for wildlife and livestock.

25. Green sprangletop *(Leptochloa dubia)* This bunchgrass grows 12 to 36 inches tall with flat base stems and flat sheaths. Stems are wiry with slightly rough leaves. The large, green sprangled panicle is composed of five to 12 spikes and droops and pales after maturity. Spikelets overlap on short pedicels and are 4- to 8-flowered. It is a good grass to include in native grass mixtures when seeding overused ranges, is a very palatable grass and grows on rocky hills and canyons in areas 2 and 4 through 10. It is a perennial, warm native that provides fair grazing for wildlife; good grazing for livestock.

26. Gulf cordgrass *(Spartina spartinae)* This 36- to 72-inch tall bunchgrass has stout, coarse stems growing from a crown of dense tufts. Leaf blades are narrow and the edges roll inward, making them appear as a heavy cord. The inflorescence is short and compact, making it appear as a cylinder. Florets are closely fitted together on opposite sides of the axis. The glumes have short, bristly hairs on the margin. It grows abundantly on saline soils in areas 2 and 6 and is a perennial, warm native that provides poor grazing for wildlife; fair grazing for livestock.

27. Hairy grama *(Bouteloua hirsuta)* This tufted, erect bunchgrass grows 6 to 30 inches tall. It has hairy glumes with black awns. Leaf blades are hairy on the margins, especially at the base. The 2 to 4 rooster comb-like spikes have a stinger. Hairy grama grows on rocky hills and plains in areas 1 through 10 and is a perennial, warm native that provides fair grazing for wildlife and livestock.

28. Hairy tridens *(Erioneuron pilosum)* This low, tufted grass grows 4 to 12 inches tall and usually has only one node above the basal cluster of leaves. Leaves have whitish margins and are abruptly pointed at the tip. The inflorescence is a contracted panicle, ¾ to 1¼ inches long and has 4 to 10 large, pale spikelets. It is found in all vegetational areas except 1 and 3, is a perennial, warm native and is rated poor grazing for livestock and wildlife.

29. Hall panicum *(Panicum hallii* var. *hallii)* This 12- to 24-inch tall grass grows in small, erect tufts and has slick, flat, green blades. The basal blades are slick and flat and turn curly when dry, resembling pine shavings. The panicle ascends above ½- to 8-inch long leaves. The single-seeded spikelets are borne on very short pedicels. Seed turn dark brown and shiny when ripe. Hall panicum grows in all areas except 1 and is a perennial, warm native that provides fair grazing for livestock and wildlife.

30. Hooded windmillgrass *(Chloris cucullata)* This tufted, erect bunchgrass grows 12 to 24 inches tall with flat, bluish-green stems and sheaths. It sometimes has short stolons. The inflorescence has seven to 18 stout, purplish, terminal spikes which turn straw yellow or black when ripe. It increases on overgrazed ranges following deferment, but is replaced by better grasses. It grows on upland sandy soil in areas 2 and 5 through 10, is a perennial, warm native and provides fair grazing for wildlife; fair grazing for livestock.

31. Inland saltgrass *(Distichlis spicata* var. *stricta)* This 6- to 24-inch tall, erect, coarse sodgrass grows from creeping, scaly rootstocks. Blades are short, rigid and pointed. Male and female spikelets are borne separately. It grows in alkaline sites in areas 7 through 10 and is a perennial, warm native that provides poor grazing for wildlife; fair grazing for livestock.

32. Johnsongrass *(Sorghum halepense)* This 36- to 72-inch tall bunchgrass grows from extensively creeping, scaly rhizomes. Blades are flat, blue-green and often splotched with purple, which is caused by a bacterial disease. The large, open panicles have branchlets, mostly in whorls of four. The awns soon fall, leaving shiny, fuzzy fruit. It grows in fields and waste places in areas 1 through 10. It is a perennial, warm, introduced grass that provides fair grazing for wildlife; good grazing for livestock. Under certain growth conditions, it produces prussic acid which is poisonous to livestock.

33. King Ranch bluestem *(Bothriochloa ischaemum* var. *songarica)* This 18- to 48-inch tall bunchgrass has stems growing from a flat crown. The stems turn upward and are freely branching. The leaves have long, silky hairs on the upper surface and are thicker near the collar. The top part of the stem is naked, producing a terminal, loose seedhead. Branches have fine, silky hairs with slender, twisted, bent awns. It grows in areas 1 through 10 and is a perennial, warm, introduced grass that provides fair grazing for wildlife and livestock.

34. Kleingrass *(Panicum coloratum)* This tufted grass grows 23 to 54 inches tall from firm, often knotty bases and has erect leaves. Stem nodes are hairless; sheaths and blades may be hairless or may have stiff, swollen-based hairs. The inflorescence is an open panicle. It is seeded in areas 5 through 8. It is a perennial, warm introduced grass that provides fair grazing for wildlife; good grazing for livestock. Under certain conditions, Kleingrass may cause photosensitization in sheep and goats.

35. Knotroot bristlegrass *(Setaria geniculata)* This 12- to 36-inch bunchgrass has erect or spreading stems growing from a bent, knee-like base. The stems arise from short, knotty, underground rootstocks. Blades and stems often have a purplish tinge. Blades are straight, flat and not twisted, longpointed at the tip and tapering toward the base. The seedhead is erect; 1 to 3 inches long; 1/4 inch wide; rounded at the top; and green, yellowish or purple in color. There are five or more bristles below each egg-shaped spikelet. Yellow bristlegrass has the same general appearance except it is an annual with no rootstock and has twisted leaves. Knotroot bristlegrass grows on open ground, cultivated soil and moist places in areas 1 through 10. It is a perennial, warm native that provides fair grazing for wildlife and livestock.

36. Little barley *(Hordeum pusillum)* This 5- to 15-inch tall grass has stems growing from small tufts. Leaf blades are flat, erect and straight until near maturity. There are no auricles at the junction of the leaf blade and sheath as in other species of *Hordeum*. The inflorescence is a dense, bristly spike, 3/4 to 2 inches long and usually yellowish in color. It invades rangeland rapidly when grasses are grazed short. It grows in areas 1 through 10 and is an annual, cool native that provides poor grazing for wildlife and livestock.

37. Little bluestem *(Schizachyrium scoparium* var. *frequens)* This bunchgrass grows 24 to 48 inches tall with flattened stems and sheaths. Blades and stems are purplish to bluish-green and turn leathery brown at maturity. Small, fuzzy seeds form a twisted awn seedhead, partially enclosed in a leaf sheath. It grows on upland and bottomland in areas 2 through 10 and decreases with heavy grazing. Little bluestem is grazed by all classes of livestock and matures seed in the fall. It is a perennial, warm native that provides poor grazing for wildlife; good grazing for livestock.

38. Longtom *(Paspalum lividum)* This tall, sod-forming grass grows 20 to 40 inches tall with smooth stems growing from a creeping base. The leaf blades are about 3 inches long and up to 1/4 inch wide. The inflorescence has four to seven loosely attached racemes which grow parallel and close to the axis. Seeds are borne in straight rows along the side of each seed branch. Longtom grows abundantly on poorly drained soils in areas 1, 2 and 6 and is a perennial, warm native that provides fair grazing for wildlife and livestock.

39. Marshhay cordgrass *(Spartina patens)* This bunchgrass grows 12 to 50 inches tall with slender stems produced from rhizomes. Leaf blades usually roll inward. The inflorescence has two to several spikes spread along the axis. It grows in area 2, decreases with heavy grazing and is a perennial, warm native that provides poor grazing for wildlife; good grazing for livestock.

40. Meadow dropseed *(Sporobolus drummondii)* This bunchgrass grows 25 to 50 inches tall and is less robust than tall dropseed. Leaf blades normally are flat, but tend to roll inward with maturity, making them appear round and tapering to a point at the tip. The panicle is slender, somewhat compressed with the base enclosed in the upper leaf sheath. Meadow dropseed grows best on heavy soil that usually receives additional moisture in areas 1 through 8. It is a perennial, warm, native grass that provides poor grazing for wildlife; fair grazing for livestock.

41. Oldfield threeawn *(Aristida oligantha)* This tufted grass grows 1 to 2 feet tall and is branched at the base and nodes. It is woolly at the base with a smooth sheath and has spreading awns 2 to 3½ inches long. It grows on uplands in areas 1 through 10 and invades disturbed and overgrazed areas. It is an annual, warm native that provides poor grazing for wildlife and livestock.

42. Pink pappusgrass *(Pappophorum bicolor)* This 18- to 36-inch tall bunchgrass is erect with dark nodes and heavily veined leaves. The pinkish, narrow, loose panicle is 5 to 10 inches long. Each spikelet is borne on a footstalk and contains three to five pineapple shaped florets, each with about 12 unequal awns. It grows on sandy or gravelly soils in areas 2, 6, 7 and 10 and is a perennial, warm native that provides poor grazing for wildlife; fair grazing for livestock.

43. Plains bristlegrass *(Setaria leucopila)* This bunchgrass grows 12 to 48 inches tall and has pale green, flattened culms branching at the base and lower joints. Blades are 1/8 to 2/5 inch, often folded and rough on the back. The panicle is slim, bristly and narrowed at the top. Usually, one bristle grows below each spikelet. Plains bristlegrass grows on open, dry ground under the protection of brush in overgrazed pastures of areas 2 through 10. This is a good plant to include in a mixture to seed overgrazed ranges, particularly after mechanical brush control. It is a perennial, warm native that provides fair grazing for wildlife; good grazing for livestock.

44. Plains lovegrass *(Eragrostis intermidia)* This tufted, erect bunchgrass grows 15 to 36 inches tall. Sheaths are conspicuously hairy at the throat and across the collar. The panicle is large, open, erect and pyramid-shaped with grayish or brownish-green, three- to eight-flowered spikelets, each borne on individual branchlets. There is a ring of hairs in the axil of the branch, along the panicle axis. Plains lovegrass grows in rich soil on rocky, gravelly or sandy land in areas 2 through 8 and 10. It decreases with overgrazing and is perennial, warm native that provides poor grazing for wildlife; good grazing for livestock.

45. Purpletop *(Tridens flavus)* This 36- to 60-inch tall bunchgrass is erect but droops at maturity. Sheaths are flattened and overlapping at the base. The panicle is open and spreading in a pyramid shape. Branchlets of the panicle give off a sticky juice and dirt clings to it. Spikelets are 5- to 7-flowered, green to purple and pale when ripe. At á glance, purpletop in winter resembles Johnsongrass. It prefers shady, woody and sandy soil in areas 1 through 5, 7 and 8 and is a perennial, warm native that provides fair grazing for wildlife and livestock.

46. Rattail smutgrass *(Sporobolus indicus)* This 18- to 42-inch tall bunchgrass has slender, erect stems with a rattail appearing seedhead, sometimes partly included in the sheath. The panicle often is infested with a black fungus, hence the name. The seed are reddish. Rattail smutgrass invades pastures, meadows, waste places and under the perimeter of trees—probably distributed by birds. It grows in areas 1 through 4 and is a perennial, warm, introduced grass that provides poor grazing for wildlife and livestock.

47. Red grama *(Bouteloua trifida)* This 5- to 10-inch tall, tufted bunchgrass grows erect or prostrate from short rootstock. The slim blades and stems have 3 to 7 red, purplish to pale spikes. The spikelets have three short, rough awns. It grows on upland hills and ridges and invades overgrazed ranges in areas 2, 3 and 5 through 10. It is a perennial, warm native that provides poor grazing for wildlife and livestock.

48. Red lovegrass *(Eragrostis secundiflora)* This 12- to 30-inch tall, tufted bunchgrass is branching and spindly. Blades are 3 to 12 inches long. The panicle is green to purplish, 8 to 18 inches long and becomes straw yellow when mature. Spikelets are crowded in clusters. Lemmas are ⅛ inch long. It grows on upland, sandy soils and invades all overgrazed sites in areas 1 through 10. It is a perennial, warm native that provides poor grazing for wildlife and livestock.

49. Rescuegrass *(Bromus unioloides)* The lower sheaths and blades of this 12- to 36-inch tall bunchgrass are often fuzzy. The inflorescence is erect or drooping, flat and green, but turns straw yellow when ripe and dry. Spikelets are overlapping, forming v's with short or no awn. A papery ligule at the collar is split on top. It grows from seed in winter, providing early forage. Rescuegrass is managed as a cool season pasture plant and matures seed in early spring. It is adapted to areas 1 through 10 and is an annual, cool, introduced grass that provides fair grazing for wildlife and livestock.

50. Ryegrass *(Lolium perenne)* This 18- to 36-inch tall bunchgrass has erect, dark green stems with dark, swollen nodes. Spikelets are set edgewise and fit into the concave rachis. Lemmas are awned. It has prominent auricles at the top of the sheath. It grows in meadows and improved pastures in areas 1 through 5 and 7 and is an annual, cool, introduced grass that provides fair grazing for wildlife; good grazing for livestock.

51. Sand dropseed *(Sporobolus cryptandrus)* This 18- to 42-inch tall bunchgrass is erect or spreading with the finally open panicle mostly included in the sheath. The sheath has a distinct tuft of hair at the throat. The panicle is lead colored to purplish with small, one-flavored spikelets borne on short pedicels. It invades sandy soil, overgrazed and blown-out areas in areas 2 through 10. Sand dropseed is a perennial, warm native that provides poor grazing for wildlife; fair grazing for livestock.

52. Sand lovegrass *(Eragrostis trichodes)* This 24- to 48-inch tall bunchgrass is tufted and erect with hairy sheaths at the throat. The long, open, oblong panicle (1 to 2 inches) has purplish to pale, 6- to 10-flowered spikelets borne in clusters at the tip end of seed branches. It is very palatable, grows on upland, sandy soils and is best managed in a pure stand. It is a perennial, warm native that provides poor grazing for wildlife; good grazing for livestock.

53. Scribner dichanthelium *(Dichanthelium oliogosanthes var. scribnerianum)* The 10- to 25-inch tall stems are smooth to harshly hairy, growing from a decumbent base. The leaf sheath has fine, parallel veins that are smooth to hairy. Leaf blades are erect, rather wide, rounded at the base and smooth on the upper surface and rough on the lower surface. An open, spreading panicle with a single spikelet is produced on each branch. This perennial, cool native grows in areas 1 through 10 and provides fair grazing for wildlife and livestock.

54. Sideoats grama *(Bouteloua curtipendula var. curtipendula)* This 12- to 42-inch tall bunchgrass grows from strong, scaly rootstocks. Hairs grow out of small, bulb-like spots on the blade edges. The seedhead is long and zig-zag with many spikes (20 to 50) twisting around on the side when ripe. Seeds resemble oats. Sideoats grama grows on a wide variety of range sites and is grazed by all kinds of animals, decreasing with heavy grazing. It matures seed in spring and fall and grows in areas 2 through 10. It is a perennial, warm native that provides good grazing for wildlife and livestock.

55. Silver bluestem *(Bothriochloa saccharoides var. torreyana)* This 18- to 42-inch tall bunchgrass usually grows from an inclined base with no rhizomes. The leafy, bent stems are smooth with white nodes and a fuzzy, white terminal panicle with short, awned spikelets. It grows on prairie and rocky slopes and increases in abundance when poor condition ranges are deferred; is replaced with better grasses as conditions improve. It is grazed heaviest during early fall and is adapted in areas 1 through 10. This perennial, warm native provides poor grazing for wildlife; fair grazing for livestock.

56. Switchgrass *(Panicum virgatum)* This 36- to 72-inch tall bunchgrass grows in small to large clumps with many scaly, creeping rhizomes. The large, robust plants have bluish blades up to 2 feet long. The ligule is a dense ring or cup of hairs on the upper leaf surface at the collar. Stems are hollow. Panicles are pyramid-shaped with many purplish spikelets. In winter, the seedhead resembles branches of a seedling willow tree. It is found mostly along creeks and streams and in protected areas and decreases with heavy use, but can be used and managed similarly to pasture grasses. Switchgrass grows in areas 1 through 10 as a perennial, warm native that provides fair grazing for wildlife; good grazing for livestock.

57. Tall fescue *(Festuca arundinacea)* This 18- to 48-inch tall grass has slender stems produced from large crowns. Leaves have a rough upper surface. The panicle is erect, but nodding with maturity. It grows mostly in bottomlands in areas 2, 4 and 6 through 9 and is a perennial, cool, introduced grass that provides fair grazing for wildlife; good grazing for livestock.

58. Tanglehead *(Heteropogon contortus)* This 12- to 42-inch tall bunchgrass grows in tufts, erect, with flat overlapping sheaths. Foliage turns reddish brown with straw yellow stems on maturity and tastes like molasses. The 2- to 4-inch long, twisted, one-awned, fuzzy, brown florets fall, leaving overlapping florets which look like braid. Tanglehead grows on rocky hills and ridges in areas 2, 6, 7 and 10 and is a perennial, warm native that provides poor grazing for wildlife; good grazing for livestock.

59. Texas bluegrass *(Poa arachnifera)* This upright bunchgrass grows 12 to 36 inches tall with the plant arising from slender, creeping rootstocks. The flat, whitish to purplish base has long, overlapping sheaths. Blades are long, heavily veined and boat shaped at the tip. The seedhead is oblong and dense to open. Male and female flowers grow on different plants, often at widely separated locations. The male heads are smooth while those of the female appear fuzzy and cobwebby. Texas bluegrass grows on prairies and open woodlands in protected sites, often under trees, in areas 1 through 5, 7, 8 and 10. It decreases with heavy grazing and is a perennial, cool native that provides fair grazing for wildlife; good grazing for livestock.

60. Texas cupgrass *(Eriochloa sericea)* This bunchgrass grows 12 to 48 inches tall in large tufts. Stems have a feel similar to a lead pencil at the base. The blades are soft and lax; the ligule is a dense ring of straight hairs. The pale-colored seedheads have single fuzzy seed in rows, borne on very short, hairy stems. Seeds are set in a cup having a ring-like base and fall, leaving a fuzzy zig-zag stem. Texas cupgrass grows on hills and ridges, mostly in protected areas in areas 2 and 4 through 8, and decreases with heavy grazing but will increase with proper use. It contains some green vegetation during winter on properly stocked ranges, is a perennial, warm native and provides fair grazing for wildlife; good grazing for livestock.

61. Texas grama *(Bouteloua rigidiseta)* This tufted grass grows 5 to 12 inches tall with a few erect stems and smooth, dark nodes. Leaves are short and crowded at the base and often are wavy or curling when mature. Six to eight woolly-based, bell-shaped spikes are attached to each wavy seed stem; hence, the old name "bell grama." Three to five seeds are in each spike. Texas grama grows on dry plains, rocky hills and abused sites and invades orvergrazed ranges in areas 2 through 10. It is a perennial, warm native that provides poor grazing for wildlife and livestock.

62. Texas wintergrass *(Stipa leucotricha)* This bunchgrass grows 12 to 24 inches tall, sometimes as tall as 42 inches. Stems usually are erect but sometimes are prostrate with short, hairy nodes. Dark green blades are beset with short, bristly, white hairs and are rough on both sides. The light brown seed has a single, twisted, bent awn, 2½ to 4 inches long, and a barbed callus in the base; hence, it is sometimes called speargrass. In late spring, the white, persistent glumes resemble oats after the awned seeds have fallen. A self-fertilized spikelet may be found at the base of the stem. It is the most abundant native winter grass in Texas and grows on bottomland soil and mesquite flats in areas 1 through 10. It is a perennial, cool native that provides fair grazing for wildlife and livestock.

63. Thin paspalum *(Paspalum setaceum)* This grass grows 15 to 40 inches tall with spreading stems growing from a small base. The sheaths usually are smooth but the lower ones can be hairy. Leaves are 5 to 15 inches long and ⅛ to ½ inch wide, with many hairs along the margin. The inflorescence usually has two racemes. Flat, round seeds appear in pairs, have a slightly pointed tip and are covered with short, sparse hairs. Thin paspalum grows on a variety of soils throughout the state but is adapted in areas 1, 2 and 3. It is grazed most often following rains as it greens up rapidly. Thin paspalum is a perennial, warm native that provides fair grazing for wildlife and livestock.

64. Tobosa *(Hilaria mutica)* This sod-forming grass grows 12 to 24 inches tall from a coarse, woody, scaly rootstock. Spikes are purplish to pale when ripe. Glumes are wedge-shaped, broad and hairy at the tip. It greens up readily after rain, turns ashy gray and coarse during drouth and grows in bunches in flats and heavy soils in areas 6 through 10. It is a perennial, warm native that provides poor grazing for wildlife; fair grazing for livestock.

65. Tumblegrass *(Schedonnardus paniculatus)* This low, tufted bunchgrass grows 8 to 25 inches tall with overlapping, flattened sheaths and spirally twisted blades with white margins. Scythe-shaped culms turn downward and the panicle breaks off and tumbles in the wind. The panicle is green to purple to pale with alternating 1- to 5-inch spikes. One-flowered spikelets grow in two rows on one side of the slender seed stem. Tumblegrass grows on sandy soil and invades overgrazed pastures in areas 1 through 10 and is a perennial, warm native that provides poor grazing for wildlife and livestock.

66. Tumble windmillgrass *(Chloris verticillata)* This erect grass grows 4 to 20 inches tall from a tufted, decumbent base. The lower nodes sometimes take root. Leaves are crowded at the base. Sheaths are compressed. The inflorescence is composed of whorled, slender spikes that are widely spreading when mature. It is an invading plant that grows in areas 1 through 10 and is a perennial, warm native that provides poor grazing for wildlife and livestock.

67. Vinemesquite *(Panicum obtusum)* This 12- to 30-inch tall grass produces long, tough stolons with swollen, woolly joints that take root at the nodes. The erect, flattened internodes are slick. The topmost blade clings closely to the narrow seedhead, with the seeds turning from green to brown on maturity. It grows along banks of streams or ditches in bottomland in areas 2 through 10 and is a perennial, warm native that provides fair grazing for wildlife; good grazing for livestock.

68. Virginia wildrye *(Elymus virginicus)* This perennial with stems in small clusters grows from 23 to 48 inches tall. The leaves usually are hairless but sometimes have minute hairs. The inflorescence is a stiff, erect, bristly spike, usually 2 to 6 inches long and often partly enclosed by the upper sheath. The glumes are yellowish, hard and bowed out at the base. It is found in all vegetational areas except 9 and 10 and is a perennial, cool native that provides fair grazing for wildlife; good grazing for livestock.

69. Weeping lovegrass *(Eragrostis curvula)* This erect bunchgrass grows 24 to 48 inches tall with an erect seed stalk and narrow, drooping, coarse blades. The seedhead is a loose, open panicle with many seeded grayish-green spikelets. The panicle resembles lace when mature. Leaves are rough on the bottom and top surfaces, with hairy, basal sheaths. It is managed best in a pure stand and grows on sandy soils in areas 1, 3, 6, 8, 9 and 10. Weeping lovegrass is a perennial, warm, introduced grass that provides poor grazing for wildlife; fair grazing for livestock.

70. Western wheatgrass *(Agropyron smithii)* This 12- to 24-inch tall bunchgrass grows from gray, slender, creeping rootstocks with blue-green stems and leaves. Leaves are straight, broad, rough, strongly nerved on the upper surface and roll inward with maturity. The flat seedhead usually is awnless. Western wheatgrass grows most abundantly in moist bottomland in areas 8 and 9 and decreases with overgrazing. It is a perennial, cool native that provides fair grazing for wildlife; good grazing for livestock.

71. White tridens *(Tridens albescens)* This 12- to 36-inch tall bunchgrass has erect stems and a whitish to purplish base. The panicle is dense, greenish or purplish to white and narrow with 8 to 12 flowered spikelets. The glumes are nearly equal—5/32 inch. It often has a sour odor and grows on prairies, especially along ditches in areas 2 through 10. It is a perennial, warm native that provides fair grazing for wildlife and livestock.

72. Wright threeawn *(Aristida wrightii)* This densely-tufted bunchgraass has 12- to 42-inch-tall, erect stems. There are hairs on the leaf collar. The seedhead is purplish at first and then straw yellow to ashy gray when dry. Clusters of 2 to 4 spikelets grow along the main seed stem and have 3 spreading awns up to 1 inch long, with two bending horizontally about mid-point. It grows on upland hills and plains in areas 4 through 10 and is a perennial, warm native that provides poor grazing for wildlife; fair grazing for livestock.

73. Yellow Indiangrass *(Sorghastrum nutans)* This 36- to 84-inch tall bunchgrass grows from short, scaly rhizomes. Nodes are fuzzy with the ligule long and appearing as rabbit ears when dry. The panicle is 8 to 12 inches long and bronze to yellowish with ½-inch awns, bent once and closely twisted to the bend. It decreases with heavy grazing but produces high yields when managed in a pure stand. It is a heavy seed producer and grows in areas 1 through 5 and 7 through 10. Yellow Indiangrass is a perennial, warm native that provides fair grazing for wildlife; good grazing for livestock.

FORBS

1. Bitter sneezeweed *(Helenium amarum)* The plant is a bright green, leafy forb that reproduces by seeds and has smooth, erect stems 6 to 24 inches tall and branches toward the top. The plant has a bushy appearance and the lower leaves shed from the stems early. Leaves are alternate, coming directly out of the stems. The seedhead has many small, yellow flowers that are very showy in late summer. The flower petals tend to turn backward and have fewer bracts at the base of the flower. Bitter sneezeweed grows in areas 1 through 8 and when grazed causes a bitter taste to milk. It is an annual, warm season native that provides poor grazing for and is poisonous to wildlife and livestock.

2. Broadleaf milkweed *(Asclepias latifolia)* This plant has stout, simple stems 6 to 24 inches tall with four or more pairs of large, thick leaves more than 1½ times as long as wide. Flowers are greenish and give rise to two to four smooth pods about 1½ inches long. The plant is noted for its robust nature and large leaves, while other species of milkweed have narrower leaves. It grows in areas 7 through 10 and is a perennial, warm native that provides poor grazing for and is poisonous to wildlife and livestock.

3. Broom snakeweed *(Xanthocephalum Sarothrae)* This many-branched, semi-woody based plant has erect stems 9 to 18 inches tall. Leaves are alternate, simple and thread-like. Many small, yellow flowers appear in late summer. Each flower head is top-shaped. Broom snakeweed grows in areas 2, 5, 8, 9 and 10 and is a perennial, warm native that provides fair grazing for wildlife; poor grazing for and is poisonous to livestock.

4. Common broomweed *(Xanthocephalum dracunculoides)* This annual plant has a single stem 15 to 30 inches tall, branching near the top to form a uniform crown with small, yellow flowers. First leaves usually are lanceolate and form along the main stem, shedding when the crown begins to develop. Older leaves are fine and alternate along the branch stems. It grows most abundantly on heavy clay soils in areas 2 through 5 and 8 through 10. It is an annual, warm native that provides poor grazing for wildlife and livestock.

5. Engelmanndaisy *(Engelmannia pinnatifida)* This light green, upright plant has alternate, scalloped or lobed leaves. Upper leaves are attached directly to the stem with short hairs covering the stems and leaves. Flower branches have yellow flowers. This palatable forb grows in areas 2 through 10 and is a perennial, cool native that provides good grazing for wildlife and livestock.

6. Field bindweed *(Convolvulus arvensis)* Slender, sometimes branching, stems grow 12 to 42 inches long and trail on the ground or climb on other plants. Leaves are arrow-shaped, slender, have short stems, are not scalloped on the margin and are pointed or nearly so at the tip. Flowers are like a morningglory except smaller—

about 1 inch across and white with a slightly pink cast, especially on the inside. Seeds are irregular in shape and dark brown to black. This troublesome pest can grow on all sites in areas 2, 4, 5, 7, 8, 9 and 10. This perennial, warm, introduced forb provides poor grazing for wildlife and livestock.

7. Maximilian sunflower *(Helianthus Maximiliani)* This upright plant, produced from seed or rhizomes, has bristly stems 36 to 72 inches tall and long, narrow, rough, scabrous leaves that taper at both ends. Leaves are alternate along the stems. A flower stalk is produced in the axis of the leaves and terminates into a large, yellow flower. Flowers may cover the upper third of the stems and are quite showy along the roadsides in early fall. This forb grows in areas 2 through 5 and 7 through 9. It is a perennial, warm native that provides fair grazing for wildlife and livestock.

8. Mexican sagewort *(Artemisia ludoviciana)* This upright plant, produced from rhizomes, has 12- to 26-inch tall stems that may branch along the main stem. Leaves are alternate and scalloped, with three to seven lobes per leaf. Leaves are light green to gray on the under side; dark green on the upper side. Upper leaves near the flower head are not lobed. Flowers are small, inconspicuous and produced in a panicle. This forb grows in areas 2 and 4 through 10 and is a perennial, warm native that provides poor grazing for wildlife; good grazing for livestock.

9. Nuttall deathcamas *(Zygadenus Nutallii)* This member of the lily family has 12- to 24-inch stems and is produced from an underground bulb. Growth begins 2 to 3 weeks before grass starts in the spring. The long leaves are dark green and grasslike. Flowers are greenish-white, grow in a dense cluster at the terminal of the main stem, soon die and the main stem remains above ground for a short period. All parts of the plant are poisonous to livestock and humans. It grows in areas 1, 3, 4, 5 and 7. This perennial, cool native provides poor grazing and is poisonous for all classes of animals.

10. Orange zexmenia *(Zexmenia hispida)* This shrubby plant grows 12 to 36 inches tall and has much-branched, round stems with distinct leaf bud scars covering half the diameter of the stem. Leaves are long, narrow and pointed with irregularly serrated margins. Leaf margins and stems have short, bristly hairs. Leaves are opposite and have short or no leaf stem. Seven to nine orange-yellow flowers are produced at the apex end of a long, slender stem. This perennial, warm native grows in areas 2, 6 and 7 and provides poor grazing for wildlife; good grazing for livestock.

11. Silverleaf nightshade *(Solanum eleagnifolium)* This plant has strong, creeping rootstocks that produce stems 10 to 24 inches tall. Leaves are silvery white, oblong to linear with wavy margins. Stems and leaves have thin to heavy, yellow spines. Flowers are violet, yellow or black. Fruits are light yellow with green stripes when mature. All parts of the plant are poisonous. The plant has a wide distribution, particularly in old, cultivated fields and overgrazed bottomland pastures. It grows in areas 1 through 10 and is a perennial, warm native that provides poor grazing for and is poisonous to wildlife and livestock.

12. Slim aster *(Aster subulatus* var. *ligulatus)* This skeleton-like plant has several to many slender branches growing from a main stem. Usually, the branches are from one side of the main stem, which is woody. Plants are dusty green and from 12 to 36 inches tall. Leaves are very slender, attached directly to the stem and pointed. Upper leaves often are folded against the stem, making the plant look like a skeleton plant. The tiny purple to white flowers are showy in the early fall. This annual, warm native grows in areas 1 through 10 and provides fair grazing for wildlife and livestock.

13. Texas croton *(Croton texensis)* This grayish-green plant grows 12 to 36 inches tall and its one main stem has 2 or 3 forked branches at the top. Leaves have smooth margins and are long and narrow, tapering to the end. The apex end is blunt or rounded. Flowers are inconspicuous and the fruit is a 3-lobed capsule covered with a grayish-white mat of hairs. It grows in areas 2 through 10 and is an annual, warm native that provides good grazing for wildlife and poor grazing for livestock.

14. Threadleaf groundsel *(Senecio longilobus)* This evergreen has many stems that grow from 12 to 36 inches tall from a central crown. Stems are herbaceous except at the base. Leaves are light green and divided into three to seven segments that may be hairy or nearly smooth. The yellow flowers bloom during mild winters and following summer rains. This perennial, warm native grows in areas 7 through 10 and provides poor grazing for and is poisonous to wildlife and livestock.

15. Upright prairie-coneflower *(Ratibida columnaris)* This hairy-stemmed plant reproduces from seed or short underground stems. Stems grow from 12 to 40 inches tall and branch near the top. Leaves are strongly lobed into distinct, long, narrow, pointed segments. Flowers with yellow to brownish petals and a dark brown center up to 1 inch long are borne at the terminal end of the slender stems. This perennial, warm native grows in areas 1 through 10 and provides good grazing for wildlife; poor grazing for livestock.

16. Western bitterweed *(Hymenoxys odorata)* This many-branched plant varies in height from 4 to 24 inches tall. Each branch produces a flower head. The alternate leaves are small and roll inward when mature. Flowers are small and yellow with six to eight petals. All plant parts are poisonous, both green and dry. This annual, cool native grows abundantly on ranges in poor condition in areas 6 through 10 and provides poor grazing for and is poisonous to wildlife and livestock.

17. Western ragweed *(Ambrosia psilostachya)* This plant grows from long rootstocks with many-branched stems that are stout and from 12 to 72 inches tall. Leaves are 2 to 5 inches long with deep serrations along the margins. Serrations are sometimes pointed and sometimes rounded. Leaves are thick, hairy or bristly and gray-green in color. Seed are borne along a central stem 2 to 6 inches long at the apex of the plant. Seed clusters are chaffy, becoming pointed and bristly with maturity. This perennial, warm native grows in areas 1 through 10 and provides good grazing for wildlife; poor grazing for livestock.

18. Yankeeweed *(Eupatorium compositifolium)* Plants are produced from strong underground rootstocks with stems 24 to 48 inches tall. Lower leaves are opposite, lobed and compound; upper leaves are less compound and often entire. Flowers are white and produced as a long head. This perennial, warm native grows in areas 1, 2, 3, 6 and 8 and provides poor grazing for wildlife and livestock.

LEGUMES AND RATANY (Herbaceous)

1. Alfalfa *(Medicago sativa)* Stems grow 16 to 30 inches tall from a crown. The plant produces leaf branches with three leaflets on the tip of a short, hairy leaf branch. Usually, there are two appendages at the base of each leaf branch. The middle leaflet has a slightly longer leaf stalk than the other two leaflets. The seed pod is coiled on itself several times. This perennial, warm, introduced legume grows in areas 1 through 5 and 7 through 10 and provides good grazing for wildlife and livestock.

2. Austrian winterpea *(Pisum arvense)* Leaves are borne throughout the length of slender, hollow stems that are 24 to 72 inches long. Each leaf bears three pairs of broad leaflets and is terminated by a slender tendril. Flowers are reddish-purple to white. This annual, cool introduced legume grows in areas 1 through 5, 7 and 8 and provides fair grazing for wildlife and livestock.

3. Bur-clover *(Medicago polymorpha* var. *vulgaris)* This low-growing plant has many-branched, spreading stems 6 to 30 inches tall. Leaves are produced along the stems with three leaflets at the end of the leaf branch. Small, yellow flowers are produced in clusters of five to 10 and the petals fall off soon after blooming. Pods usually grow in clusters and are tightly coiled and fringed with a double row of soft spines. This annual, cool, introduced legume grows in areas 2 through 7 and 10 and provides fair grazing for wildlife; good grazing for livestock.

4. Crimson clover *(Trifloium incarnatum)* This erect plant is covered with soft hairs. Few branches grow from the main stem which grows 6 to 36 inches high from a crown. Three leaflets come from the same point of the apex end of the leaf branch. A growth shaped like a fist and thumb and covered with soft hairs grows at the base of each leaf branch. Red flowers are sessile to the top of the central stem. This annual, cool, introduced legume grows in areas 1 and 3 and provides fair grazing for wildlife; good grazing for livestock.

5. Hairy vetch *(Vicia villosa)* This pea-green, viny plant is covered with fine hairs and has slender, weak stems. Leaves are compound; leaflets come from opposite sides of a central stem, are mostly alternate, entire and abruptly pointed on both ends and are not sessile. Leaf stems have tendrils at the apex end of the extended leaf stem. Flowers are bright purple and the fruit is borne on a slender, hairy seed branch. There are two leaf-like appendages at the base of seed branches. Seed are in small pods. This annual, cool, introduced legume grows in areas 3, 4, and 5 and provides fair grazing for wildlife; good grazing for livestock.

6. Nuttall milkvetch *(Astragalus Nutallianus* var. *Nuttallianus)* Plant are 6 to 18 inches tall with several weak stems growing from a base. It has compound leaves, with 11 to 17 leaflets on a central leaf branch. Leaflets are small, narrow and may be rounded or notched at the tip end. The clustered flowers are violet and with age turn purple with a white spot at the base of the upper petal. Seed are in smooth pods that are slightly curved, about ¾ inch long and grooved on one side. This annual, cool native grows in areas 1 and 3 through 8 and provides poor grazing for wildlife; fair grazing for and is poisonous to livestock.

7. Singletary pea *(Lathyrus hirsutus)* This winter legume germinates in the fall, makes most of its growth in the spring and produces seed in May and June. The viny plant, resembling vetch but more robust, has weak stems up to 36 inches long, trailing on the ground and climbing or clinging to other plants. The reddish flowers are tinged with purple and the hairy leaves and seed pods give the plant a silvery appearance. Leaves are pinnate compound with long, narrow, pointed leaflets on each side of a common axis. The height or length of the viny stems depends on soil fertility. This annual, cool, introduced legume grows in areas 1, 3 and 4 and provides fair grazing for wildlife; good grazing for livestock.

8. Texas bluebonnet *(Lupinus subcarnosus)* This gray-green plant produces many stems from a main stem. Leaves are compound, usually with five leaflets which are long and narrow, tapering at both ends and with a midrib. Leaflets are sessile to the apex end of the leaf branch. Flowers are blue with a white spot in each. It grows in areas 2, 3 and 6 and is an annual, cool native that provides poor grazing for wildlife and livestock.

9. Trailing ratany *(Krameria lanceolata)* Thick, woody rootstocks produce stems that are ascending and erect or spreading and decumbent, usually 8 to 24 inches long. Stem length depends on growth conditions. Leaves are simple, oblong and spine-tipped. The red flowers have five petals and the round fruit, commonly referred to as a heel-bur, is ¼ to ½ inch in diameter with very stout spines. Trailing ratany grows in areas 2 through 10 and is a perennial, warm native that provides fair grazing for wildlife and livestock.

10. White clover *(Trifolium* repens*)* Plants grow 4 to 12 inches tall with many branches from the base. Branches creep and often take root at nodes. Leaves are on long leaf branches having three leaflets, all being almost sessile. Leaflets are distinctly veined, rounded and slightly toothed around the entire margin. The length of the leaflets is 1½ times the width. Small, pointed, leaf-like appendages are at the base of each leaf branch. Plants are free of hairs. Flowers are white and seed pods usually have four seeds. White clover grows in areas 1 through 7 and is a perennial, cool, introduced legume that provides fair grazing for wildlife; good grazing for livestock.

11. White sweetclover *(Melilotus alba)* This erect plant branches at the base with stems 24 to 96 inches tall and free of hairs. Leaves are made up of three leaflets on a short stalk or branch. The center leaflet is on the extended end of the branch and the other two are almost sessile. Leaflets, strongly veined and slightly toothed on the margin, are long and narrow, rounded at the apex end and narrow at the base. Flowers are white. There are no appendages at the base of the leaf branches as there are with yellow sweetclover. This annual, introduced, warm legume grows in areas 2 through 10 and provides fair grazing for wildlife; good grazing for livestock.

12. Woolly loco *(Astragalus mollissimus)* This branched plant produces decumbent stems 6 to 18 inches long from a woody base. Leaves are composed of an odd number of leaflets, ½ inch long and about ⅛ inch thick. Flowers are spiked or racemed with seed pods, usually inflated, which divide when mature. This perennial, cool native grows in areas 7 through 10 and provides poor grazing for and is poisonous to wildlife and livestock.

13. Yellow neptunia *(Neptunia lutea)* This vine-like plant has creeping stems up to 48 inches long. The compound leaves have many small, paired leaflets that are sensitive, folding when touched. The round flower clusters have many tiny yellow blossoms. Seed pods are narrow and have four angles. This perennial, warm native grows in areas 2, 3, 4 and 5 and provides fair grazing for wildlife and livestock.

WOODY PLANTS

1. Ashe Juniper *(Juniperus ashei)* This evergreen tree produces limbs from the main trunk. The slender leaves are sharp pointed with a round or elliptical, pink or greenish gland on the back. On long leaves, these glands are elongated and tapering. The blue-black berry has a waxy, white bloom. The dark gray or brown bark breaks into long, pliable strips. This perennial, cool and warm native grows in areas 5 and 7 through 10 and provides fair grazing for wildlife; poor grazing for livestock.

2. Black brush *(Acacia rigidula)* This shrubby tree grows up to 12 feet tall and produces limbs from a central trunk. The zig-zag branches have short, straight thorns in pairs. Leaves are twice compounded, with both divisions having one to eight small leaflets. Flowers are white and the 2- to 4-inch-long seed pods are narrow, curved and flat. Pods have divisions between the seeds and are reddish brown when ripe. This perennial, warm native grows in areas 2, 6, 7 and 10 and provides fair grazing for wildlife; poor grazing for livestock.

3. Blackjack oak *(Quercus marilandica)* This large hardwood tree has bark that is nearly black, very rough and in ridges on the trunk. Leaves are scalloped with short, white hairs on top and brownish fuzz on the under side. Leaves are 3- to 5-lobed, with a bristle tip on each lobe. This perennial, warm native grows in areas 1, 2, 3, 7 and 8 and provides fair grazing for wildlife; poor grazing for and is poisonous to livestock.

4. Coyotillo *(Karwinskia Humboldtiana)* Branches grow from a central crown of this spineless, bushy shrub, with stems up to 8 feet tall. Leaves are opposite with veins that end in the untoothed margins. Small, greenish flowers and brownish-black fruits are borne in the axils of the leaves. This perennial, warm and cool native grows in areas 2, 6, 7 and 10 and provides poor grazing for and is poisonous to wildlife and livestock.

5. Guajillo *(Acacia Berlandieri)* Stems up to 8 feet tall, with short thorns, grow from a crown on this shrubby plant. Leaves are twice pinnate and flowers are produced in heads. Seed pods are flattened, four to six times as long as wide and have thickened margins. This perennial, warm native grows in areas 2, 6 and 7 and provides fair grazing for and is poisonous to wildlife and livestock.

6. Honey mesquite *(Prosopis glandulosa)* This small tree has a central stem or many branches produced from a crown. Stems bearing the leaves tend to zig-zag with a pair of short spines at each leaf bud and at other points on stems. Leaves are twice compound on a single leaf branch. Each section has a number of sessile leaflets that are entire. The yellow flowers are borne on a raceme 2 to 4 inches long. Seed pods are 4 to 8 inches long, usually curved and constricted between each seed in the pod. This perennial, warm native grows in areas 2 through 10 and provides fair grazing for wildlife; poor grazing for livestock.

7. Huisache *(Acacia farnesiana)* This small tree or bush-topped shrub has stems up to 15 feet tall. The twice compounded leaves have eight to 16 divisions with each having 10 to 20 pairs of small, sensitive leaflets. Flowers are produced on a fragrant, yellow, fluffy ball with many clusters of yellow stamens. Seed pods are cylindrical, 1½ to 3 inches long and turn dark brown or black when mature. This perennial, warm native grows in areas 2, 3, 4, 6 and 7 and provides poor grazing for wildlife and livestock.

8. Live oak *(Quercus virginiana)* This 30- to 50-foot tall evergreen has many branches along its strong, central trunk. The wide crown is dense. Leaves are elliptical to oblong, 2 to 5 inches long, rounded on the tip, dark green and somewhat hairy on the under surface. This perennial, cool and warm native grows in areas 2, 3, 5, 6, 7 and 8 and provides good grazing for wildlife; fair grazing for and is poisonous to livestock.

9. Loblolly pine *(Pinus taeda)* This 50- to 110-foot-tall evergreen has a rounded, dense crown. The scaly bark is nearly black on young trees, turning to reddish brown on old trees. Leaves are in fascicles of three and are slender, 6 to 9 inches long and yellow green. Flowers are yellow. The cone is 2½ to 6 inches long. This perennial, cool and warm native grows in areas 1, 2 and 3 and provides poor grazing for wildlife and livestock.

10. Lotebush *(Ziziphus obtusifolia)* This rigid, intricately branched, thorny shrub grows up to 6 feet tall and is greenish gray. The oval to oblong shaped leaves are ½ to 1½ inches long, are entire or shallow toothed. The flowers are inconspicuous. The fruit is black, mealy and stone-like, about the size of a pea. Sharp, straight thorns are numerous along the stems. This perennial, warm native grows in areas 2, 5, 6, 7, 8 and 10. It provides good grazing for wildlife; poor grazing for livestock.

11. Post oak *(Quercus stellata)* This 30- to 60-foot-tall tree has a few large branches and a rounded crown. The bark is reddish brown. Leaves are oblong, about 4 to 6 inches long, deeply five-lobed with the rounded middle lobes opposite, giving a cross-like appearance. The dark green leaves have hairy under surfaces. This perennial, warm native grows in areas 1 through 8 and provides fair grazing for wildlife; poor grazing for and is poisonous to livestock.

12. Redberry juniper *(Juniperus pinchoti)* This spreading, bushy tree grows up to 10 feet tall with no central stem developed. Leaves have resin producing glands, grow in dark green masses and are very slender, thin and sharp pointed. The fruit is red or reddish brown. The bark is gray, quite thin, appears in scale like form and peels off in narrow strips. This perennial, cool and warm native grows in areas 5, 7, 8, 9 and 10 and provides poor grazing for wildlife and livestock.

13. Sand sage *(Artemisia filifolia)* This low growing shrub is silvery green. Stems are branched and from 1 to 3 feet tall. Branches are rigid and rather brittle, especially with age. Nearly all of the 1- to 2-inch-long leaves are separated into 3 slender parts, all about the same length. The fruiting head is a central stem with many shorter, fruit-bearing stems. The flower and seed receptacle has a scale-like covering over the bowl; there usually are three to five of these in a cluster. Sand sage is a perennial, warm native that grows in areas 8, 9 and 10 and provides poor grazing for wildlife and livestock.

14. Shortleaf pine *(Pinus echinata)* This evergreen tree grows 70 to 100 feet tall with a narrow pyramid crown. The bark is scaly plated and reddish brown on mature trees. Leaves are in fascicles of two to three, mostly twos, and 3 to 5 inches long, slender and yellow green. Flowers vary in color, with the male purple and the female a pale rose. Cones are nearly sessile and 1½ to 5 inches long. The shortleaf pine is a perennial, cool and warm season native that grows in areas 1, 2 and 3 and provides poor grazing for wildlife and livestock.

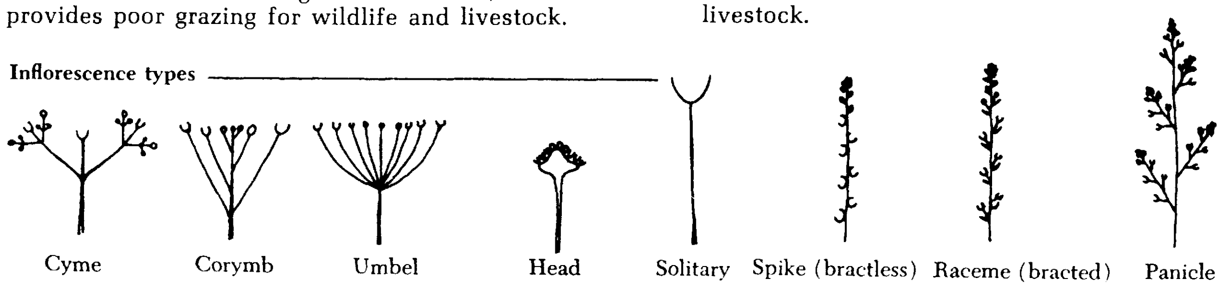
15. Skunkbush *(Rhus aromatica* var. *flabelliformis)* This low growing shrub, up to 10 feet tall, has many branches. Leaves are in 3 leaflets with scented foliage. Flowers are yellow and fruits are red. Skunkbush is a perennial, warm native that grows in areas 4, 5, 7, 8 and 10 and provides fair grazing for wildlife and livestock.

16. White brush *(Aloysia gratissima)* This low growing, shrubby plant has many branches growing from a central crown. The pale, brittle branches may extend to a height of 8 feet. Leaves are dull green, opposite, less than 1 inch long, slender and quite fragrant. The small, white or bluish flowers are in open, leafy panicles of elongated spikes or spikelike racemes. Whitebrush blooms every time effective rainfall is received, grows in areas 2, 4, 5, 6, 7, 8 and 10 and is a perennial, warm native that provides poor grazing for and is poisonous to wildlife and livestock.

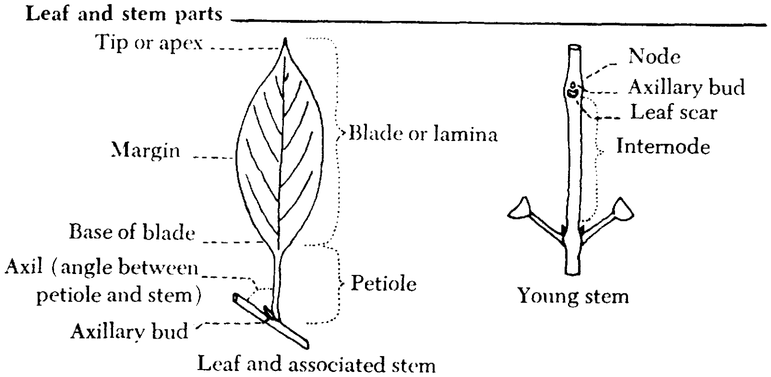
17. Willow baccharis *(Baccharis salicina)* This smooth shrub has many branches and grows 3 feet or more high. Leaves are alternate, long and narrow, are entire or sparingly indented on the margin, taper at the base and are fairly pointed at the tip. Leaves are dotted with resin. Flowers are in clusters on short flower stalks and form a single series of dull white bristles. Willow baccharia blooms in late summer and fall, grows in areas 2, 4, 5, 6, 7, 8, 9 and 10 and is a perennial, warm native that provides poor grazing for and is poisonous to livestock and wildlife.

18. Yaupon *(Ilex vomitoria)* This low growing, evergreen shrub has branches up to 20 feet tall. Yaupon will form a trunk when trimmed. Leaves are oval, 2 to 4 inches long, entire with smooth margins. Flowers are white and fruits are bright red. Yaupon grows in areas 1, 2, 3, 6 and 7 and is a perennial, cool and warm native that provides good grazing for wildlife; fair grazing for livestock.

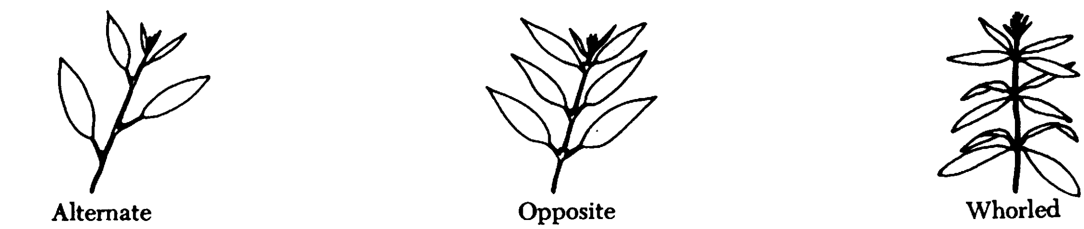
Inflorescence types



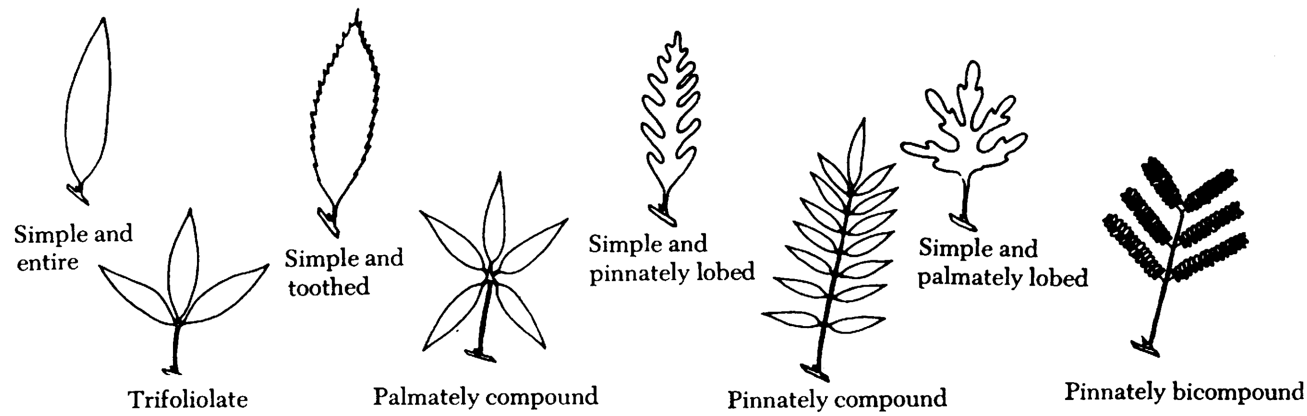
Leaf and stem parts



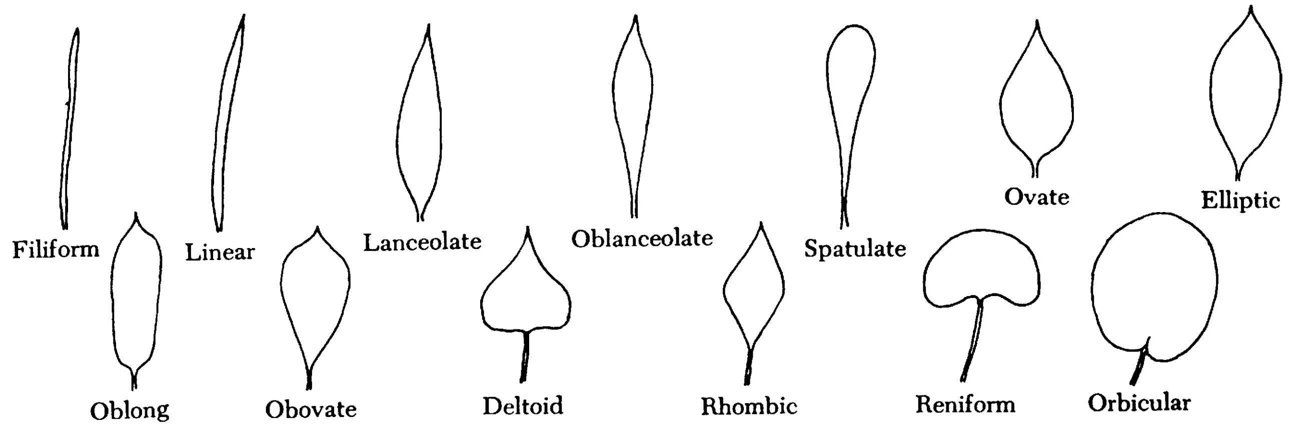
Leaf arrangement



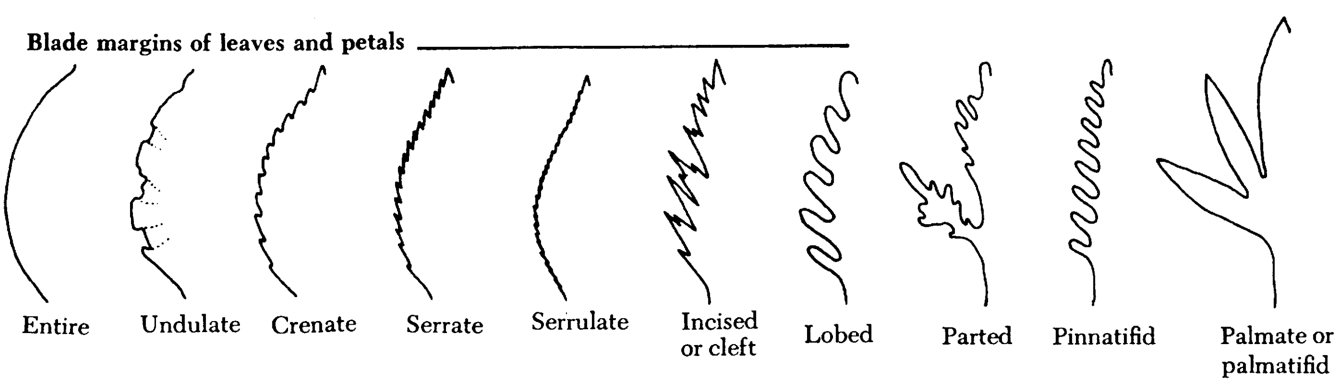
Blade complexity

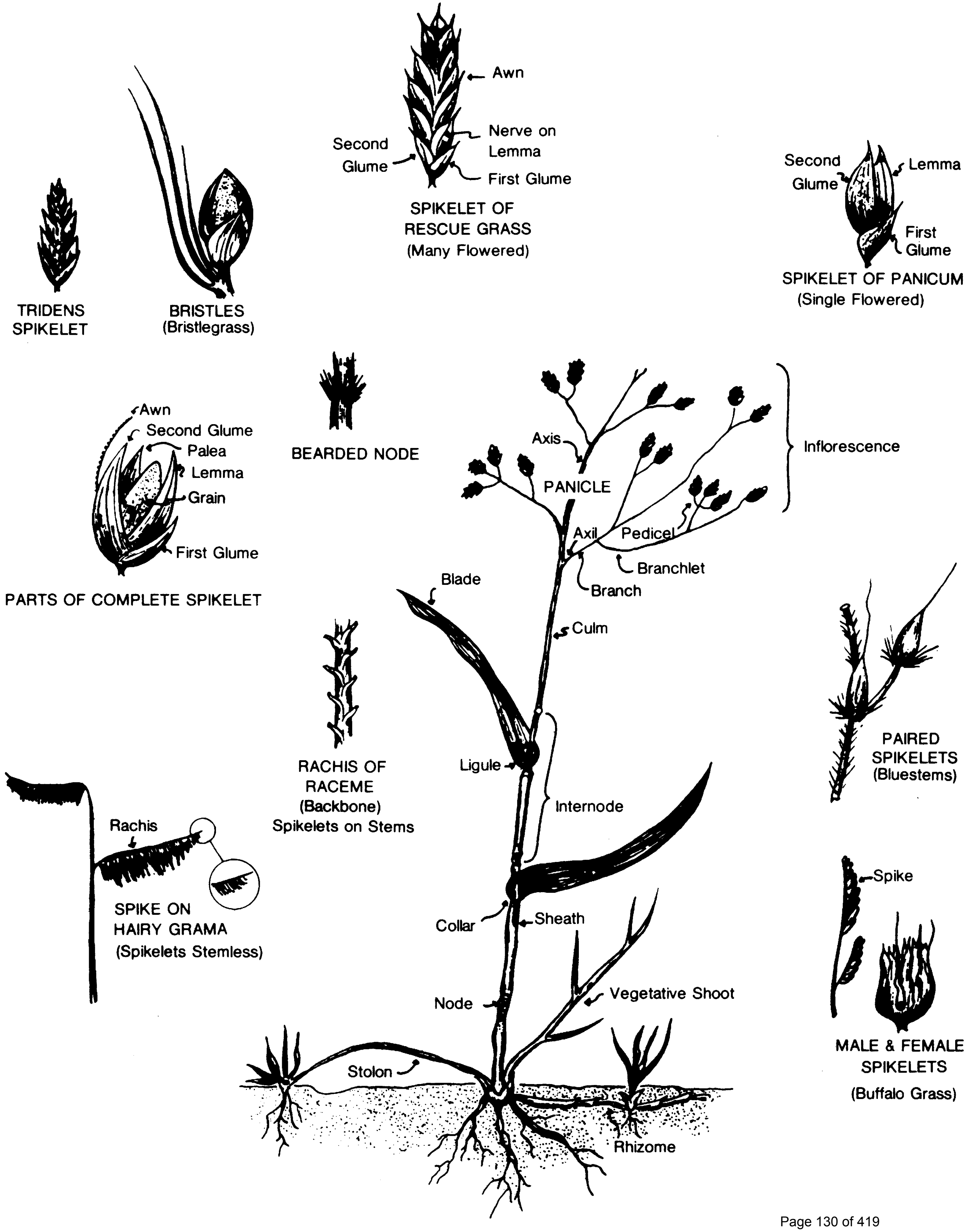


Blade shape of leaves and petals

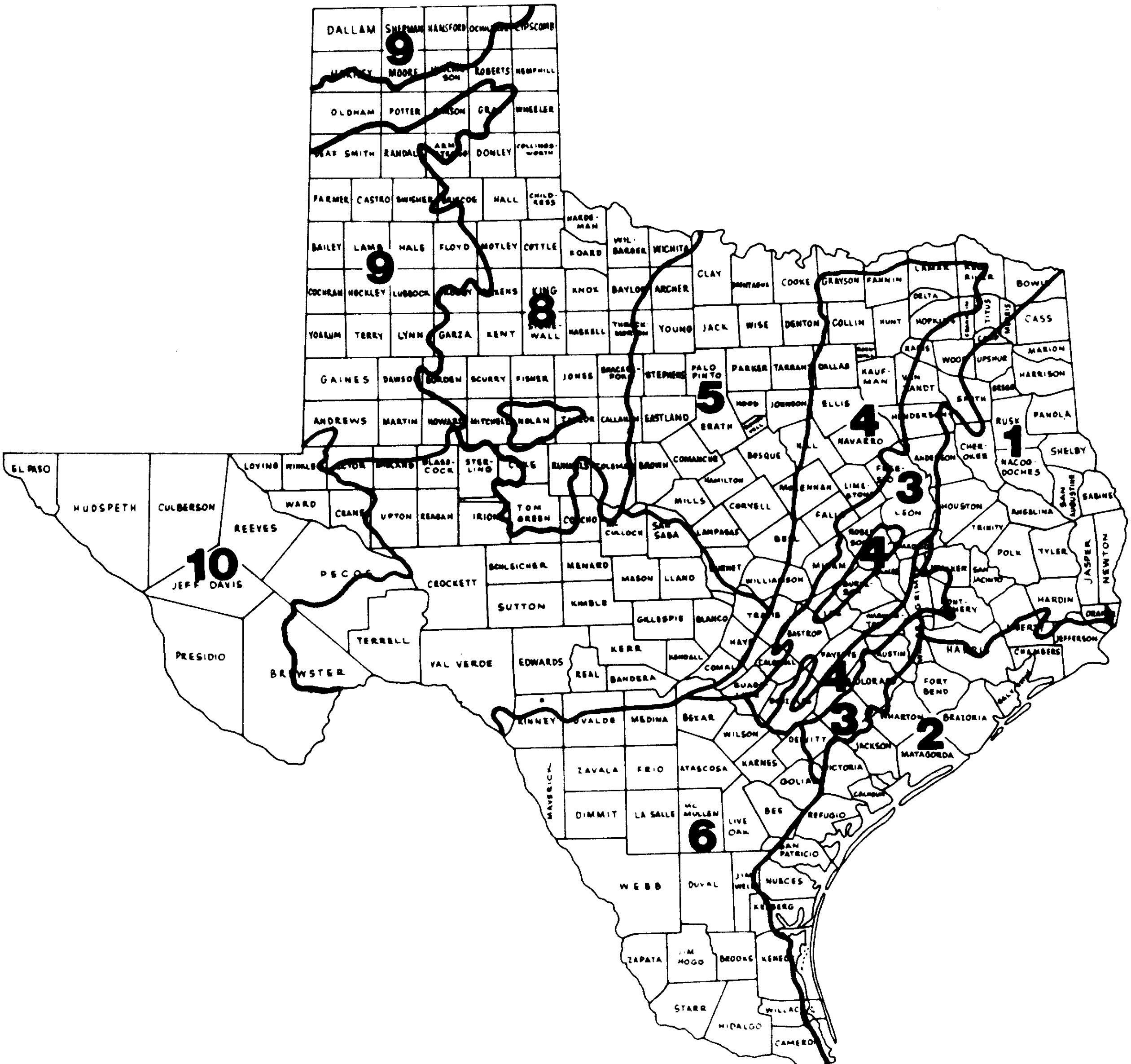


Blade margins of leaves and petals





TRIDENS SPIKELET
BRISTLES (Bristlegrass)
Awn
Second Glume
Nerve on Lemma
First Glume
SPIKELET OF RESCUE GRASS (Many Flowered)
Second Glume
Lemma
First Glume
SPIKELET OF PANICUM (Single Flowered)
Awn
Second Glume
Palea
Lemma
Grain
First Glume
PARTS OF COMPLETE SPIKELET
BEARDED NODE
Axis
PANICLE
Inflorescence
Axil
Pedicel
Branchlet
Branch
Blade
Culm
RACHIS OF RACEME (Backbone) Spikelets on Stems
Ligule
Internode
PAIRED SPIKELETS (Bluestems)
Rachis
SPIKE ON HAIRY GRAMA (Spikelets Stemless)
Collar
Sheath
Spike
Node
Vegetative Shoot
MALE & FEMALE SPIKELETS (Buffalo Grass)
Stolon
Rhizome



Vegetational Areas of Texas

1. Pineywoods
2. Gulf Prairies and Marshes
3. Post Oak Savannah
4. Blackland Prairies
5. Cross Timbers and Prairies
6. South Texas Plains
7. Edwards Plateau
8. Rolling Plains
9. High Plains
10. Trans-Pecos, Mountains and Basins

Adapted from TAES L-492, "Vegetational Areas of Texas."

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<u>Great Trinity Forest Management Plan</u>

Grasslands

Native Warm-Season Grasses and Wildlife

Wildlife Habitat Management Institute

WILDLIFE HABITAT COUNCIL℠

Native Warm-Season Grasses and Wildlife

May 2005 *Fish and Wildlife Habitat Management Leaflet* *Number 25*

Introduction

Native grasslands once covered vast expanses of North America, providing habitat that supported more than 800 native species of plants and animals. Native warm-season grasses were the dominant component of these prairie grassland ecosystems. Native warm-season grasses have minimal requirements for supplemental water or fertilizer. Once established, they are drought tolerant and almost completely disease free. Peak growth periods of these mostly perennial bunch grasses are from June through August. Like other native plants, they have coevolved with the local climate, soils, and rainfall, and are well suited to the growing conditions found in different regions across North America. Likewise, wildlife associated with grasslands are adapted to the habitats that native warm-season grasses provide.

When Europeans began to settle the North American prairies in the late 1800s, they converted large tracts of native grassland to crop production and introduced cool-season grasses. They also began suppressing fire, which had been essential to maintaining natural grasslands. Many of the introduced cool-season grasses were hardy and aggressive species that flourished in the North American climate. These species can grow in dense mats that are almost impenetrable by wildlife and consequently are poor providers of nesting and escape cover for many species. One of the most common introduced cool season grasses is fescue, which often carries a toxic endophyte fungus that can cause reproductive problems for both wildlife and livestock.

Modern development continues to change the landscape and destroy natural grasslands. Today, less than 10 percent of the original tallgrass prairie and 30 percent of shortgrass prairie remains. This loss has directly affected native wildlife; many prairie-dependent species are declining, threatened, or endangered. However, new efforts to restore pre-settlement habitats are helping to educate landowners about the benefits of grasslands. Many people do not realize that warm-season grasses can benefit humans and livestock as well as wildlife. The deep root systems of native grasses hold soil in place, reducing erosion and decreasing runoff, which helps keep waterways healthy and recharges ground water. When native grasses die, their roots decay and add significant amounts of organic matter throughout the soil, replenishing fertility.

Billy Teels, NRCS

Reconstructed tall-grass prairie

This leaflet serves as an introduction to native warm-season grasses and the benefits they provide to wildlife and livestock. The leaflet also provides an overview of the management of native warm-season grass habitat projects. Landowners are encouraged to consult with natural resource professionals to design the most suitable grassland habitat and associated management techniques for their property.

Benefits to wildlife

Native warm-season grasses provide optimum habitat conditions to more native wildlife species than do cool season grasses. They provide three of the basic habitat requirements of grassland wildlife species – food, shelter, and space. The habitat provided by native warm-season grass species is preferred by ground-dwelling wildlife such as rabbits, wild turkeys, ring-necked pheasants, northern bobwhites, and a variety of songbirds and small mammals. Table 1 provides examples of some wildlife species associated with native warm-season grasses.

The growth form of native warm-season grasses is a key factor in their wildlife habitat value. The bunch grass open structure provides bare ground between the plants allowing for easy wildlife movement while providing protective overhead cover. Many cool-season grasses, such as tall fescue, grow too densely for easy wildlife movement. This is particularly important for seed eating birds that pick seeds from the ground. Native warm-season grasses provide effective brood rearing habitat for game birds, allowing chicks to move easily on the ground in search of food. Native warm-season grasses are generally associated with a greater number of important food sources, such as broadleaf forbs, legumes, and insects, than are cool-season grasses.

Native warm-season grasses are structurally durable, with stems capable of withstanding heavy loads of snow in the winter. This characteristic provides wildlife with winter cover and decreases winter mortality. Some warm-season grass species will stand upright even under 2 feet of snow.

Victor Love, IBM Boulder, CO

The eastern cottontail uses native warm-season grasses for food and nesting cover.

Warm-season grasses provide ideal nesting cover for many species, which consists of scattered clumps of herbaceous plants interspersed with bare soil or soil with only a light litter layer. Warm-season grasses provide particularly useful nest sites for ground-nesting birds. Their bunching nature provides the type of structure and materials important for nest building. Where warm-season grasses are harvested, typical haying dates of late June to late July enable early nests to succeed before haying. In contrast, haying

Bobwhite quail: A habitat example

Northern bobwhite populations have been in decline in the eastern U.S. since the late 1960s. Shrinking native grasslands, with corresponding increases in forest and pasture, are main causes of this decline. Bobwhite quail require habitat that has clumps of vegetation where they can nest, in close proximity to sparsely vegetated, recently disturbed areas with bare ground where quail chicks can access insects. Good quail habitat consists of native warm-season grasses, particularly broomsedge, Indiangrass, and little bluestem, interspersed with native legumes such as partridge pea, lespedezas, and beggarticks. Ideally, the landscape also provides scattered shrubs, briers, and blackberry thickets for contrast and escape cover. Quail require a minimum of nine inches of overhead cover for nesting, which is easily supplied in stands of well-managed warm season grasses.

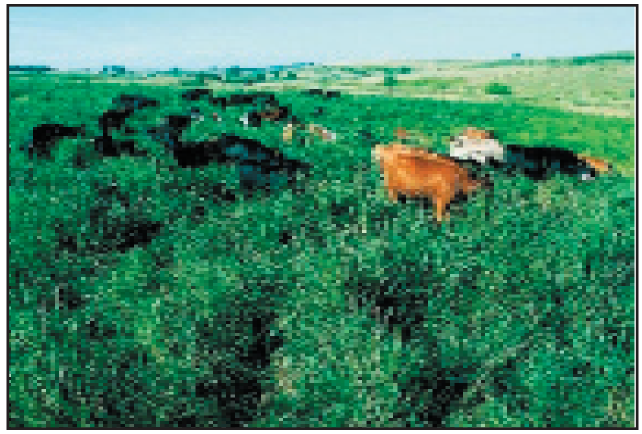
U.S. Fish and Wildlife Service

Native warm-season grasslands provide many of the habitat requirements of the northern bobwhite.

dates of cool-season grasses are much earlier, causing the destruction of many grassland bird nests. Studies have shown that pheasants build 20 percent more nests in switchgrass than in orchardgrass/alfalfa fields. In many regions of the U.S., the use of warm-season grasses has resulted in extraordinary rebounds of several upland game bird populations. The conversion of as little as 5 percent of hayfields to warm-season grasses can increase bird populations 10-fold.

Benefits to livestock

Native warm-season grasses have been shown to be very beneficial for livestock production. Warm-season grasses thrive and provide high quality forage during hot summer months, during which time cool-season grasses are slow growing and unproductive. Approximately 60 to 90 percent of the annual growth of warm-season grasses occurs during June through August, whereas, more than 60 percent of the growth of cool-season grasses occurs before June. Landowners without adequate warm-season grass pastures frequently have to feed hay to their livestock during the height of summer. Some warm-season grasses are more palatable and produce significantly higher weight gain in livestock than some popular cool-season grasses. The ratio of weight gain by cattle feeding on big bluestem and switchgrass to those that feed on tall fescue is approximately 2:1. The high productivity of warm-season grasses, combined with their high digestibility (70% or more) and high protein content (6 to 12%) make warm-season grasses a valuable summer forage.



Lynn Betts, NRCS

Native warm-season grasses provide nutritious forage during hot summer months.

Table 1 Warm-season grassland types and associated wildlife species

	Tallgrass prairie	**Mixed prairie**	**Shortgrass prairie**
Region	Corn Belt (Kansas, Oklahoma, Iowa, Minnesota, North Dakota, South Dakota, Wisconsin, Missouri, Illinois)	Great Plains Region (North and South Dakota, Nebraska, Kansas, central Oklahoma, north central Texas)	Montana, eastern Wyoming, Colorado, western Kansas, Oklahoma panhandle, northern Texas, North and South Dakota, Alberta, Saskatchewan
Grasses	Big bluestem, Indiangrass, little bluestem, side-oats grama, switchgrass	Little bluestem, buffalo grass, grama grass	Blue grama, buffalo grass, needle grass
Associated	Pocket gophers, ground squirrels, elk, white-tailed deer, mule deer, rabbit, coyote, greater prairie-chicken, sandhill crane, loggerhead strike, waterfowl	Pronghorn, black-tailed jackrabbit, desert cottontail, coyote, eastern cottain-tail, mule deer, white-taileddeer, prairie dog, ground squirrel, gopher, burrowing owl, grassland birds	Prairie dog, pronghorn, swift fox, bison, black-tailed deer, white-tailed deer, bobcat, cougar, short-horned lizard, rattlesnake, burrowing owl, ferruginous hawk, Swainson's hawk, golden eagle, sharp-tailed grouse, sage grouse, mountain plover, killdeer

Management

Table 2 provides management considerations for landowners in planting and maintaining native warm-season grasses. Management techniques vary from region to region. Landowners are encouraged to consult local grassland management experts, local conservation districts, state wildlife agencies, or local NRCS offices for more information on site preparation, planting, burning, and grazing management.

Landowner assistance

Financial and technical assistance for native grassland projects are available from an array of government agencies and public and private organizations. Table 3 lists the contact information of organizations that can provide information about grassland management, as well as other natural resource projects, and describes their associated conservation incentive programs.

Conclusion

The benefits to both wildlife and livestock from warm-season grasses far surpass the initial investment of time and money to plant and establish them. Native warm-season grasses provide food and nesting and escape cover for a variety of grassland wildlife species. They also serve as valuable summer forage for livestock. With some assistance from local agencies, landowners can plant and maintain warm-season grasses on their properties. Native warm-season grasses provide a relatively low-maintenance land cover alternative that is extremely beneficial to both landowners and wildlife.

Top: Little bluestem (Schizachyarium scoparium), big bluestem (Andropogon gerardii). Bottom: Switchgrass (Panicum virgatum), Indiangrass (Sorghastrum nutans). Photos courtesy Charlie Rewa, NRCS.

Table 2 Management considerations for native warm-season grasses

Planning	Determine site conditions (soil types, topography, rare plants and animals, existing vegetation, hydrological characteristics) Identify project goals
Obtaining seed	Ensure that purchased seed has been tested by a certifying agency Purchase seed as Pure Live Seed (PLS) and not as bulk seed Consult the PLANTS National Database (*http://plants.usda.gov/*) for help with seed selection Consult the Plant Materials Program (*http://www.plant-materials.nrcs.usda.gov/*) for fact sheets and planting guides to select the plant releases that are best suited to a particular area and for source identified or selected releases to use for widlife purposes Ensure that seed does not contain undesirable species If collecting seed, ensure that collection is legal and that seeds are adapted to local conditions
Site preparation	If necessary, pack the soil with a cultipacker. The site is properly packed when a footprint barely registers in the soil
Planting	For sites smaller than half an acre, seed by hand For sites larger than half an acre, use a native drill seeder, which will reduce labor and costs, plant seed uniformly, and produce consistent successful results
Controlling weeds	Reduce weed competition during the first few years by mowing to allow sunlight to reach developing seedlings. Other methods include plowing, hand pulling, burning, grazing, or applying herbicides
Prescribed burning	Obtain a burn permit before a prescribed burn is performed Because proper timing of burning operations is dependent upon the landowner's objectives, landowners should consult their local NRCS office for assistance with timing of native grass burns Burn rotationally every three to five years To suppress established warm season grasses that get too dense and rank for wildlife benefit, summer or early fall burns will set back warm season grasses
Mowing	Only mow if burning is not an option If mowing is necessary, mow after peak wildlife nesting times on a three to five year rotation. Peak nesting times vary from region to region and can continue through the end of July in some areas
Discing	To suppress established warm season grasses that get too dense and rank for wildlife benefit, use light discing or strip discing to open stands
Rotational grazing	Do not allow warm season grasses to be grazed lower than 10 inches Allow grasses to regrow to approximately 18 inches before they are grazed again Grazing pure stands of switchgrass can be potentially toxic to horses, sheep, and goats

Table 3 Financial and technical assistance available to landowners with habitat projects

Program	Land eligibility	Type of assistance	Contact
Conservation Reserve Program (CRP)	Highly erodible land, wetland and certain other lands with cropping history; streamside areas in pasture land.	50% cost-share for establishing 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 local office
Environmental Quality Incentives Program	Cropland, rangeland, grazing land and other agricultural land in need of treatment.	Up to 75% cost-share for conservation practices in accordance with 1- to 10-year contracts. Incentive payments for certain management practices.	NRCS state or local office
Partners for Fish and Wildlife Program (PFW)	Most degraded fish and/or wildlife habitat.	Up to 100% financial and technical assistance to restore wildlife habitat under minimum 10-year cooperative agreements.	Local U.S. Fish and Wildlife Service office
Wildlife Habitat Incentives Program (WHIP)	High-priority fish and wildlife habitats.	Up to 75% cost-share for conservation practices under 5- to 10-year agreements.	NRCS state or local office

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(301) 588-8994

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<u>Great Trinity Forest Management Plan</u>

Grasslands

Grassland Birds

United States Department of Agriculture
NRCS Natural Resources Conservation Service
Wildlife Habitat Management Institute

WILDLIFE HABITAT COUNCIL™

Grassland Birds

October 1999 — *Fish and Wildlife Habitat Management Leaflet* — *Number 8*

U.S. Fish and Wildlife Service

Western meadowlark

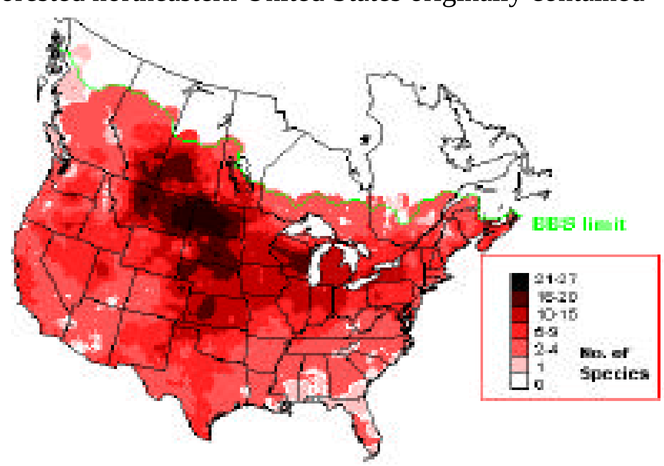
General Information

Grassland birds, or those birds that rely on grassland habitats for nesting, are found in each of the 50 United States and worldwide. Various species of waterfowl, raptors, shorebirds, upland gamebirds and songbirds rely on grasslands for nesting and other habitat functions. Historical population fluctuations in grassland-nesting bird species have coincided with changes in land uses and agricultural practices. Many North American grassland-nesting birds species have experienced marked population reductions in recent decades. Continued nationwide declines in some grassland-nesting bird species have increased awareness for the need to preserve, manage, and restore grassland habitat in order to recover and maintain viable grassland-nesting bird populations.

This leaflet is designed to serve as an introduction to the habitat requirements of grassland birds and to assist landowners and managers in developing comprehensive grassland bird management plans for their properties. The success of grassland bird management in a given area requires that managers consider the present habitat conditions in the area and the surrounding landscape and identify management actions to enhance habitat quality for local grassland birds.

Grasslands of the United States

Native grasslands in the United States have experienced many changes since the arrival of Europeans to North America. There is little doubt that the predominately forested northeastern United States originally contained parcels of open grasslands, including those cleared by native Americans. These grassland areas undoubtedly supported populations of grassland birds. By the 1800s, grasslands were widespread in the northeast due to the forest clearing activity of European settlers to create pastures and hayfields. The establishment of these agricultural grasslands was associated with increases in some grassland bird species populations. In the Midwest and Great Plains regions, settlers found vast expanses of native grassland that had covered much of the landscape. Most of these grasslands were converted to agricultural fields and livestock pastures in the late 1800's and early 1900's as farmsteads and European settlement expanded westward.



Breeding Range of 27 grassland birds. Species include upland sandpiper, long-billed curlew, mountain plover, greater prairie-chicken, sharp-tailed grouse, ring-necked pheasant, northern harrier, ferruginous hawk, common barn-owl, short-eared owl, horned lark, bobolink, eastern meadowlark, western meadowlark, chestnut-collared longspur, McCown's longspur, vesper sparrow, savannah sparrow, Baird's sparrow, grasshopper sparrow, Henslow's sparrow, Le conte's sparrow, Cassin's sparrow, dickcissel, lark bunting, Sprague's pipit, and sedge wren.

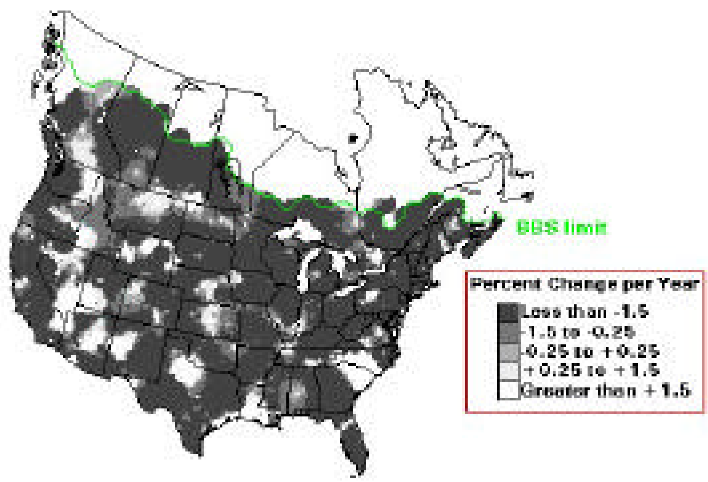
The 1900s also brought major changes to the character of grasslands in both eastern and midwestern/Great Plains regions. Changes in agricultural practices with the advancement of modern machinery and an increasing demand for agricultural products continued to reduce native grassland acreage in the west. Plowing of fields, removal of native grazers (bison), loss of wetlands, implementation of plantation forestry practices, and invasion of woody vegetation resulting from fire suppression have all contributed to significant losses of native grassland habitats. As farms moved westward, many once-large expanses of eastern grasslands became fragmented and began to disappear as idle farmland reverted back to old field and second-growth forest. Development of large farming operations in the Midwest and Great Plains has significantly changed the composition of grasslands; intensively managed crop fields and improved pastures have largely displaced native grasslands on most of the agricultural landscape. In the Midwest, pasture and hayland is also being replaced by more intensively-managed row crops. On the high plains and other areas of the west, a larger percentage of the landscape remains grassland habitat. Many of these rangelands are used extensively for grazing livestock.

Declines in Grassland Bird Populations

Breeding Bird Surveys (BBS) conducted by the Biological Resources Division of the U.S. Geological Survey and volunteers throughout the country reveal that grassland birds, as a group, have declined more than other groups, such as forest and wetland birds. There are many examples of population decline in grassland birds, most notably the extinction of the heath hen from the northeastern United States. Over the 25-year period 1966-1991, New England upland sandpiper and eastern meadowlark populations declined by 84 and 97 percent, respectively. The greater prairie-chicken has experienced an average annual rate of decline of over 10 percent during this same 25-year period. These examples and others illustrate the decline in grassland birds on a continental scale.

The figure at the right illustrates how widespread the decline in grassland birds has been in recent decades. Only 23 percent of the species tracked showed an average annual positive trend in population size, while the remainder either had no change or declined. As the figure illustrates, most areas have experienced long-term declines in grassland bird populations.

While loss of grassland breeding habitat is likely the largest factor contributing to the decline in many grassland bird species, other factors have played a role. Brood parasitism by brown-headed cowbirds, increased use of pesticides and other agricultural chemicals toxic to birds, mortality during migration, and loss of wintering habitats may have contributed to population declines in many species.



Average annual population changes in 28 grassland bird species from 1966 to 1996.

Habitat Requirements

General

Each grassland-nesting bird species has a unique set of habitat requirements. Table 1 illustrates some of the habitat preferences of many grassland-nesting bird species. While there are similarities among many species habitat requirements, habitat management to meet the specific needs of one species may or may not benefit other species. It is beyond the scope of this leaflet to identify detailed habitat requirements for each individual grassland-nesting bird species inhabiting various regions throughout the United States. However, generalizations can be made for the grassland-nesting bird habitat guild, and broad concepts can be addressed and considered in developing habitat management plans for grassland-nesting birds.

Grassland birds are naturally adapted to native grasslands and prairie ecosystems throughout North America. While these communities offer some of the highest quality nesting habitats, they are now extremely rare, especially east of the Great Plains. Fortunately, many grassland birds do not require native vegetation for breeding habitat. "Surrogate grasslands" on agricultural landscapes, in the form of hayfields, small grains, fallow and old fields, pastures, and idled croplands provide most of the important nesting habitats for grassland-nesting birds. Strip habitats such as right-of ways for utility lines, highways, railroads, and secondary roads; and field borders, grassed waterways, filter strips and similar linear habitats maintained in early successional communities provide valuable nesting and foraging habitats as well. On landscapes where intensive row crop agriculture is the dominant land use, these strip habitats are extremely important habitats for grassland birds and other wildlife. Grassland bird assemblages vary with the physical habitat structure, disturbance patterns and other factors. For each species or group of species, these habitats provide protective cover for nesting and brood-rearing activities. Adequate cover of undisturbed grassland is among the greatest factors affecting grassland bird populations, and the continued loss and conversion of grassland breeding and nesting habitat remains the largest threat to the future of many grassland bird species. Preserving and properly managing grassland communities can help maintain and increase local grassland bird populations, as well as populations of other wildlife species that use these habitats.

Table 1. Habitat preferences of common grassland nesting birds.

Species	Preferred grassland growth form			Avoids woody vegetation[1]
	Short	Med.	Tall	
Upland Sandpiper	X	X		X
Long-billed Curlew	X			
Mountain Plover	X			
Greater Prairie-chicken	X	X		X
Sharp-tailed Grouse	X			
Ring-necked pheasant		X	X	
Northern Harrier			X	X
Ferruginous Hawk	X	X		
Common Barn Owl	X	X	X	X
Short-eared Owl		X		X
Horned Lark	X			X
Sedge Wren			X	
Sprague's Pipit		X		
Bobolink		X		X
Eastern Meadowlark		X		
Western Meadowlark	X			X
Chestnut-collared longspur	X	X		
McCown's longspur	X			
Vesper Sparrow	X			
Savannah Sparrow	X	X		X
Baird's Sparrow		X	X	
Grasshopper Sparrow	X			X
Henslow's Sparrow		X	X	X
Le Conte's sparrow			X	X
Dickcissel		X	X	
Lark Bunting	X	X		

[1] While species marked avoid areas with woody vegetation, most can tolerate some woody vegetation within areas dominated by grassland.

Food Resources

The foods eaten by grassland birds are as diverse as the types of birds that inhabit grassland ecosystems. While insects are likely the most common food source, a wide variety of plant and animal matter is consumed. The box below lists some of the many food items of grassland birds.

Important grassland-nesting bird food items.

Insects and other invertebrates: grasshoppers, crickets, beetles, dragonflies, caterpillars, ants, katydids, alfalfa weevils, cutworms, wasps, spiders, snails, earthworms, sow bugs, others.

Raptor prey items: mice, gophers, voles, shrews, moles, prairie dogs, rabbits, snakes, lizards, songbirds, others.

Fruits, seeds and cultivated crops: wild berries, seeds of sedges, weed seeds, tame grass seeds, corn, oats, wheat, barley, other small grains

Native grass seeds: big bluestem, little bluestem, switchgrass, Indiangrass, green needlegrass, western wheatgrass, side-oats grama.

The Importance of Grassland Cover

While all grassland birds rely on herbaceous cover for nesting or foraging, there are many differences in cover requirements among individual species and groups of species. In addition, some species are area-sensitive, requiring large blocks of unbroken grassland habitat for nesting (see minimum habitat area section below). Some species, such as the barn owl, require woody vegetation or other non-grassland structures in which to nest (e.g., tree cavities or nest boxes), while the presence of woody vegetation can be detrimental to other species. Some species require the presence of nearby water or wetlands. Both the vegetation density and growth form – short, medium height, or tall grass – as well as surrounding land use also influences the assemblage of birds that may occur in a given area. In general, where large blocks of undisturbed grassland occur, grassland birds are able to fulfill most courtship, nesting, brood-rearing, feeding, escape, and loafing cover requirements during the nesting season. For many bird species, these habitats provide winter and migration cover as well.

Grasslands in eastern North America provide habitat for grassland-nesting birds within a predominantly forested landscape.

In agricultural landscapes, pastures and crop fields provide cover attractive to many grassland birds. However, in many situations, cultural practices and harvesting operations may destroy nests and adults that attempt to nest in these areas. Although these impacts are unavoidable in many instances, measures discussed in this leaflet can be taken to minimize impacts to nesting birds during field operations.

Landscape Factors

Habitat value for grassland birds is greatly affected by the condition of the landscape in the area and surrounding land uses. Small, isolated parcels of grasslands in landscapes that are heavily wooded have limited potential to support grassland birds. On the other hand, blocks of grassland habitat that occur within landscapes dominated by open grass cover are much more likely to attract and support grassland birds. Interspersion of various types of grassland can maximize habitat quality for some species. However, interspersion of grassland habitat with woody vegetation and other land uses that fragment grassland habitats may be detrimental. Some area-sensitive obligate grassland species (and also some habitat specialists) require large unbroken blocks of grassland habitat with little or no interspersion with other habitat types. For this reason, it is crucial to consider landowner objectives, local landscape features and management potential, and area-wide population goals of target grassland species in the area when planning management actions for grassland birds. Consultation with state and Federal wildlife agencies and review of established grassland bird priorities for the region (e.g., Partners in Flight Bird Conservation Plans – see *www.partnersinflight.org*) can assist in this process.

The greater the variety of grassland growth forms available and successional growth stages that occur within grassland landscapes, the greater the number of grassland bird species they can support. In addition, the more grassland that is available in an area, particularly in large unbroken blocks, the greater the number of area-sensitive grassland birds the area is able to support.

Area-sensitivity and Minimum Habitat Area

Many "area-sensitive" grassland bird species require a certain amount of habitat to be present, usually in contiguous patches or unbroken blocks, before individuals will use a given site. Estimates of the minimum size of suitable nesting and breeding habitat required to support breeding populations of grassland birds vary greatly among species. Species-specific area requirements may also vary among geographic regions and landscape characteristics. For example, the size of habitat patches needed to attract individuals of a given species may be smaller in landscapes that contain a large amount of grassland and open habitats compared to areas with little grassland habitat.

In order to support an array of grassland-nesting bird species within an area, contiguous grassland blocks of at least 500 acres provide the greatest potential. However, smaller grassland blocks provide viable habitat patches for many grassland bird species. A general rule may be to maximize the size and interconnectedness of grassland habitat patches available, while conducting management actions that maximize the habitat quality within these habitat patches.

Grassland and Rangeland Management for Grassland Birds

Grassland bird habitats in existing grasslands, whether unbroken native prairie, retired farmlands, improved pasture, or other grassland systems, can be maintained and improved through various management actions.

***Rotational mowing*:** Rotational mowing can be used to maintain grassland communities in various stages of growth and vegetation diversity. This management practice is conducted by dividing an area into 15 to 25-foot wide strips (depending on the area's size) that are separated from one another by 50 to 85 feet (see Fig. 1). Wider strips can be established to provide larger habitat blocks as well. A single strip is mown to a height of four to eight inches either once or twice a year depending on the species of grassland-nesting birds present in the area. Smaller areas can be divided into three strips; mow one strip in early spring (mid-March to mid-April, depending on the region) before grassland birds commence nesting activities, and again in late summer after nesting activities are completed. The following year, the second strip would be mowed in the same months. The third strip would be mowed in year three, and the process begins again in year four. Larger areas evenly divided into six or more strips can be rotationally mown in pairs, so that strip one is worked with strip three, strip two with strip four, strip three with strip six, and so forth. Note: Landowners should work closely with local NRCS field officers, state department of natural resource officers, and other wildlife professionals when planning grassland management to determine mowing dates and techniques that minimize impacts to nesting birds. Knowing the types and habits of species for which an area is managed will also help to determine whether or not residual cover should be provided for nesting birds, and thus whether or not the area should be mowed a second time within the same year in late fall.

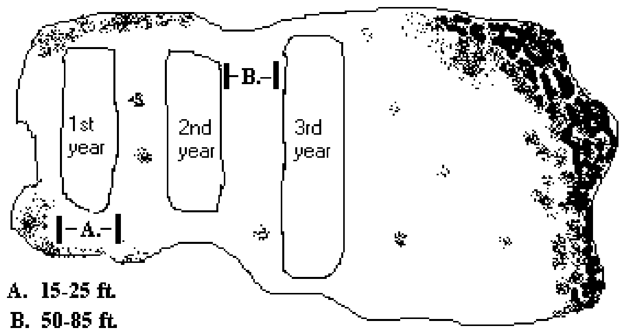
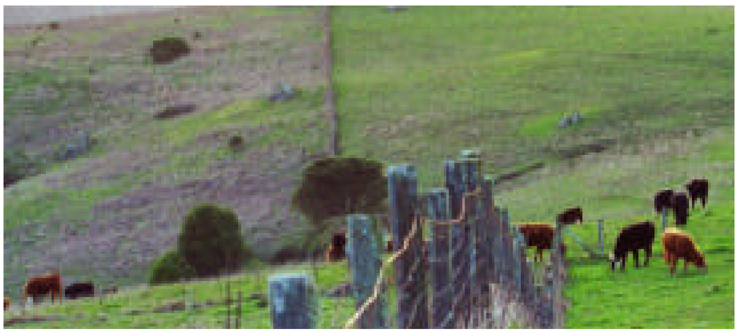


Fig. 1. Rotational mowing configuration to provide various grassland growth forms for grassland birds.

Prescribed grazing: Rotational, deferred, or continuous gazing can be conducted to benefit both forage quality and grassland bird habitat. Grazing by bison in the west was once a natural means of grassland management, and grassland birds may benefit today from controlled livestock grazing in many areas. Depending on the region, grassland composition, and the bird species managed for, grazing types and practices may vary. Rangelands can be maintained in good condition, providing quality forage and suitable grassland bird habitat for many species by one or more of the following measures:

- Provide 30 to 50 days of rest between grazing periods in each paddock .
- Defer grazing in some nesting areas until late in the nesting season.
- Restrict livestock from sensitive nesting areas.
- Graze the entire pasture at a light rate (allowing grass height to be maintained at least 10 inches tall) all summer and put the entire herd on just one half of the pasture during the late season.



- Avoid heavy continuous grazing.
- Rotationally graze cool season grasses in spring and fall and warm season grasses in mid-summer to maximize productivity while minimizing habitat disturbance.

Prescribed burning: Prescribed burning is used to maintain grassland communities in various stages of growth and vegetation diversity similar to rotational mowing and managed grazing. Burning returns valuable nutrients to the soil and maintains grasslands as open habitat, thus preventing conversion of grasslands to wooded communities through invasion or natural plant succession. Most native grasslands benefit from fire. The suppression of natural wildfires in the United States has reduced the quality of many remaining grassland communities. Although beneficial, prescribed burning is a highly regulated technique and should only be conducted in compliance with all state and local laws and with appropriate technical assistance. Agencies and qualified individuals can help develop burn plans and provide necessary tools, equipment, and supervision, and can assist in obtaining required burning permits. Prescribed burns should be conducted on a three- to five-year rotational basis, but shorter rotations may be used to benefit some species. Most prescribed burning should be done in the early spring (March-April, depending on the region), but late-summer and fall burns may also be appropriate in some circumstances. Dividing the burn area into strips or plots is important in order to leave undisturbed nesting habitat adjacent to burned plots. Adequate firebreaks should be planned for prescribed burn areas.

Woody vegetation removal: In areas managed for birds that are intolerant of woody vegetation, grassland management through prescribed burning, mowing and grazing can help maintain grassland habitats. Manual removal of trees and shrubs may be necessary where these practices have not been conducted or where scattered trees and shrubs become established in odd areas. However, some species of grassland birds are benefited by scattered trees, shrubs, and woody fencerows (e.g., loggerhead shrike, Bell's vireo, field sparrow, clay-colored sparrow, and vesper sparrow, as well as savanna birds such as red-headed woodpecker and orchard oriole). In addition, in some areas, birds that use scrub habitats (e.g., yellow-breasted chat, indigo bunting) may be in greater decline than grassland birds, making maintenance of some scrub habitats (non-forest) a priority. Linear woody cover that fragments large blocks of grassland habitat may be more detrimental to grassland birds than scattered patches, due to their use as travel corridors by nest predators. Landowners and managers should carefully consider bird species habitat objectives before proceeding with woody vegetation removal actions.

Cropland Management for Grassland Birds

Hay fields: Ideally, hay mowing activities should be delayed until mid-July or early August to allow grassland birds to complete most nesting activities. However, in many instances this is not feasible for farmers who need to harvest high quality forage. In these circumstances, birds may be drawn to nest in the cover provided by the hay crop only to lose the nest or be killed by hay mowing operations. However, the following measures can be taken to minimize impacts on birds nesting in production hay fields.

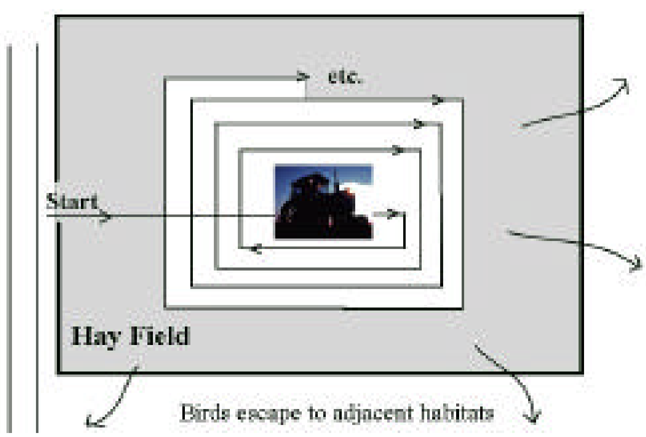


Fig. 2. Hay fields should be mowed from the center outward to allow birds to escape to adjacent habitats.

1) Hay fields should be mowed from the field center outward to provide cover that allows fledgling birds to escape to the edge of the field (see Fig. 2).
2) Fields can be broken into sub-units and mowed on a rotational basis to allow for some useable habitat to be available at all times.
3) Adult nesting birds and roosting individuals are less likely to flush from cover during the night. Therefore, night mowing should be avoided to prevent adult bird mortality.
4) Flushing bars should be mounted on harvesting equipment to minimize bird mortality during mowing operations.

5) Strip cover and similar herbaceous cover should be left undisturbed until well after the nesting season (mid to late August) to allow birds that failed to successfully nest in active hayfields the opportunity to successfully re-nest in these alternative adjacent habitats.

Small grains and row crops: Small grain and row crop fields provide surrogate grassland habitat structure for some grassland birds. While some species nest in conventionally-tilled row crop fields (see Table 2), nest success is generally low due to the frequency of disturbance during the nesting season. Small grain fields, which are typically harvested later in the nesting season, provide more productive nesting habitats for some species. Measures can be taken to improve grassland bird habitat quality in crop fields and to minimize impacts to nesting birds.

1) Use no-till practices to provide residual nesting cover and waste grain availability for winter food.
2) Minimize the number of equipment passes through conservation tillage practices. Allow 35 to 40 days if possible between equipment passes to allow for complete nesting cycles.
3) Use contour buffer strips and strip cropping practices to provide some undisturbed habitat adjacent to crop fields that are disturbed by equipment passes.
4) Reduce the use of pesticides and inorganic fertilizers through Integrated Pest Management practices.
5) Explore use of alternative crops and cropping practices such as native grass biomass crops and inter-cropping practices.
6) Make use of set-aside programs that idle sensitive cropland and establish and maintain high-quality cover consisting of a diversity of native grasses and forbs.

Table 2. Bird species found to nest in conventionally-tilled (T) and no-till (NT) corn and soybean fields[1] (from Best 1986).

	Corn		Soybeans	
Species	T	NT	T	NT
Ring-necked pheasant		x	x	x
Killdeer	x	x		
Mourning dove	x	x	x	x
Horned lark	x		x	
American robin		x		
Common yellowthroat		x		
Bobolink		x		
Eastern meadowlark		x		
Western meadowlark		x		x
Red-winged blackbird	x	x		
Brown-headed cowbird	x	x	x	x
Dickcissel		x	x	
Savannah sparrow		x		
Grasshopper sparrow		x		
Vesper sparrow	x	x	x	x
Field sparrow		x		x

[1] Some NT fields were pastures treated with a burn-down herbicide.

Grassland-nesting Birds Habitat Requirements Summary Table.

Habitat Component	Habitat Requirements
General	· Grasslands, crop/grassland/forb-mixed communities, prairies, meadows, hayfields, grazed pastures and rangelands, reverted agricultural fields, idle pastures and old fields, utility and roadway right-of-ways and other strip habitats, coastal grasslands, and other open herbaceous habitats.
Food	· Insects and other invertebrates · Fruits, seeds and cultivated crops: wild berries, weed seeds, exotic grass seeds, seeds of sedges, corn, oats, wheat, barley, other small grain crops · Native grasses seeds: big bluestem, little bluestem, switchgrass, Indiangrass, green needlegrass, western wheatgrass, side-oats grama
Interspersion – grassland obligate species	· Mixture of short, medium, and tall grass areas in large, unbroken grassland blocks with less than 5% woody vegetation cover. Native grasses provide optimal conditions, but introduced cool season grasses may also provide suitable habitats for many grassland birds.
Interspersion – species requiring woody vegetation	· Grassland communities adjacent to woodlands, savannas, wetlands, shrubland, old field communities, overgrown fencerows and shelterbelts. Individual bird species requirements must be considered in determining woody vegetation requirements.
Minimum Habitat Size	· Minimum size of suitable nesting and breeding habitat required to support a breeding population of grassland birds varies among species. Depending on species habitat objectives, minimum habitat size may range from as little as 10 acres to as much as 500 acres or more. For grassland bird management, at least 40 acres of grassland should be available unless adjacent to larger grass habitat blocks.

Habitat Inventory and Assessment

Managing habitats for grassland birds relies on assessing the management potential of each area within the surrounding landscape and deciding which species or groups of grassland birds should be targeted. For planning purposes, use the table below to inventory the site to subjectively rate the availability, quality, and potential of grasslands and surrounding habitats, as well as their proximity to one another, based on the above narrative habitat requirement descriptions. Keep in mind that site conditions may provide good habitat conditions for some species and poor habitat for others. For example, habitat quality for species that rely on large unbroken expanses of grassland such as the northern harrier, greater prairie chicken, upland sandpiper, and grasshopper sparrow may be limited in areas with high interspersion with woody habitat types. However, species that tolerate or require some woody vegetation such as the eastern bluebird, loggerhead shrike and field sparrow benefit from high interspersion among grassland and woody habitat types. Therefore, grassland bird community objectives must be considered in determining limiting factors and management objectives for an area.

Habitat Component	Availability/Quality/Potential			
	High	**Medium**	**Low**	**Absent**
Nesting cover: Short grass nesting species				
Medium grass height nesting species				
Tall grass nesting species				
Food				
Diversity of surrounding habitat				
Interspersion: Large grassland blocks available (circle one)	>250 ac.	25-250 ac.	<25 ac.	
Grassland fragmented by forest/other land uses				

Management Prescriptions

Management treatments should be designed to match the planning area with grassland bird habitat conditions and objectives for the local landscape and address the habitat components that are determined to be limiting habitat potential for the target grassland bird species. For planning purposes, select among the possible action items listed below to raise the quality or availability of each habitat component determined to be limiting. NRCS Conservation Practices and various programs that may provide financial or technical assistance to carry out specific management practices are listed where applicable.

U. S. Fish and Wildlife Service

Savannah sparrow

Habitat Component	Management options for increasing Habitat quality or availability	Cons. Practices & Assistance Programs
Food	· Preserve and maintain grassland/forb communities by conducting prescribed burning, rotational mowing, and prescribed grazing (especially during drought) when and where appropriate. Encourage a forb component in grasslands.	327, 338, 528A, 645, 647 WHIP, EQIP, PFW, CRP
	· Plant native warm season grasses adapted to the site such as big bluestem, little bluestem, switchgrass, eastern gama, and Indiangrass, and native cool season grassses such as green needlegrass, western wheatgrass, and side-oats grama.	327, 390, 643, 645, 647 WHIP, EQIP, PFW, CRP
	· In areas where fragmentation of large grassland blocks is not a concern, preserve overgrown fence-, tree-, and establish hedgerows that provide a diversity of plant and insect life and wild fruits and seeds.	380, 391, 422, 650 WHIP
	· Leave waste corn, oats, wheat, barley, rye, sorghum, and other small grain crops on ground after harvest activities. Avoid fall tillage.	329
	· Limit herbicide and insecticide use on range- and other grasslands to small areas or use mechanical means so as to reduce reduction of forbs, invertebrates (insects), or mast (seeds) used as food.	329
Nesting cover	· Preserve and maintain grassland/forb communities by conducting prescribed burning, rotational mowing, and prescribed grazing (especially during drought) when and where appropriate. Encourage a forb component in grasslands.	327, 338, 528A, 645, 647 WHIP, EQIP, PFW, CRP
	· Plant native warm season grasses adapted to the site such as big bluestem, little bluestem, switchgrass, eastern gama, and Indiangrass, and native cool season grassses such as green needlegrass, western wheatgrass, and side-oats grama.	327, 390, 643, 645, 647 WHIP, EQIP, PFW, CRP
	· Restore hydrology and vegetation in herbaceous wetlands and establish adjacent grassland buffers	657 PFW, WRP
	· Establish field borders, hedgerows, shelterbelts, and other habitat corridors on agricultural land (may harm some area-sensitive species while benefiting other species). This can conflict with management for open grassland species by fragmenting open grassland; the exception may be in row crop-dominated systems.	380, 386, 390, 391, 422 WHIP, EQIP. PFW. CRP
	· Conduct haying activities in a manner that minimizes bird mortality and allows for some nesting success where feasible.	
	· Reduce herbicide use when application results in loss of nesting and winter cover provided by grasses and forbs.	
Interspersion & minimum habitat size	· Combine above prescriptions to increase interspersion of habitat components or amount of suitable grassland bird habitat. · Provide large (500 acres if possible), diverse grassland blocks or connect smaller grassland blocks with adjacent grassland areas.	

NRCS Conservation Practices that may be useful in undertaking the above management actions.

Conservation Practice	Code	Conservation Practice	Code
Conservation Cover	327	Hedgerow Planting	422
Residue Management	329	Prescribed Grazing	528A
Prescribed Burning	338	Restoration of Declining Habitats	643
Windbreak/Shelterbelt Establishment	380	Upland Wildlife Habitat Management	645
Field Border	386	Early Successional Habitat Development	647
Riparian Herbaceous Cover	390	Windbreak/Shelterbelt Renovation	650
Riparian Forest Buffer	391A	Wetland Restoration	657

Available Assistance

Landowners interested in making their individual efforts more valuable to the community can work with WHC and NRCS to involve school, scout, and community groups and their families in habitat projects when possible. On-site education programs demonstrating the necessity of grassland-nesting bird habitat management can greatly increase the value of your individual management project as well. Corporate-owned land should encourage interested employees to become involved. Involving federal, state and non-profit conservation agencies and organizations in the planning and operation of a grassland-nesting bird management plan can greatly improve the project's success. Assistance programs available through various sources are listed below.

Programs that provide technical and financial assistance to develop 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. Streamside areas in pasture land	50% cost-share for establishing permanent cover and conservation practices, and annual rental payments for land enrolled in 10 to 15-year contracts. Additional financial incentives are available for some practices	NRCS or FSA State or local Office
Environmental Quality Incentives Program (EQIP)	Cropland, range, grazing land & other agricultural land in need of treatment	Up to 75% cost-share for conservation practices in accordance with 5 to 10-year contracts. Incentive payments for certain management practices	NRCS State or local Office
Partners for Fish and Wildlife Program (PFW)	Most degraded fish and/or wildlife habitat	Up to 100% financial and technical assistance to restore wildlife habitat under minimum 10-year cooperative agreements	Local office of the U.S. Fish and Wildlife Service
Waterways for Wildlife	Private land	Technical and program development assistance to coalesce habitat efforts of corporations and private landowners to meet common watershed level goals	Wildlife Habitat Council (301-588-8994)
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 local Office
Wildlife at Work	Corporate land	Technical assistance on developing habitat projects into a program that will allow companies to involve employees and the community	Wildlife Habitat Council (301-588-8994)
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 local Office
State fish and wildlife agencies and private groups such as Pheasants Forever and Prairie Grouse Technical Council may have assistance programs or other useful tools in your state.			State or local contacts

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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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The Wildlife Habitat Council's mission 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

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Great Trinity Forest Management Plan

Grasslands

Mowing and Wildlife: Managing Open Space for Wildlife Species

Mowing and Wildlife: Managing Open Space for Wildlife Species

Many property owners want clean-cut, attractive lawns or fields. However, what appears to be a healthy lawn to property owners isn't necessarily the best option for wildlife. In fact, continual mowing can reduce or remove valuable habitat and discourage many wildlife species from visiting a landowner's property. However, when properly used, mowing can be a useful habitat management tool.

Key Facts for Wildlife-Friendly Mowing

Realistic goals must be considered for any habitat management practice, including mowing. If you are targeting a particular species, the species must occur – or potentially occur – at the desired location, based on it's habitat requirements, life cycle, and distribution. After determining that a target species may occur on your property, several considerations should be kept in mind when deciding if you should mow and at what time you should apply this habitat management practice. For instance, mowing during spring and summer months may reduce or even kill nesting and young animals, such as eastern meadowlarks, bobwhite quail, ring-necked pheasants, rabbits and deer. The uncut areas allow the young animals to hide from predators, and provide seasonal forage and thermal cover.

White-tailed deer

Mowing to control "weeds" also may not be beneficial for some wildlife. Although controlling problem plants such as thistles and Atlanthus is important, many "weeds," including nettles, foxtail and ragweed, are palatable to wildlife or attract insects needed to meet the diet requirements of many bird species. The trick is providing a balance between volunteer forbs (weeds) and other desirable plants. However, without some management, foxtail and other persistent plants can dominate grass stands and reduce diversity. In addition, some weedy-looking tall grasses, such as Indiangrass, switchgrass, big and little bluestems, broom sedge, Canada wild rye, and Virginia wild rye are actually native grasses.

Native grasses grow in clumps and are used to reestablish native grasslands in Pennsylvania under programs such as the Conservation Reserve Program (CRP) and the Conservation Reserve Enhancement Program (CREP). These native grasses provide excellent year round cover and forage for wildlife, while retaining enough bare ground areas for animals to move through the field in search of food. Still, to maintain the existence of a native grass field, occasional disturbance from mowing, burning, spraying, or disking is needed. Without mowing or other disturbances, succession will take place, and your grassland will be replaced by woody vegetation. Subsequently, wildlife requiring grassland or meadow habitat will be replaced by more common woodland wildlife. Mowing in cycles and pattern mowing are beneficial management alternatives for wildlife that rely on grasslands. These techniques involve cutting different blocks of meadow or grassland each year on a two to five year cycle. Mowing in cycles creates habitat with different-aged, diverse vegetation and deters the growth of trees and shrubs, thus preserving your grassland.

Giant Foxtail

Switchgrass

Common Wildlife Nesting Periods:

White-tailed deer	May 15th to July 15th
Eastern cottontail rabbits	February 1st to September 30th
Wild turkeys	April 15 to July 31st
Bobwhite quail	April 15th to July 31st
Ring-necked pheasant	April 15th to June 30th
Grassland songbirds:	Average (June 1st to August 15th)
- Eastern meadowlark	May 15th to July 31st
- Grasshopper sparrow	June 1st to August 15th
- Field sparrow	May 15th to August 15th
- Bobolink	May 15th to June 30th
- Dickcissel	June 1st to July 31st

Mowing Considerations

When, why, where, and how to mow should be considered before using mowing to manage wildlife habitat.

When to Mow:

To maximize wildlife benefits and reduce wildlife mortality, mowing should be done outside of the nesting and brood-rearing season, which generally occurs from April to August. Late summer and late winter are the best times to mow for wildlife.

Cool season grasses and forages (Canada wild rye, Virginia wild rye, orchardgrass, timothy, clovers, etc.) should be left uncut every other year to improve soil, cover, and forage conditions for wildlife. When managed for premium hay production, cool season grasses are often cut during the nesting season. A balance between habitat and hay production is achieved when harvest occurs in late May. At this time, cool season grasses are highly nutritious, resulting in quality hay. As a wildlife benefit, mowing in late May allows some regrowth to occur prior to peak nesting season.

Compared to cool season grasses, native warm season grasses (switchgrass, big and little bluestems, indiangrass, etc.) mature later in the growing season. This allows the grasses to be mowed after the peak nesting season. Mowing for native warm season grasses should occur from August 1 to August 15 to allow enough regrowth for winter cover. Mowing warm season grasses at this time also allows grasses to build energy reserves necessary for hearty regrowth in the spring.

Old field areas experiencing woody encroachment should be mowed during late winter (February or early March) or early fall (September) to maintain food and cover for wildlife. The key, as with grasses, is to avoid mowing during the prime nesting and brood-rearing periods.

Reasons for Mowing:

Reasons to mow:

- To maintain or enhance wildlife habitat.
- To maintain grasslands and meadows.
- To suppress the growth of noxious weed species such as Canada thistle and multiflora rose.
- To remove browning cool season grasses in the late summer and stimulate the growth of warm season grasses and flowers that provide wildlife food and cover for the remainder of the year.
- To prepare land for other land management practices, such as applying herbicides, prescribed burning, and seeding.
- If local zoning ordinances require a specific lawn length and the management of "weeds."

Reasons not to mow:

- Mowing is expensive. Fuel costs are high, and equipment must be repaired and maintained.
- Continuous mowing has little value for wildlife. Areas not mowed frequently provide excellent habitat for wildlife to nest, raise young, and forage.
- Grasses with shallow roots cannot uptake nutrients or prevent erosion as well as grasses that are deeply rooted.
- Mowing takes time.
- Mowing adds pollutants to the air.
- Frequent mowing creates thatch buildup, resulting in undesirable groundcover conditions.

Where to Mow…

Yards or Lawns (less than 1 acre)	Maintaining grass at a height of at least three inches and setting aside other areas of the yard for wildlife-friendly plantings (e.g. black-eyed Susan, red clover, alders, viburnums, dogwoods, etc.) will enhance wildlife habitat and wildlife feeding areas. However, some urban and

suburban jurisdictions restrict lawn length and the presence of "weeds." You should check with your local zoning board and adhere to mowing requirements if they exist or propose changing them to benefit wildlife.

Fallow fields, grasslands, and maintaining existing cover

To keep valuable grasses from being overtaken by competition, mow one-third of a field once a year in succession, rotating sections of the opening so each is mowed every third year. Mowing should be performed outside of wildlife nesting periods (mid August). This allows nesting wildlife such as cottontails and quail to mature during the spring and summer with minimal disturbance. Mowing height is also critical. Native grasses should not be cut below 10 inches. Cutting these grasses too low many damage or kill them, because the grasses store much of their energy at their bases. Also, cutting at a minimum height of 10 inches, provides some wildlife cover until regrowth of the plant canopy can occur.

Split the desired mowing location into three strips. Mow one strip the first year, a different strip the next year, and the last unmowed strip the next year. This will create diverse vegetation stands with differing age structures, which will provide food and cover for many wildlife species. It will also keep woody stems small enough to be mowed. When possible, grasses should be baled to remove thatch from the field and prevent buildup at ground level.

For weed suppression

Weeds can be described as unwanted or undesirable vegetation. What may be a "weed" in your lawn or garden might not be a weed in a field for wildlife. Some weeds, like ragweed are actually desired by wildlife for food and attract insect food sources, while other noxious weeds are not and compete with more wildlife-friendly vegetation. Spot mowing in problem areas while the weeds are flowering may help control noxious species such as Canada thistle and multiflora rose, while minimizing negative impacts to wildlife. Mowing at this time for weed suppression works by stopping seed production. However, controlling these problem species will probably require additional herbicide treatments or physical removal.

For haying

Many options exist for landowners who need some hay, but still want to help wildlife. Cutting forage grasses or legumes at the peak of production may be compatible with wildlife habitat value. Mowing times are dependent on the type of forage being used for hay. Native grasses should be cut during the early seedhead stage, when their nutritional content is greatest. To make harvesting more efficient, consider squaring off fields and leaving the odd spaces unmowed until August or leaving a 30-ft border along wooded areas or fence rows. These areas are often less productive for hay, dry slowly, or have fallen branches that damage haying equipment. However, these field borders are valuable to wildlife. Mowing cool season grasses at their boot stage in May minimizes the effects of mowing on most nesting wildlife by allowing some regrowth prior to the peak nesting season (June-July). If cool season grasses are clipped as a first cut during June and July, nests may be destroyed, young wildlife may be killed, and the hay quality will be lower. Warm season grasses (such as Indiangrass, switchgrass, Eastern gamagrass, etc.) grow largely during the mid to late summer (July-August) and provide excellent food and year-round cover for wildlife. Since their peak growth does not usually occur until after the nesting season, mowing warm season grasses is usually less of an issue for wildlife and should take place between August 1 and August 15. Native warm season grasses should be cut to a minimum of 10 inches, and you should allow regrowth of 10-12 inches before the first killing frost. This new growth, following a late summer cutting, will provide adequate winter cover for grassland wildlife.

Roadsides, ditches, and field edges	These areas provide important nesting and foraging areas for birds, small mammals, deer and insects. Wildlife habitat can be enhanced along roadsides by reduced mowing, delayed mowing, planting native grasses, and mowing at a higher height. Contrary to popular belief, mowing more than 10 feet along roadsides does not significantly reduce mortality of wildlife on roads. Mowing should be limited along roadsides, ditches, and field edges. By limiting how often designated areas are mowed, you allow vegetation to attain optimal height for wildlife habitat. Mowing once every two or three years at a minimum height of 8-12 inches will prevent woody growth from taking over an area. Mowing along roadsides should occur in late summer (August 1-31) to allow most nesting birds and small mammals to successfully rear their young. Countless nests and young are destroyed if mowing occurs earlier in the year, and most equipment operators are unaware of the high number of nests that are destroyed while they are mowing.

Harvesting seed from warm season grasses

Types of Mowing:

There are three main types of mowing: block mowing, strip mowing, and random pattern mowing. Block mowing is performed by dividing long, narrow fields into three or four blocks and mowing the blocks on a an annual rotational mowing cycle. Strip mowing is accomplished by dividing a field into strips that are at fixed or variable widths. Rotate mowed and unmowed strips, but do not strip mow the same area each year. On the other hand, random pattern mowing is done by randomly mowing sections of a field into irregularly-shaped patterns of cut and uncut vegetation cover. Fields should be rotationally mowed in a three- to five- year cycle to reduce the encroachment of woody vegetation. Whatever type or pattern you use for mowing, you should avoid leaving unmowed cover strips too narrow (less than 100 feet wide) or too small (less than a half-acre). Blocks or strips that are too small or narrow can serve as habitat sinks, making it easier for predators to hunt small animals that you may be trying to benefit by your habitat management objectives.

Mowing young trees and brush in a native grass field

Alternatives to Mowing

For controlling noxious weeds and woody plant invasion on grass stands, the preferred alternative to mowing is spot spraying with selective herbicides. During the establishment period of grass stands, invasive vegetation can encroach into grasslands. The use of selective herbicides before and after grass/legume plantings can help control noxious weeds and establish a successful grass stand. Random or strip spraying may be performed throughout the year, so long as the established grass stand is not damaged. Random or strip herbicide spraying is performed by spraying random patches or fixed strips within a field. Controlling invasives in grass stands is more economical and effective if outbreaks are treated at first detection. APPLY ALL HERBICIDES ACCORDING TO THE LABEL!

Another alternative to mowing is strip or rotational disking. Disking is a simple, effective, and inexpensive wildlife habitat management tool. In strip disking, a disk or harrow is used to create ground disturbance and set back natural succession by breaking up grassy vegetation. Disking opens up grass stands, reduces thick mats of grass, stimulates germination of seed-producing plants, and increases insect populations as a wildlife food source.

Prescribed burning also should be considered as an alternative to mowing, especially when managing many larger fields. Controlled fire sets back natural succession and stimulates growth of valuable grasses and legumes, by releasing nutrients. Prescribed burning is less expensive and time consuming than mowing, and produces many wildlife and forage benefits. However, prescribed burning requires careful planning and controlled conditions to be an effective management tool.

Prescribed burn of native grasses

If you carefully examine where, when, why, and how mowing should be implemented on your property, mowing can be a simple and effective way to manage early successional habitats beneficial to wildlife!

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Great Trinity Forest Management Plan

Grasslands

Grazing Systems for Profitable Ranching

L-2211

Texas Agricultural Extension Service
The Texas A&M University System

Grazing Systems for Profitable Ranching

C. Wayne Hanselka, B.J. Ragsdale and Barron Rector*

For today's rancher to remain in the ranching business, he has to be more efficient in his operation to overcome the "cost price squeeze" of livestock production. Increasing costs force the rancher to risk over-capitalization on each animal unit owned. Profit depends upon the managerial ability of the operator, who must produce livestock and wildlife at the lowest cost through good herd and forage management, combined with sound economic and marketing procedures.

Range forage is the lowest-cost feed available although the quality may be low at times. Deficiencies in quality can be corrected with protein, energy and mineral supplementation. Range forage production is an integral part of profitable ranching, and the quantity and harvest of forage produced are dependent upon knowledge of sound range management.

An estimated 75 percent of the 107 million acres of Texas rangeland produces less than half its potential because of range deterioration resulting from past management, drought, etc. These deteriorated rangelands are characterized by predominance of unpalatable and low-producing forage species and topsoil loss. To improve range condition, desirable forage species must be allowed to reproduce and spread.

A good system of grazing can be defined as one that manipulates animals in order to obtain maximum sustained animal and forage production at a low cost. Grazing systems generally have been designed to improve the vegetation, with plant requirements the basic criteria used in designing them. The benefits to vegetation have been improved plant vigor and production; improved grazing distribution; and improved species composition of the vegetation with more desirable species.

Grazing systems should be designed based on forage plant, livestock and wildlife needs. Grazing is timed so that livestock receive a varied, high quality diet correlated with growth patterns of vegetation. This usually results in more effective maintenance and production per animal unit and for the herd. Therefore, the objectives are to meet the nutritional needs of animals, avoid stress on livestock and reduce supplemental feeding. Additional objectives are to minimize labor costs and improve or maintain habitat for wildlife.

Not all grazing systems achieve both goals of meeting plant and animal requirements. Some favor the plants whereas others favor the livestock and/or wildlife. An ideal grazing system is one that meets both goals depending upon rancher objectives.

Decisions

There are basically three approaches to grazing management:

1. Continuous grazing has been the traditional method. This is the constant use of forage in a given area, either throughout the year or during most of the growing period.
2. Deferred rotation systems have been tried and tested in Texas for more than 30 years. In this type of system, half or more of the total land is grazed at any given time. The time a pasture is grazed equals or exceeds the period of rest. These systems have proven effective at providing long-term range improvement and high animal performance, especially where combinations of stock can be managed.
3. Short duration grazing (SDG) systems are those in which livestock are concentrated on less than half the total land area an the lengths of deferment periods exceeds the length of grazing periods. These may be "extensive" or "intensive."

Several decisions must be made with respect to grazing management. Under any type of grazing, a rancher must decide on stocking rate, kind and class of animals, pasture size(s), water location and supplement locations.

Deferred rotation and short duration systems require that additional decisions be made before implementation. These include land area per system, number of pastures per system, number of herds per system and grazing cycle (length of rest periods, length of grazing periods).

Under continuous grazing, stocking rate is the only variable the producer can adjust; thus, little flexibility is possible in response to stress periods such as drought. Rotation systems provide more flexibility in regard to stocking rates, stocking density, grazing pressure, and time and frequency of grazing.

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Planned Considerations

No grazing system can compensate for overstocking. Animal numbers must be balanced with forage production. Therefore, light continuous grazing may improve range but cause lower returns per acre than another system. Deferred rotation systems tend to allow the animals to graze more selectively than do the heavy continuous or extensive short duration systems. This results in increased animal performance and a slower rate of range improvement. Extensive short duration systems favor greater perennial plant growth. Depending upon rancher objectives, a short duration system may be implemented to promote more rapid range improvement. Later, after the desired level of improvement is reached, a deferred rotation system or continuous grazing at moderate stocking rate may be substituted to maintain range condition and maximize livestock production.

The specific type of grazing system to choose will depend upon many factors:

1. The system must satisfy the rancher's objectives and meet the needs of livestock and/or wildlife and the grazing resources. Also, the size of range, number of grazing units, climate, range sites and range condition are important.
2. Physical facilities such as fencing, working pens and water storage should be considered in terms of forage use, livestock distribution and costs/benefits. Increased numbers of livestock per pasture will require additional water supplies.
3. Special provisions for prolonged drought or other unusual circumstances should be included.
4. Sufficient forage reserves to facilitate operations such as breeding, lambing, kidding or calving must be planned for. The numbers and kinds of livestock in grazed pastures can vary to fit the forage and livestock needs.
5. Rest periods should be long enough and at the proper season to accomplish specific management objectives for key forage species, but maintain high forage quality for good livestock nutrition. Grazing period should be short enough to provide adequate animal nutrition but not long enough for animals to graze regrowth before plants recover.
6. All domestic livestock must be removed from pastures being rested.
7. Numbers of wildlife animals should be controlled to prevent overuse of desired plants, provide higher quality diets and improve the animals' performance.
8. The grazing system should be started when there is sufficient forage in the pastures(s) to be grazed.
9. The number of grazing animals and the amount of forage must be kept in balance. Herd size should be flexible.
10. Grazing periods must be alternated during the growing season of the desired plants so that the same units are not used at the same time each year.
11. Stock water must be provided in each grazing unit as needed for the number of stock and the period of grazing expected.
12. Variations from a planned grazing system may be required to meet the needs of plants, livestock or wildlife. Necessary changes should reflect sound forage and livestock management. A system must be flexible.
13. Records of livestock and wildlife performance and pasture use and condition must be kept.

Kinds of Systems

Planned use refers to how, when and where the animals are to be grazed. Planned use is based upon the needs and characteristics of the ranching enterprises and is designed to give maximum and efficient use of the forage over the entire ranch. When designed and executed properly, a planned system can improve range and sustain maximum production. Adjustments may be necessary for a particular system to work in a particular livestock and wildlife operation. The rancher is responsible for the success or failure of a planned system. Each system must be flexible enough to adjust to current and expected conditions as well as to changes in ranch objectives.

All systems are based on the main principle of grazing management - controlling the frequency and severity of defoliation of individual plants. The immediate response of an individual plant to grazing may be:

1. increased plant vigor, as evidenced by increased size or reproduction;
2. decreased plant vigor or death; or
3. neither a positive nor a negative reaction.

The major factor controlling the frequency and severity of defoliation, regardless of the type of grazing system, is grazing pressure (defined as the animal unit, or forage demand, to forage supply ratio). Severity and frequency of defoliation will always increase as grazing pressure increases.

Under continuous grazing schemes stocked with a single class of livestock, grazing pressure can only be manipulated by stocking rate (the number of animals that a given area of range actually supports for a period of 12 months). This is also the case in the deferred rotation systems. However, in these systems a period of rest is periodically scheduled to ensure that the grazed plants have an opportunity to regain their vigor. Under any short duration grazing system there is much greater control of the frequency and severity of defoliation because the stocking rate, stocking density and length of graze/rest periods can be manipulated to benefit plants or animals.

Continuous Grazing

Since the number of desirable forage species is limited on poor or fair ranges, it is difficult for them to reproduce under year-long grazing pressure, even with very light stocking rates. This is because animals are selective grazers and will graze the palatable species first. With year-long grazing the desirable species are grazed continuously. On ranges in good condition, continuous grazing with moderate stocking rates generally does not harm animal or forage production. Animal production is often more erratic under continuous grazing, but this system generally returns more income/acre than most other grazing systems.

Deferred Grazing

Removing grazing animals for an adequate period of time gives desirable plant species an opportunity to regain vigor and reproduce. Deferred grazing can be of several types, any of which can be designed to meet the requirements of both forage plants and grazing animals.

Decision Deferment

Decision deferment is based on adapting the grazing system to specific needs or situations. The deferment usually is for the entire growing season, or for a part of it when moisture conditions are best. Success of this system depends upon the ability of the manager to make a correct decision. Decision deferment is recommended following range seedling and brush control, or in situations where systematic deferment cannot be applied economically.

Off an On

The off-and-on system is a method or rotating deferment based upon forage utilization. The animals are switched from one pasture to another when proper use of the key forage species has been obtained. The duration of grazing is not specific because the time required to obtain proper utilization can vary from year to year and from season to season. Also, the time of deferment is not specific because the animals are not returned to a pasture until the key forage species have regained their vigor and can be grazed without harm.

Systematic Deferment Grazing Programs

Four Pasture Deferred Rotation

This system was developed in 1949 by Dr. Leo B. Merrill at the Texas Agricultural Experiment Station near Sonora, and is known as the "Merrill" system. The four-pasture deferred rotation grazing program is rather simple in design (Fig.1). All four pastures should be about equal in grazing capacity. This is important because overgrazing will be detrimental to the forage and cause the system to fail. The total proper stocking rate of all four pastures is calculated and stock are divided into three herds. Three pastures are then grazed while one is deferred. The deferment seasons should be based on climatic factors, rainfall, growing season, nutritional needs of the livestock and requirements of the range plants.

Figure 1. It takes 4 years to complete the four-pasture deferred rotation grazing system. Each pasture is grazed 12 months then deferred for 4 months. There are three 16-month grazing cycles.

Pasture Deferred 1 July-October, first cycle November-February, second cycle March-June, third cycle	**Pasture Deferred 2** November-February, first cycle March-June, second cycle July-October, third cycle
Pasture Deferred 3 March-June, first cycle July-October, second cycle November-February, third cycle	**Pasture Deferred 4** March-June, first cycle July-October, second cycle November-February, third cycle

Two-Pasture Deferred Rotation

This system is sometimes called South African Switchback. The two-pasture system is generally satisfactory, but may not give results as good as the four-pasture deferred rotation system. However, the system is superior to year-long grazing.

Two pastures of nearly equal grazing capacity are necessary. The total grazing capacity of both pastures is combined into one herd, so that the herd is rotated between the two pastures. The design of a two-pasture system is given in Figure 2.

Figure 2. The two-pasture deferred rotation grazing system is completed in 2 years. There are 12-month grazing cycles with staggered grazing and deferment periods occurring in the same year.

Pasture Deferred 1 June 16-November 15, first cycle November 16-February, second cycle March-June 15, third cycle	**Pasture Deferred 2** March 15-June 15, first cycle June 16-November 15, second cycle November 16-February third cycle

The dates and periods of deferment should be selected for the specific area in which the system is to be used. The pasture being grazed should be observed often for signs of excessive overuse or deterioration.

Seasonal Grazing

Seasonal grazing is less common in the Southwest than in the West and involves grazing in a specific season only, such as spring, fall, summer or winter. Stocker operations may use a winter/spring grazing season. This type is best used in the Southwest in situations involving both rangeland and tame pastures. The tame pastures should be grazed during their most productive seasons, while the rangeland is deferred. Such a system can result in highly efficient livestock production at a low cost.

Short Duration Grazing

Short duration grazing (SDG) has relatively short history in Texas. It is possible to improve range very rapidly with long, frequent rest periods. However, there may be reduced livestock production. There is a continuum in the deferment-grazing cycles of SDG that ranges from short to long rests and short to long grazing periods (Table 1). Extensive SDG is often called "non-selective" grazing. The quality of the livestock diet often declines after they have been in a pasture longer than seven days. Also, the long rest periods allow pastures to accumulate high amounts of cured forage of lower quality. Intensive SDG refers to more rapid rotation with short grazing periods and correspondingly shorter rest periods. The shorter graze period usually improves livestock diet quality through more selective grazing and reduces the possibility that livestock will graze regrowth before a rest period allows recovery.

High Intensity-Low Frequency Grazing (HILF)

HILF systems concentrate livestock into one herd and allow them to graze a pasture until proper use is obtained. They are then moved to another pasture and the process is repeated. Multiple pastures are necessary so that significant time may elapse before the original pasture is regrazed. In areas of high rainfall and rapid vegetation growth, the length of the rest period may need to be six months or less.

The rancher should determine in which months maximum growth and forage production can be expected, and in which months little growth can be expected. The system should be designed to promote maximum production in all possible pastures during the growing season, and allow for standing forage to remain for use during periods of dormancy.

Several advantages accrue to this type of system. Re-establishment of desirable plants is rapid. Individual animal production is lower than with other systems, but higher stocking rates compensate with a higher return per land area. Emergency feed costs usually are much higher if animal performance is maintained.

Table 1. A continuum exists for lengths of rest and grazing periods in Short Duration Grazing. These should be adjusted according to plant and animal needs, depending on the physical location.

Days of	Intensive SDG		SDG	Extensive SDG (HLIF)
Graze	1-3	4-7	7-15	15-30
Rest	30-60		45-90	90-180

Length of grazing period can be calculated by the following formula:

$$\text{Average grazing period} = \frac{\text{Average rest period}}{\text{Number of pastures resting}}$$

Rapid Rotation SDG

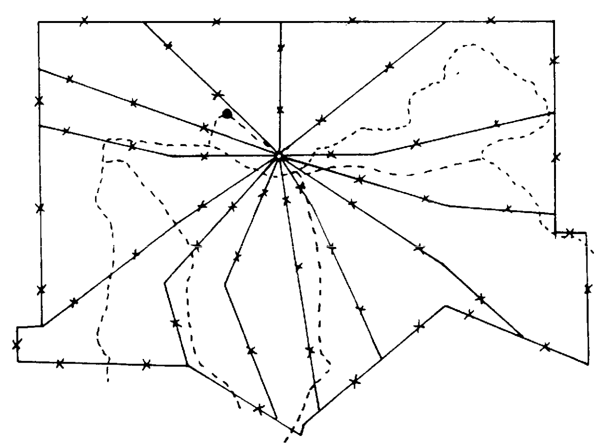
This is a relatively new method of grazing in Texas. In this method the livestock usually are grouped into one herd for each group of pastures, and moved through the system in such a manner that they select a high quality diet, begin in a pasture only a short time; are in a pasture too short a time to overuse plants; and are off the pasture long enough for the grazed plants to recover enough to withstand another grazing period.

Stock are grazed on pasture from 1 to 145 (usually no more than 5 to 7) days before being moved. An average grazing period is adjusted for each pasture relative to differences in production and size. Pastures are rested from 30 to 90 days (up to 120 days during drought). Longer deferment periods are possible during the dormant season but should not be used during the growing season. The system can utilize existing pastures but may require roundups to rotate the animals.

The "cell" system involves fencing that radiates from a central watering and working facility like spokes on a wheel (Fig. 3). This reduces livestock handling stress and the need for developing a water source in each pasture.

Figure 3. Fence design for a 13-pasture short duration grazing system with water and working pens located in the center. Livestock graze each pasture for a very short period and will return to that pasture less than two months later.

$$\text{(Average grazing period} = 5 \text{ days} = \frac{60 \text{ days rest}}{(12 \text{ pastures resting})}$$



A planned grazing system is not a "cure-all" for ranching problems. It is a tool for controlling when, where and how much vegetation is grazed. If the system is adapted to fit ranch operations and to meet objectives, it can boost animal production and provide a sound forage base for livestock and/or wildlife. A grazing system can benefit plants, livestock and man when the proper stocking rate is used.

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Great Trinity Forest Management Plan

Grasslands

Grazing and Browsing: How Plants are Affected

Texas Cooperative EXTENSION
The Texas A&M University System

B-6114
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RangeDetect Series

Grazing and Browsing: How Plants are Affected

Robert K. Lyons and C. Wayne Hanselka*

Grazing can have a neutral, positive or negative effect on rangeland plants, depending on how it is managed. Land owners and managers can better protect rangeland plants, and, in turn, other rangeland resources, if they understand:

- The effects of grazing and browsing (eating the leaves and young twigs of trees and shrubs) on individual plants and plant populations.
- The indicators that show which plants are in danger of overuse by grazing and browsing animals.
- The grazing management practices that help preserve the rangeland resource.

Understanding these factors and knowing the available management options allows landowners and managers to make better decisions about which actions are best for a particular site and when to take action. Timely action can preserve the long-term health of the rangeland as well as the viability of livestock and wildlife operations.

Interactions between range plants and range animals

Rangelands are ecosystems that have adapted to withstand such disturbances as drought, flood, fire, and grazing. All disturbances affect plants to some extent, either directly or indirectly, depending on the timing, intensity, and frequency of the disturbance. Generally, the more diverse the vegetation, the better rangeland can withstand disturbance.

Rangeland plants provide nutrients—proteins, starches and sugars—to grazing and browsing livestock and wildlife. These nutrients, or plant foods, are produced by photosynthesis. Because photosynthesis occurs only in green plant tissue and mostly in the leaves, a plant becomes less able to produce food, at least temporarily, when its leaves are removed (defoliation) by grazing and browsing animals.

Products of photosynthesis are just as important to plants as they are to animals. Like all other living things, plants need food to survive and grow. The food that plants make for themselves through photosynthesis is used for major plant functions such as surviving dormancy, growing new roots, growing new leaves in the spring, and replacing leaves lost to grazing or browsing.

Most native rangelands evolved under grazing. Therefore, rangeland plants have developed the ability to withstand a certain level of grazing or browsing. Although grazing animals do disturb rangeland, research has shown that rangelands gain few benefits when livestock are totally excluded for long periods.

What happens to a plant after grazing or browsing?

Grazing affects not just the leaves, but also other parts and functions of plants, including the root system, food production after defoliation, and the destination of food products within the plant after defoliation.

Food reserves and the root system

When a plant's leaves are removed, its roots are also affected. Excessive defoliation makes the root system smaller.

Removal of too many leaves has a profound effect on the root system (Figure 1). Research on grasses has demonstrated that when 80 percent of the leaf is removed, the roots stop growing for 12 days. When 90 percent of the leaf is removed, the roots stop growing for 18 days. Root growth drops by half when 60 percent of leaf is removed.

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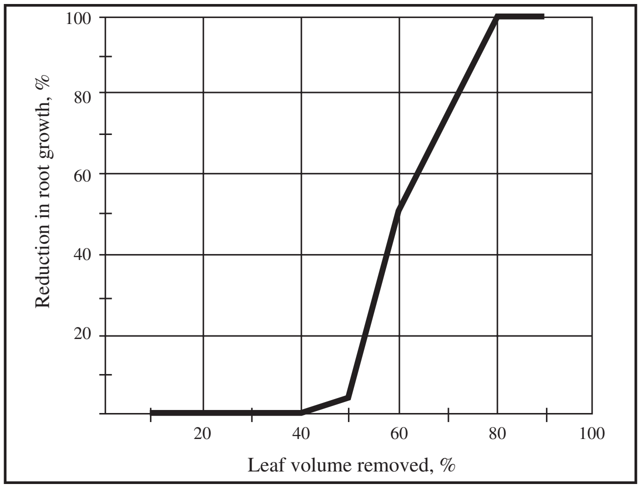

Figure 1. The effect of leaf removal on the root growth of a grass. With 80 percent leaf removal, roots stopped growing for 12 days; with 90 percent removal, root growth stopped for 18 days.

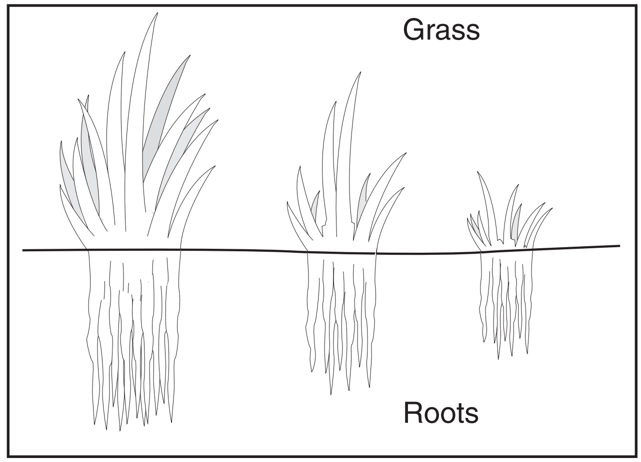

Figure 2. Heavy, frequent defoliation stops root growth and reduces the size of the root system. It reduces the plant's ability to absorb water and other nutrients, thus making the plant less drought resistant and less able to manufacture food.

As root growth is reduced or stopped, root volume decreases (Figure 2). Plants with smaller roots have less access to water and other nutrients in the soil needed to manufacture food. A smaller root system also makes plants less drought resistant.

Early research demonstrated that roots lose stored foods after defoliation. These observations led to the conclusion that the roots and crown of grasses were major sources of food for the initiation of growth after defoliation.

However, recent information indicates that, at least in grasses, stored foods are not as important in initiating this growth. Although food reserves decline in grass roots after defoliation, these reserves do not appear to be sent to the food-producing parts of the plant.

Recent research indicates that this decline in food stored in grass roots after defoliation results from a combination of:

- Remaining leaves sending less of the food they manufacture to the roots, and
- Roots themselves using the root food reserves.

In addition, studies involving grass crowns have shown that this part of the plant stores only about a 3-day supply of food reserves. This finding indicates that this part of the plant does not supply enough food to promote significant growth after defoliation.

If roots do not contribute stored food to promote growth after defoliation, where does the plant get this food?

Food production after defoliation

Grazing and browsing decrease, at least temporarily, a plant's food production by reducing the amount of green plant material available to produce food. Other factors affecting food production after grazing or browsing include the amount, kind, and age of plant material (leaf, sheath, stem) remaining on the plant.

For example, grass leaf blades, whether mature or young, often produce food at a higher rate than leaf sheaths (the leaf base enveloping the stem) or stems. In addition, young leaves produce food at higher rates than older leaves. Therefore, the more leaf material left after grazing, the faster grasses recover from grazing.

In many plant species, including some grasses, the leaves on grazed or browsed plants produce food at higher rates than leaves of the same age on plants that have not been grazed or browsed. In plants where it occurs, this process happens over several days in leaves remaining on a grazed or browsed plant and in new leaves developing after grazing or browsing. This process is one way that some plants partially cope with grazing or browsing.

Destination of food products after defoliation

Plants use the foods they produce for growth and maintenance. Any excess food is sent from the food-producing plant parts to other parts both above and below ground, where it is stored.

Once a plant has been defoliated, it may change the destination of its food products. The destination of that food varies with plant species. In some species, more food is sent to growing shoots and less to roots. This process occurs for a few days until the food-producing tissues can be reestablished. In some grass species, more food products may even be sent to the more active food-producing leaf blades rather than to less active leaf sheaths.

A plant's ability to send food products to new shoots after defoliation can help it quickly reestablish its food-producing parts. Plant species that have this ability are better able to tolerate grazing.

In investigations of grazing tolerance, researchers compared two western grass species that had different levels of grazing tolerance. They found that after defoliation, the grazing-tolerant species sent more food products to new leaves and fewer products to the roots. In contrast, the grazing intolerant species sent large amounts of food products to the root system. This finding helps explain why some grasses are better able to resist grazing.

How do plants cope with grazing and browsing?

The ability of plants to survive grazing or browsing is called grazing or browsing resistance. The most grazing-resistant plants are grasses, followed by forbs (herbaceous plants other than grass), deciduous shrubs and trees, and evergreen shrubs and trees.

When a grass seedling develops, it produces a primary tiller, or shoot. This primary tiller has both a main growing point and secondary growing points located at or below ground level.

Additional tillers can develop from secondary growing points at the base of a tiller. Tillers can also develop from buds at the nodes of stolons (above-ground lateral stems, such as in buffalograss) or rhizomes (below-ground lateral stems, such as in Johnsongrass) of grasses with these structures.

Cool-season grasses begin growth in the fall, maintain some live basal leaves through winter, and continue growth in the spring. Tillers produced in the fall are exposed to cold and can produce seedheads in spring. Tillers initiated in the spring usually do not produce seedheads.

In comparison, warm-season grasses produce new tillers in late summer and early fall. Although these young tillers die back when exposed to frost, their buds will produce new tillers the following spring.

Tillers of most grasses live only 1 to 2 years. Individual leaves usually live less than a year and most only a few months.

A plant can produce leaves only at an intact growing point. As long as that growing point is close to the ground, it is protected from being eaten (Figure 3). At some point, most grasses elevate at least some of their growing points to produce tillers, or shoots, that have seedheads.

Tillers stop producing new leaves when a seedhead develops from the growing point or when the growing point is eaten. Plants then must depend on other tillers to continue producing new leaves or wait until basal buds produce new tillers.

Excessive grazing of a grass plant when its growing points are elevated reduces new leaf production, and therefore, the ability of the plant to produce food and tolerate grazing. Destruction of the growing point also prevents seed production and production of new seedlings. Grasses should be rested from grazing periodically to allow them to produce leaf material to feed the plant and to allow seed production.

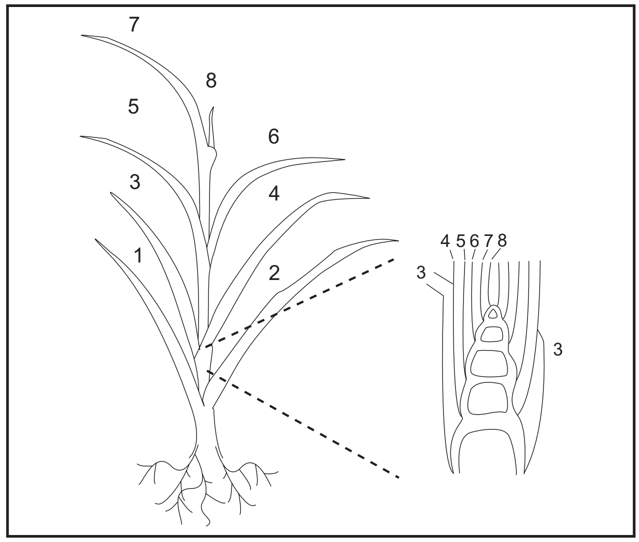

Figure 3. This illustration represents a grass tiller (or shoot) and its main growing point. On the left are the grass tiller and eight leaves, numbered 1 to 8. On the right is an enlargement of the area near the base of this tiller where the main growing point is located. All the leaves shown have developed from this growing point. As long as the growing point is close to the ground as shown here, it is safe from being eaten and can continue to produce leaves for the life of the tiller (1 to 2 years).

Timing of growing point elevation varies among grass species (Table 1). For example, growing points of buffalograss and other sod-forming grasses remain close to the ground, giving these grasses high grazing resistance.

Little bluestem and sideoats grama keep their growing points close to the ground until just before seedheads emerge. Although this strategy protects growing points from being eaten for a longer period, these two grasses produce many tillers with seedheads, which means that many growing points are exposed. The combined effect of delayed elevation and the production of many tillers with seedheads gives these two grasses moderate grazing resistance.

Yellow indiangrass and switchgrass elevate their growing points above ground level soon after growth begins. This early elevation results in low grazing resistance.

Grasses with low (yellow indiangrass and switchgrass) to moderate (little bluestem and sideoats grama) grazing resistance require more care in grazing management. This care can be accomplished in several ways.

One way to manage these low- to moderate-grazing-resistant grasses is to lower grazing pressure by stocking fewer animals to allow some plants to escape grazing.

Table 1. Examples of growing point elevation and grazing resistance for some common range grasses.

Grass Species	Growing Point Elevation/Reproductive Tiller Ratio	Grazing Resistance
Buffalograss	Remain close to ground	High
Little bluestem	Elevation late w/ large number reproductive tillers	Moderate
Sideoats grama	Elevation late w/ large number reproductive tillers	Moderate
Switchgrass	Elevation early	Low
Yellow indiangrass	Elevation early	Low
Johnsongrass	High proportion of reproductive tillers	Low

Another method is to make sure that pastures with these grasses are rested from grazing every 3 or 4 years during the growing season to allow the plants to produce seed.

Still another method that has been used successfully is intensive-early stocking. With this approach, grazing animals are stocked at higher than normal numbers for the first part of the growing season and then removed from pastures for the rest of the growing season. This approach has typically been used with stocker (young steer and heifer) operations.

Johnsongrass is an interesting contradiction. Because it produces strong rhizomes (underground stems), it should be resistant to grazing. However, Johnsongrass also produces a high proportion of reproductive stems, which cancels the advantage of rhizome production and results in lower grazing resistance.

The growing points of forbs, like those of grasses, remain close to the ground early in the growing season. Forb species that elevate growing points early are less resistant to grazing.

For woody plants, growing points are elevated above ground and, therefore, are easily accessible to browsing animals. If these growing points are removed, lateral buds are stimulated to sprout and produce leaves. However, woody plants replace leaves relatively slowly.

Grazing avoidance and grazing tolerance

Grazing resistance can be divided into avoidance and tolerance (Figure 4). Grazing avoidance mechanisms decrease the chance that a plant will be grazed or browsed. Grazing tolerance mechanisms promote growth after grazing or browsing.

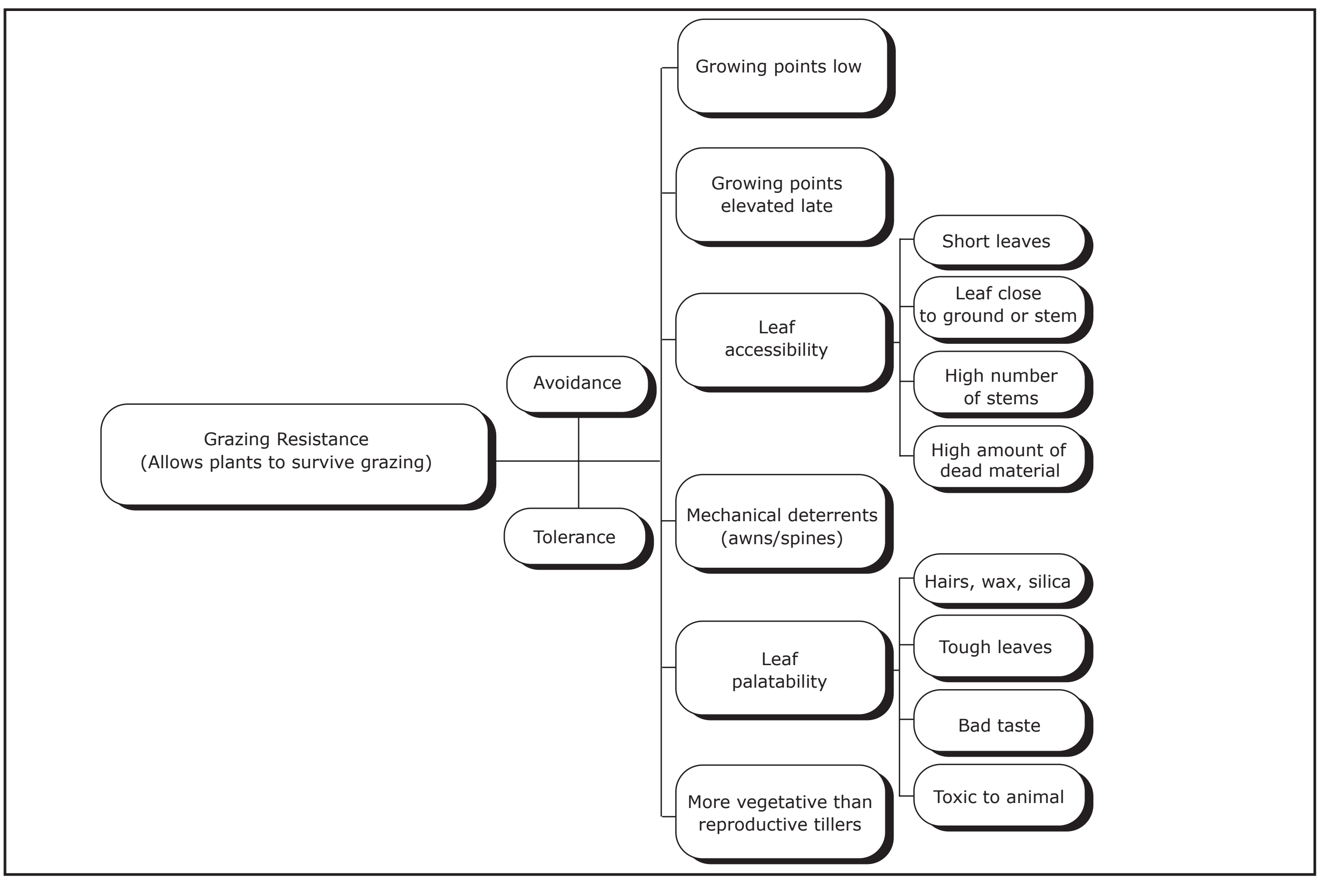

Figure 4. Examples of plant grazing-resistance mechanisms.

Grazing resistance factors can be related to plant anatomy, plant chemistry or plant physiology:

- Anatomical features that help plants resist being grazed include leaf accessibility (leaf angle, leaf length), awns or spines, leaf hair and/or wax, tough leaves, grass species with more vegetative stems (fewer growing points exposed) than reproductive stems, and the ability to replace leaves, which depends on growing points.
- Chemical factors of grazing resistance include those compounds that make plants taste bad, toxic, or hard to digest.
- Physiological factors include sending new food products to new leaves, water-use efficiency, and root growth and function.

Competition and grazing

Competition from neighboring plants for soil nutrients and water affects plant response to defoliation. Studies have shown that when competition is reduced, leaf growth in defoliated plants can be similar to that in nondefoliated plants. Competition can be reduced by 1) lowering grazing pressure by stocking fewer animals and 2) resting plants from grazing.

If competition is not reduced, new leaf growth may not occur because of a lack of available nutrients to grow new leaves. Therefore, plants that are grazed severely while neighboring plants are not grazed or grazed less severely are at a competitive disadvantage.

Do plants benefit from grazing?

It is not clear if plants benefit from being grazed. Certain species may benefit from grazing but not necessarily from being grazed. For example, plants may benefit indirectly from removal of competition or from the creation of a favorable environment for seed germination or directly from removal of self-shading or removal of inactive leaves.

Some grazed plants experience compensatory photosynthesis (food production). However, this response does not mean that the plants benefit from being grazed, only that they have ways to cope with grazing.

Browse management considerations

Browsing animals such as goats and deer prefer certain browse species. Preferred species vary with natural regions (such as the Edwards Plateau, Rio Grande Plain, Trans Pecos, etc.) of Texas. However, Texas kidneywood and Texas or Spanish oak are examples of highly preferred species; live oak represents a moderately preferred species; and ashe juniper (blueberry cedar) and mesquite are examples of low-preference species.

Without proper management, the more desirable browse species can disappear because of these preferences, while less desirable or undesirable species become more abundant. From a livestock perspective, proper management involves controlling browsing livestock numbers and controlling access to browse plants to provide rest from browsing. From a wildlife standpoint, proper management involves harvesting animals when wildlife census numbers and browse use signs indicate a danger to the browse resource.

Just as with grasses, browse species can be managed to promote and maintain key species, that is, the preferred plants that make up a significant part of the production of browse available for animals to eat. This task is accomplished by controlling animal numbers and providing rest from browsing.

How to determine if the range is being overused

Managers can use browse indicators to help make management decisions about the browse resource. These indicators include degree of use, hedging, and the presence or absence of seedlings.

Degree of use is the amount of the current season's growth that has been removed by browsing animals. It is best observed at the end of the growing season in late fall for deciduous plants and late winter for evergreens. When determining degree of use, consider only current season growth by comparing browsed twigs with unbrowsed twigs.

Browse use can be divided into three levels of current season growth removal: light use is marked by less than 40 percent removal; moderate use ranges from 40 to 65 percent removal; and heavy use is more than 65 percent removal.

Moderate use on key browse species is the correct management goal. When use approaches the upper limit of moderate use for key species, browsing pressure should be reduced by 1) resting areas from browsing livestock use or reducing livestock numbers and/or 2) reducing wildlife numbers.

Hedging is a plant response to browsing marked by twigs that have many lateral branches. A moderate degree of hedging is acceptable (Figure 5) because it keeps browse material within easy reach of animals and stimulates leaf and twig growth.

However, excessive hedging produces short twigs with smaller than normal leaves and twigs. Eventually, entire plants can die from excessive hedging.

Another indicator of excess browsing pressure is the hedging of low-preference plants such as agarita (Figure 6). When animals consume plants they do not normally eat, it usually means that not enough of their preferred food is available.

Figure 5. A moderate degree of hedging as shown on this Texas kidneywood plant, a highly desirable browse species, is acceptable.

Figure 6. The hedging on agarita, a low-preference browse plant, indicates excessive use.

To provide forage, browse plants must be within reach of browsing animals (Figure 7). As hedging increases, the lower branches disappear and a browse line develops. A browse line is the height on trees or shrubs below which there is little or no browse and above which browse cannot be reached by animals.

Areas where trees or shrubs have a highly developed browse line have a park-like appearance. In the early development of a browse line, light begins to show through the lower vegetation. With continued browsing pressure, a distinct browse line develops (Figure 8). Development of browse lines on low-preference plants such as ashe juniper (blueberry cedar) also indicates excessive use of the range (Figure 9).

Figure 7. The absence of a browse line on desirable woody species indicates that forage is accessible to animals and that the number of animals is probably in balance with the supply of browse.

Figure 8. A prominent browse line on moderately preferred browse species such as live oak is an indication of past overuse.

Figure 9. A prominent browse line on ashe juniper (blueberry cedar), a low-preference plant, is an indication of severe overuse of the browse resource.

The height of browse lines depends on browsing animal species. For example, white-tailed deer usually browse to about 3 to 4 feet, goats to about 4 to 5 feet, and exotic wildlife species to 6 feet and more.

To keep woody plant populations healthy, plants must be allowed to reproduce. Therefore, the presence of seedlings of desirable browse plants is another indicator that managers can use to check for range overuse.

Management considerations

Regardless of whether a ranch's production goal is livestock or wildlife, plants feed these animals and protect the soil from erosion. A good steward should aim to conserve the soil and plant resources so that animals are produced in a way that can be sustained over time.

To influence the effect of grazing disturbances on range plants, managers can control three factors of grazing or browsing:

- Intensity refers to the amount of grass or browse that is eaten. It is the most important factor because it affects the amount of leaf available for food production as well as the amount of root system in grasses and the production of seed.
- Timing of grazing affects plants more severely at certain stages of their development. The most critical grazing period is usually from flowering to seed production. Although the least critical period is dormancy, leaving plant residue is important even during dormancy. Research and demonstration work have shown that removing high quantities of forage during dormancy is almost as detrimental to plant productivity as during active growth periods.
- Frequency refers to how often plants are grazed or browsed. Animals tend to come back to the same plants to graze or browse during a growing season. If a plant is repeatedly defoliated, it can be weakened and may die.

To manage grazing and browsing and protect the range resources, managers should:

- Observe the status of and changes in grasses, forbs, and woody species as well as in livestock or wildlife. Make adjustments when either the range plants or animals show signs that the range is being overused.
- Rest grasses periodically, but not at the same time every year. Grasses differ as to when growing points are elevated, making it difficult to find one optimum rest period for all species.
- Leave enough residual forage ungrazed to keep plants healthy and to capture rainfall. The best way to prevent excess rainfall runoff is to maintain adequate ground cover. When the range has enough plant material to promote water infiltration into the soil, less rainfall is required to produce forage.
- Note when the more palatable key species start to show overuse. Grazing and browsing animals are selective: They graze or browse the most palatable forage species first and often. If the more palatable species are overused and disappear, the plant species that survive will be those that can best resist grazing. Animals often avoid eating plants that are abundant but not palatable; instead, they spend time and energy searching for plants that are more palatable but scarce. Therefore, overuse of more-palatable species can reduce animal performance.
- Adjust livestock and wildlife browsing by reducing animal numbers and/or resting pastures when you notice more than moderate use or excessive hedging on desirable brush plants and before the development of browse lines.

For more information

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Great Trinity Forest Management Plan

Grasslands

Integrated Brush Management Systems for Texas

Texas Agricultural Extension Service
The Texas A&M University System

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Integrated Brush Management Systems for Texas

C. Wayne Hanselka, Wayne T. Hamilton and Barron S. Rector*

What do we mean by integrated brush management systems, or IBMS? IBMS means managing brush with a "long-term" perspective. It means setting management objectives based on an inventory of range resources, the identification of problems, and the economic and environmental analysis of alternative solutions. Those management objectives must consider all enterprises affected by brush management, such as livestock and wildlife management. IBMS is a planning process that follows a logical sequence of steps (Fig. 1) leading to implementation of the system. Successful use of IBMS should result in improved management processes and greater profitability of the ranch.

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The term "brush management" is more appropriate than "brush control" because it describes current attitudes toward woody plants on rangeland. During the 1940s and early 1950s, many ranchers tried to eradicate brush. It soon became obvious that this was not possible. The concept of "brush control" became popular in the mid-1950s; its goal was suppression rather than elimination, although there were still attempts to eliminate entire stands of woody plants.

The concept of "brush management" recognizes the potential value of some quantity of woody plants in range management. The development of this concept is closely tied to the realization that wildlife is an economic asset and that management objectives should accommodate the habitat needs of wildlife. While increasing livestock production is usually a high priority in range management, it should not be done at the expense of other products, such as wildlife, that might yield economic returns. Therefore, brush management strategies should be part of an effort to manage rangeland as a multiple-use resource.

Many shrublands were formerly open grasslands that are now densely infested with woody species. They are apparently "steady state" systems that resulted from changes in the conditions that produced the earlier grasslands. These shrublands have successfully resisted man's efforts at eradication and, for the most part, even effective control. There are several reasons why this is true.

There are many woody species and they reproduce easily, making brush management difficult. In south Texas, brush stands may be composed of 12 to 15 different species, all with basal stem, crown and/or root

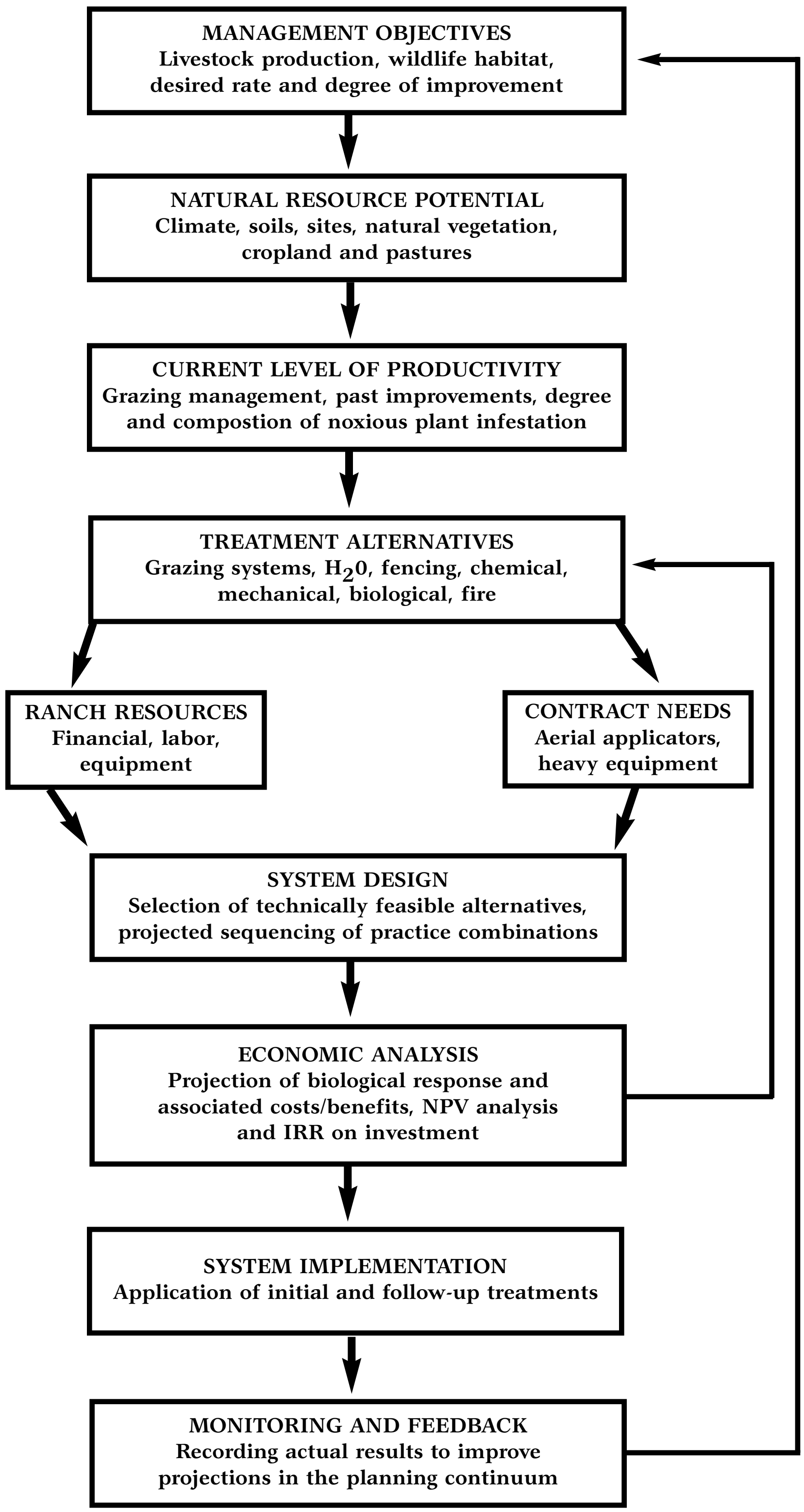

Figure 1. Diagram of the IBMS planning system.

resprouting potential. The mix of brush species within stands varies in different regions of Texas.

The differences in resource potential and desired level of management vary widely among ranches. Thus, it is unlikely that generalized "prescriptions" are possible, or that any two brush management programs should be exactly the same. Moreover, brush management programs must be economically viable. Control methods can be justified only if their cost is recovered over a reasonable period of time.

Effective brush management uses technology from a number of disciplines, including range management, wildlife biology, animal science and economics. Other disciplines such as recreation and tourism sciences also may be needed to address the potential for ecotourism or other range-related activities. In 1981, a group of Texas Agricultural Experiment Station scientists and Extension specialists with similar concerns for management of south Texas rangelands, but with different areas of expertise, formed an IBMS work group. Their perspective and recommendations are the basis for this bulletin.

Brush - Is There A Problem?

The first step in considering brush management strategies is to determine if a problem exists. "Brush" has often been described as a dense growth of bushes, shrubs and small trees. There is little question that brush has increased in density and distribution in areas that were once open grasslands. (Some land management practices have contributed to brush invasion.) Where this has occurred, brush plants are usually labelled as pests.

Managers often describe any plants that reduce forage availability to livestock as brush or weeds. However, cattle and other livestock species are exotic, introduced animals, and it must be realized that although many native rangeland plants have no value for livestock production in a typical ranching environment, these plants are essential to the survival of native wildlife, including game, non-game animals, birds and even insects. Brush species provide wildlife with food, water, shelter and nesting cover.

The value of a plant, then, often lies in the eyes of the beholder, and brushy plants may not always be pests. Certainly brush competes with forage for water, and shading by brush over a long period can change the forage species composition from warm-season grasses, valued for livestock production, to cool-season grasses that grow beneath the canopy. However, cool-season grasses also can be an asset. They can be grazed in the winter to reduce supplemental feed expenses.

Other ecological shifts that may occur when brush invades grassland can be beneficial. Brush stands alter the environment underneath their canopy and may provide a more nutrient rich environment for other plants. Deep-growing roots can bring minerals to the soil surface where other plants may benefit through the recycling of leaf litter. Stands of plants with thorns or barriers to grazing, such as prickly pear, protect desireable, sensitive plants growing within them. Such protected areas allow these plants to survive as future seed sources. Desirable woody plants also often grow inside the protective canopy of spiny plants.

Brush also may increase the price of land being sold for rural and suburban development. In fact, acreages cleared of all brush may sell for 60 percent less than land where the brush was left intact because developers, builders and future buyers value an aesthetically pleasing view. So in dealing with brush, it is wise to consider how the future value of a property may be affected.

Some woody plants have value other than for grazing, shade or aesthetic value. Honey mesquite, for example, can be cut for firewood, bar-b-que chips, wood for making charcoal and fine heart wood for making expensive furniture.

Brush often occurs in mixed stands, and it is necessary to identify the individual brush species when deciding whether or not there is a problem. Simply classifying the plants as brush limits any understanding of their value or of the techniques and strategies needed to manage the area.

Developing and Implementing an IBMS

If a brush problem is identified, then a logical plan for addressing the problem can be developed. These are the steps in developing and implementing an IBMS.

1. Setting Objectives

The IBMS planning process should begin with identifying the general objectives of ranch management. These might include increasing forage production and carrying capacity of the range, realizing income from a wildlife-related enterprise, or preserving the future value of the property. Specific objectives are determined after conducting a comprehensive inventory of soil and vegetation resources, projecting the responses of those resources to treatment alternatives, and considering what effects those treatment alternatives will have on livestock, wildlife and related ranch programs. Treatment alternatives have different input costs, follow-up maintenance requirements, and predicted economic performance. Each also will affect the appearance of the land in a different way.

2. Conducting an Inventory

Range sites are areas of the landscape with different production potentials. Conducting an inventory of the resources on each range site is an essential element of the planning process. Managers should have an accurate picture of the brush species composition and distribution for each range site, the current and potential level of forage production, the characteristics of the land (terrain, contour, rainfall, soils, etc.), the wildlife species that are present and what their needs are, and the kind and number of domestic animals that will use the land. Brush species have different values according to the planned uses of the range, the ways they respond to control treatment, and their relationships to the production potential of the different kinds of land involved. The most appropriate management strategies are those which produce the best results for the cost, in relation to the planned use and potential of the range site.

3. Considering Alternative Management Strategies

After the resource inventory, the next step is to identify the most appropriate brush management strategies. To do this, those who plan IBMS must understand the growth habits and reproduction of brush species, the modes-of-action of the various treatment methods, and the ways brush species and more desireable plants will respond to them.

To help ranchers and technicians select the most appropriate brush management practices, the Texas Agricultural Experiment Station and Texas Agricultural Extension Service developed an expert system called EXSEL. It is now available for purchase by the public (further information is on page 6). The user of the system describes a brush management problem and receives technically feasible control alternatives (including chemical, mechanical, and fire) developed by brush and weed management professionals.

4. Analyzing the Economics of Treatment

The IBMS planning process must also analyze the economics of treatment alternatives. This means determining both the time period in which the investment in brush management is to be recovered, and an acceptable rate of return on the investment. Managers should select a discount rate that considers opportunities for alternative investments, as well as the risk factor associated with brush management as compared to other opportunities.

5. Improving the System with Feedback

Once the economic analysis of technically feasible alternatives is completed, the most promising plan can be implemented. Managers should record information about the actual results over time, and use it to improve the future accuracy of the planning process. In this way, IBMS becomes a planning continuum that helps managers make increasingly better decisions.

Choosing the Best Management Practices

Brush control options include mechanical, chemical, fire and biological methods. These are described in publication B-5004, "Brush Management Methods," available from the Texas Agricultural Extension Service. There is seldom one best method of brush management for any particular ranch or pasture. Brush management is usually more effective and economical when a combination of methods is integrated over a period of several years. Integrated methods, for example, can increase the effectiveness and minimize the use of herbicides. Before selecting a method, feasible alternatives must be evaluated relative to 1) the degree of control expected, 2) their characteristic weaknesses, 3) the expected life of the treatment, 4) possible secondary effects (e.g, increase of a secondary undesirable plant), 5) application requirements, 6) effect on wildlife habitat, 7) cost vs. benefit, and 8) safety.

The method chosen may be applied to individual plants or to large areas, depending on plant densities. If densities are low to moderate it may be more ecologically and economically feasible to treat individual plants. Greater densities may require broadcast methods.

The efficacy of a treatment will depend upon whether it completely kills the growing point of the plant. The growing points are usually located below the soil surface on the base of the stems but just above the first lateral roots. On most brush plants, stems will sprout from this "bud zone" if it is not completely killed.

Treatment methods must be applied in a logical sequence to take advantage of their respective strengths and weaknesses. After the initial reclamation of a pasture, maintenance measures are necessary. Maintenance is that time period when the production benefits of the initial treatment are held near optimum with low-cost secondary treatments. For example, prescribed burning, low-energy grubbing, goating, and individual plant treatments with herbicides can be used to extend the life of initial treatments.

Integrating Grazing Management Into the System

The goal of brush management is often to encourage desirable forage plants in order to increase livestock carrying capacities and stocking rates. However, improper grazing management after treatment can undermine this goal. The way the land is grazed after treatment affects the response of plants to treatment and the time required to realize the benefits of treatment. Proper use and rest allow desirable forage plants to thrive and gain a competitive edge over brush. Therefore, grazing often should be deferred after brush management practices.

It would be best if a sound grazing management program could be established before other range improvement practices are attempted. Usually, however, a major investment and management commitment has already been made in a particular grazing system, so that brush management strategies must be incorporated into the existing system. If grazing is generally unstructured, and graze/rest decisions are made on a relatively short-term basis, brush management strategies can be based solely on their efficacy, influence on wildlife habitats, and economics.

The optimum approach to range management is to plan brush management and grazing management simultaneously, because a greater array of management combinations is then possible. These combinations can be evaluated as to their effects on production and their economic feasibility.

The ease with which brush management strategies can be integrated with planned grazing systems over a given time depends on the physical and logistical characteristics of the grazing system. The arrangement of watering locations, the shapes of pasture, the placement of fences, and the locations of corrals and roads may limit treatment alternatives. Other factors such as the number of pastures; the graze/rest sequences used; the flexibility in moving livestock; the forage's ability to absorb short-term, heavy grazing; the sensitivity of the range to the stocking rate; and the portion of the ranch committed to a structured grazing system will all interact and affect a grazing system's compatibility with long-term brush management strategies.

Post-treatment grazing strategies can be immediate, long-term, or intermittent. Immediate grazing strategies are those adjustments required after a brush control procedure (e.g., deferment after treatment). Long-term strategies promote the growth of more desirable forage species. Intermittent strategies are temporary adjustments to long-term grazing strategies needed to accommodate brush treatments.

When grazing and brush management are planned simultaneously, it is critical that they be compatible. If either system is given priority, the other must be adjusted to fit it within the context of the overall management program. The selection of specific brush management and grazing systems is always determined by ranch objectives and constraints, and by manager preferences.

Managing Wildlife with Other Resources

Each wildlife species has different habitat requirements that must be accomodated in a brush management system. Some prefer areas of dense brush. Some must have open areas. Most species prefer vegetation patterns in which there are both brushy and open areas. Removing too much brush destroys habitat, but thinning brush or creating patterns of alternating brushy and open areas can improve wildlife habitat while increasing forage production.

In implementing IBMS, a wildlife manager should design a brush mosaic suitable for the wildlife and the range site, and then treat brush to create and maintain that mosaic.

The first step in wildlife habitat management should be to determine the importance of the area to be treated in relation to the wildlife habitat on the whole ranch. What is the size of the area and what proportion is it of the total ranch area? What is its contribution to wildlife habitat? How will treatment affect its usefulness as wildlife habitat? The cover mosaic established should allow the treated segment to carry its own populations of wild animals, to contribute to the diversity and interspersion of the habitat on the ranch, and to give access for viewing and/or hunting. Where adjacent land already lacks adequate cover, or where the brush being treated acts as a wildlife shelter in a fairly open habitat, treatment should be conservative. If the area to be treated is part of a large region of mature brush thickets, treatment can be more aggressive. In order for treatments to be beneficial to both wildlife and livestock, the following must be considered:

- size and pattern of the area to be treated;
- management options available;
- application methods;
- timing of applications; and
- the presence of endangered species.

Designing a habitat mosaic begins with identifying landscape features with special utility. Then the effects of terrain, existing brush patterns, brush types, pasture shapes, and treatment history should be considered. Each design will be unique. A series of feasible alternative techniques for treating the brush should emerge from this analysis.

Feasibility is a function of the compatibility of the pattern with the method of treatment. For example, different methods are used to create strip patterns, variable rate patterns and zigzag patterns.

Likely there will be only a few pattern/treatment combinations for which equipment is locally available and which suit the preferences of ranch management. These should be ranked in terms of their utility for satisfying game management and forage production objectives. There may need to be compromise among management objectives to further limit alternatives. Finally, a system with the most promise for optimizing income from both wildlife and livestock can be identified.

Considering Economic Factors

Managing brush for both livestock production and wildlife habitat takes time. At least 15 years should be allowed for investment recovery, because the economic benefits seldom offset the costs of the initial treatment plus added costs (additional cows, etc.) until well into the maintenance period.

Predicted results of brush management need to be translated from biological into economic terms to give managers a basis for decision making. This is done by using response curves that plot how the integrated brush/wildlife/grazing management program will change the carrying capacity of the range over a given period. These production changes are then given a monetary value so the economic performance of each alternative can be analyzed.

Managers also should consider the cost of doing nothing. Brush encroachment is largely inevitable, and will reduce carrying capacity if nothing is done to manage it. Individual animal performance also may decline, and variable costs increase, thus compounding production loss. Carrying capacity and individual animal performance often increase with IBMS. One reason for improved individual animal performance is that conception rates and weaning weights may increase slightly as a result of improved forage quality. These benefits should be considered during the economic analysis stage of the planning period.

Risk associated with historic variability of rainfall can also be incorporated into the economic analyses. A computer program called ECON is available to help ranchers make these economic analyses of IBMS.

To order the EXSEL or ECON expert system, contact the Extension Range Specialists' office at (409) 845-2755.

Additional Reading

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Great Trinity Forest Management Plan

Grasslands

Brush as an Integral Component of Wildlife Habitat

BRUSH AS AN INTEGRAL COMPONENT OF WILDLIFE HABITAT

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Abstract: Shrubs and trees are absolutely essential to most kinds of wildlife which inhabit rangelands. Without at least moderate amounts of woody plants, Texas rangeland would not have such an abundance and variety of wildlife. So, consider yourself fortunate if you have rangeland with shrubs and trees on it. Your range, in all likelihood, is more valuable and more profitable than range without woody plants.

What is brush?

The word "brush" is often misused. Unfortunately, the word is often used in a generic sense to describe all of the various combinations of shrubs, trees, and vines which grow on rangeland. All definitions of the word in the rangeland context carry primarily negative connotations. In decades past, adjectives like "worthless" and "noxious" were used to describe brush. A more modern (and acceptable) definition is: *"shrubs and trees which are considered undesirable to the planned use of the area"*. This definition sheds a whole new light on the concept of brush since it defines brush relative to the objectives for a given parcel of land.

For the individual who desires to create an open prairie, all shrubs and trees might be incompatible with his goals, and would rightfully be considered brush. To the cattleman seeking to maximize grass production, and who cared little or nothing about wildlife, only a few scattered trees for shade would be desirable; the remainder would be considered brush. However, to the cattleman who desires both grazing and wildlife habitat, a moderate density of shrubs and trees would not only be tolerated, but desirable. According to his objectives, it would not be considered brush. To the rancher interested primarily in maximizing habitat for deer at the expense of grazing, a thick canopy of shrubs and trees over much of the ranch would be desirable and would not be considered brush.

Obviously, not all shrubs and trees are of equal value to wildlife. Some species are highly desirable to a great many wildlife species, while other kinds have less value. The temptation is to call the most desirable species "good brush" and the less desirable species "sorry brush". However, as will be shown, even much of the so called "sorry brush" has considerable value. The other temptation is to call the more aggressive species "brush", while acknowledging that non aggressive species may have their place. But again, some very aggressive species are desirable to certain land management objectives at certain densities.

As with most things in life, it is possible to have too much of a good thing. Some things may be good in moderation, but undesirable if excessive, e.g., rain, fire, cattle, deer, children and wives! Ditto for shrubs and trees. Yes, even mesquite, cedar, pricklypear and blackbrush are often desirable in the right amount. Conversely, hackberry, oak, coma and other more highly-valued woodies can be undesirable in large amounts, at least for certain objectives.

So, the growth of shrubs and trees on rangeland should be considered either desirable or brushy depending on the kinds and the amounts of woody plants, and the intended purpose for the land. What may be a hideous brush-infested pasture to one person, may be a tract of excellent wildlife habitat to another. What may be a worthless, brushy jungle to the cattleman may be an exceptional browse pasture to the goat raiser. Truly, brush is in the eye of the beholder.

Wildlife use shrubs and trees for two main purposes: (a) they eat it, and (b) they live in it. The different ways in which wildlife use woody plants will be described in general without doing an extensive review of scientific literature.

Food value

Browse is the leaves and tender twigs which are eaten. Browse can be a very stable source of productive and high quality forage for a select group of wildlife species. Browse is a mainstay in the diet of game species such as white-tailed deer, mule deer, bighorn sheep and many exotic hoofstock. Browse is of some importance to pronghorn antelope and elk which rely more on forbs and grass. Browse is of virtually no direct importance to the majority of mammals, birds and reptiles. For those interested in the health and well being of browsing animals, a thorough knowledge of the browse value of shrubs and trees is important, as well as a knowledge of how to manage rangeland to maintain or improve browse.

The fruits and/or seeds of woody plants are extremely important to many species of wildlife. Fleshy fruits (often called berries or soft mast) are used heavily by hoofstock (deer, javelina, hogs); carnivores (coyotes, fox, ringtail, raccoon, skunk); songbirds (bluebirds, robins, thrashers, orioles, tanagers, jays, chickadees); game birds (quail, turkey); and reptiles (box turtle, Texas tortoise). Some examples of shrubs and trees which produce fleshy fruits are: hackberry, granjeno, bumelia, lotebush, condalia, grape, honeysuckle, juniper, pricklypear, algerita, persimmon, plum, mulberry, possumhaw and elderberry.

Non-fleshy fruits (sometimes called nuts or hard mast) are also important to many of the same species of wildlife. Examples of non-fleshy fruits are: acorns, pecans, mesquite beans, sumac fruit, and pricklyash fruit.

In many cases, the fleshy or pulpy material of the fruit is what is digested by an animal, with the actual seed passing through intact. Often the digestive system enhances germination of these seed, making this a primary method of seed dispersal and establishment of many woody plants, including both highly desirable species as well as invasive species.

In other cases, animals digest the seed along with the outer parts of the fruit (hulls, pulp and flesh). Examples include acorns and pecans. Birds with strong gizzards such as turkey and quail are able to digest seeds which pass through other birds. Even hard seed such as mesquite and acacia can be digested by these birds.

The flowers and flower stalks of some woody plants are also eaten by wildlife. The most notable examples are deer and javelina use of pricklypear flowers and young yucca and lechuguilla stalks. Quail also use algerita flowers

A listing of shrubs and trees of central and south Texas, and their value as browse and fruit, is provided in Tables 1 and 2.

Woody species such as mesquite, pricklypear, cedar, persimmon, huisache and others are often considered poor quality, non-preferred browse, and often placed in the "brush" category. However, the fact is, that due to their abundance, and the relative scarcity of the more preferred species, these often make up the bulk of the browsing animal's diet in some regions of Texas. The "top 3" woody plants used as food for white-tailed deer in eleven different diet studies are listed in Table 3. It should be remembered that deer also eat large amounts of forbs when they are present, and in some of these studies, forbs did make up a significant portion of the diet. Mistletoe, an excellent browse, is counted in with mesquite for obvious reasons.

An interesting relationship exists between quail and cattle for a favorite food item. Cattle relish mature mesquite beans, but they cannot digest the seed. Quail relish the individual seed, but cannot separate the seed from the bean pods. After the cow eats the beans and digests the sweet pod, she deposits the seeds where a quail can pick them out. Possibly the tumble bug plays a part in this relationship, scattering the piles out for easier picking.

In addition to woody plants, which are directly consumed as food, shrubs and trees are also critical in the food chain of many other species. Myriad species of insects use woody plants for food, which in turn feed other animals. Examples include the use of small caterpillars found in shrub and tree canopies as food for warblers, vireos, kinglets, and wrens. Larger birds such as cuckoos, tanagers, orioles and woodpeckers live off of these shrub and tree insects during the spring and summer. Likewise, the hawks that feed on small birds, which feed on insects, are indirectly dependent on woody plants.

Cover value

Most species of wildlife in Texas depend upon woody plants for cover, shelter or protection of some kind. Most animals require cover both from predators and harsh weather. Protection from direct hot sun, cold wind, rain, wet snow and sleet are all important. The reproductive period is often the most critical time of the year for wildlife. Cover to protect nesting females, eggs and unfledged young is critical for birds. Fawning and denning cover is needed for mammals especially during the early phases of nursing. The actual woody species which provide this cover are usually not as critical as the structure or growth form of the cover. When considering cover for wildlife, more is not necessarily better. For just about any wildlife species, there can be either too much or too little cover. Some of the major kinds of cover provided by shrubs and trees for various wildlife groups will be described.

1. A moderate to dense canopy of low, shrubby cover is important to many species, white-tailed deer, javelina, ocelot, bobcat and numerous birds. Some animals require an almost continuous dense canopy while others prefer the dense, low cover to be in a pattern interrupted with openings of various size.

2. A sparse canopy of low shrubby cover is used by mule deer, pronghorn antelope, quail, and many grassland birds.

3. A dense closed canopy of taller trees with an open understory is required for many woodland birds.

4. A sparser canopy of taller trees is used by savanna birds.

5. Large hollow trees especially near water are used as den and nest trees by raccoon, squirrel, wood ducks and tree ducks.

6. Smaller snags (dead trees or dead branches) are used extensively by woodpeckers, wrens, chickadees, and bluebirds for nest cavities.

7. Larger snags are used as perch locations for hawks and owls.

8. Large trees are used as roosts by wild turkeys and turkey vultures, nest sites for various hawks, and if near water, herons and egrets.

Indirect benefits

Besides their use as food and cover, shrubs and trees have some less obvious, but nevertheless important side-benefits to wildlife habitat and to land health in general. Under the canopies of most shrubs and trees lies a layer of fallen and decaying leaves. This layer of composting mulch greatly improves soil structure, fertility, infiltration and moisture holding capacity. The improved soil, in combination with the cooler, more moist, shady conditions often allows certain beneficial plants to grow. In the absence of shrubs and trees, some of these associated plants would otherwise not exist in the pasture. Two prime examples of this are bloodberry rouge plant and Texas nightshade. Both of these perennial forbs are exceptionally good wildlife plants, producing excellent grazing for deer as well as fruit for birds. These forbs exist almost exclusively under and near the edges of shrub mottes.

The leaf fall of shrubs and trees also contributes greatly to the proper mineral cycling of a site. Whereas grass litter adequately cycles organic carbon back into the soil, shrubs and trees cycle significant amounts of nitrogen and phosphorus as well as carbon. Other minerals found beneath the rooting zone of grasses may also be cycled to the surface by deep-rooted woody plants.

Woody legumes, most notably mesquite, are nitrogen-fixing plants. Like alfalfa, vetch and clover, they can convert atmospheric nitrogen into soil nitrogen. This boost in fertility benefits all plants growing nearby.

Another great benefit of some woody plants is their ability to serve as a protective nursery area for the establishment of desirable species of forbs, grasses and shrubs. Unfortunately, over much of Texas' rangeland, there are too many deer, livestock, exotics or combinations of these. Due to overuse, the best, most preferred plants are often absent or rare in pastures except in the protection of spiny or thorny shrubs. Protected by the canopy of shrubs such as algerita, lotebush, condalia, allthorn, wolfberry, pricklypear and tasajillo are a great variety of desirable wildlife and grazing plants. These desirable species are able to survive and produce seed when protected by spiny or thorny shrubs, even if the rest of the pasture is being grazed or browsed too heavily.

When enlightened management corrects the problem of too many grazing or browsing animals, there will still be a viable remnant of better plants able to disperse from the protected areas.

Conclusions

1. You are lucky to have shrubs and trees on your ranch. Be thankful.

2. Brush is in the eye of the beholder. All that's woody is not brush.

3. The fruit and seed of shrubs and trees are more important to a wide variety of wildlife than is browse.

4. Several of the shrubs and trees often considered undesirable are among the most heavily used as food for deer.

5. The greatest variety in kinds, densities and patterns of woody growth will provide food and cover for the most kinds of wildlife.

6. Shrubs and trees enrich the soil under their canopies with leaf litter.

7. Mesquite and other woody legumes fix nitrogen into the soil.

8. Spiny shrubs serve as nursery areas to protect desirable plants.

9. When sculpting a masterpiece, selectively remove small bits at a time, using the right tools.

Table 1. Shrubs and trees used by wildlife in Central Texas.

Most highly preferred		
Kidneywood	Carolina buckthorn*	Shrubby boneset
White honeysuckle*	Spanish oak*	Mountain mahogany
Hawthorne*	Texas sophora	Texas mulberry*
Rusty blackhaw*	Possumhaw*	Mistletoe*
Littleleaf leadtree	Inland ceanothus*	

Preferred		
Hackberry*	Bumelia*	Elbowbush*
Ephedra*	Roemer acacia*	Virginia creeper*
Netleaf forestiera*	Redbud*	Poison ivy*
Western	Grapevine*	Greenbriar*

soapberry		
Old man's beard	Wild plum*	Black cherry*
Ivy treebine*	Carolina snailseed*	Elms*
Blackjack oak*	Southwest bernardia*	
Moderately preferred		
Live oak*	Flameleaf sumac*	Feather dalea
Pricklyash*	Shin oaks*	Skunkbush sumac*
Guajillo*	Hogplum*	Evergreen sumac*
Silktassel*	Bush croton*	Roughleaf dogwood*
Littleleaf sumac*	Button willow*	Post oak*
Non-preferred		
Redberry juniper*	Algerita*	Persimmon*
Mesquite*	Blueberry juniper*	Lotebush*
Condalias*	Javelinabush*	Pricklypear*
Catclaw acacia*	Catclaw mimosa*	Cenizo
Mountain laurel	Whitebrush	Willow baccharis
Little walnut	Pecan*	Sacahuiste
Yucca*	Mexican buckeye	

* *Denotes plants with demonstrated wildlife value as fruit, seed or flower.*

Table 2. Shrubs and trees used by wildlife in South Texas.

Most Highly Preferred		
Guayacan	Bernardia*	Chomonque
Kidneywood	Ebony*	Tenaza*
Coma*	Fourwing saltbush	
Preferred		
Granjeno*	Hackberry*	Colima*
Guajillo*	Brasil*	Ephedra*
Narrowleaf forestiera*	Roemer acacia*	Calderon ratany
Clematis	Huisache*	Catclaw acacia*
False mesquite*	Wright acacia*	

Moderately preferred

Live oak*	Cenizo	Pricklypear*
Blackbrush*	Twisted acacia*	Lotebush*
Persimmon*	Hogplum*	Skeletonleaf goldeneye
Desert yaupon*	Anaqua*	Peachbrush*
Bush croton*	Spiny aster	

Non-preferred

Mesquite*	Whitebrush	Wolfberry*
Allthorn goatbush	Dwarf screwbean	Creosotebush
Saladilla	Allthorn	Knifeleaf condalia*
Coyotillo*	Mountain laurel	Mariola
Algerita*	Retama*	Palo verde
Lantana*	Shrubby blue sage	

* *Denotes plants with demonstrated wildlife value as fruit, seed or flower.*

Table 3. Top three browse species used by deer in various regions of Texas.

County	Top 3 Woody Plants in Diet	Conducted By	Season
Throckmorton	Mesquite/Mistletoe; Pricklypear; Bumelia	TTU[1]	Yearlong
Tom Green	Pricklypear; Littleleaf sumac; Mesquite	ASU[2]	Yearlong
Llano	Oak; Mesquite/Mistletoe; Persimmon	NRCS[3]	Yearlong
Llano	Oak; Cedar; Persimmon	NRCS	Yearlong
Mason	Oak; Mesquite/Mistletoe; Persimmon	NRCS	Yearlong
Mason	Cedar; Oak; Persimmon	NRCS	Yearlong
Sutton	Oak; Persimmon; Cedar	TAES[4]	Winter
Terrell	Cedar; Pricklylpear; Oak	NRCS	Yearlong
San Patricio	Huisache; Pricklypear; Lime pricklyash	WWF[5]	Summer
Zapata	Prickypear; Mesquite; Coma	TAMUK[6]	Yearlong
Zapata	Pricklypear; Mesquite; Granjeno	TAMUK	Spring

[1]Texas Tech University, [2]Angelo State University, [3]Natural Resources Conservation Service,

[4]Texas Agricultural Experiment Station, [5]Welder Wildlife Foundation, [6]Texas A&M - Kingsville

Great Trinity Forest Management Plan

Grasslands

Factors to Consider When Sculpting Brush: Mechanical Treatment Options

FACTORS TO CONSIDER WHEN SCULPTING BRUSH: MECHANICAL TREATMENT OPTIONS

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Abstract: Brush sculpting is the selective application of control treatments to prepare brush-infested rangelands for multiple use. Mechanical treatments are discussed which can be used effectively for selective thinning or selective clearing to accomplish multiple use goals. Information is presented on mechanical techniques to achieve good plant kills, and numerous machines are described for individual tree or broadcast treatments including performance examples.

Brush sculpting is the selective application of control treatments to prepare brush-infested rangelands for multiple use including wildlife habitat, watershed management, traditional livestock production, and recreational enterprises. Mechanical treatments have several advantages because they are positive and immediate, but they are often misused because of the old paradigm, "wipe the slate clean." A knowledge of the regrowth characteristics of targeted brush species is vital to assure that the correct machine is used in the proper manner. In every case, a well thought out brush management plan reflecting your short- and long-term goals should be in place before attempting brush control. Brush contractors, county agents, Extensions specialists and NRCS technicians are good sources for assistant in planning. Mechanical treatments can be individual tree (e.g., selective thinning) or broadcast application (e.g., selective clearing). The purpose of this paper is to acquaint the reader with some of the equipment available and proper application.

Selective thinning

Individual tree treatment is accomplished by grubbing or clipping and is an ideal method to sculpt brush-infested land. Sculpting can involve such practices as leaving islands of brush with connecting strips to provide cover for wildlife habitat and a protected pathway to move from site to site while cleared areas provide plants for grazing, or just general thinning of the brush infestation.

Mechanical grubbing is the severing of tree roots below ground by a sharp, U-shaped blade mounted on a tractor (Fig. 1*a*). Tractors can be farm-type (Fig. 1*b*), crawlers, or wheel (Fig. 1*c*) or track loaders depending on the size of tree to be grubbed and type of terrain.

Table 1 describes the best technique to achieve good plant kills when grubbing various brush species in Texas.

Low-energy grubbing is the use of a small tractor on small trees and this can be effective and cost efficient if tree densities are not too high (Wiedemann et al. 1977). These tractors usually have hydraulically assisted blades that enhance the output by tearing roots loose as the blade is rotated. Table 2 lists the performance of a 65-hp crawler tractor with a hydraulic assisted blade (Fig. 1*a*) grubbing seven different brush species. Performance curves are shown in Figure 2.

Grubbing rates vary due to tree size, density, distribution, soil moisture and type of terrain. Grubbing is best suited to tree infestation of 20 to 250 trees per acre. Brush species such as Ashe (blueberry) juniper which do not sprout from the roots can be clipped above ground. This is accomplished by a small loader with hydraulic shears.

With the advent of foam filling of off-road tires, the use of rubber-tired equipment on thorn-infested rangeland is now practical (Wiedemann and Cross 1982). Rubber-tired loaders are especially useful for grubbing (Fig. 1*c*) because they can travel on roads between sites, and the bucket can be useful for many material handling jobs. Crawler tractors have to be hauled with large trucks between sites. Performance of a wheeled loader in mesquite regrowth 10 years following rootplowing is shown in Figure 3. Farm tractors with front-end loaders are useful for grubbing juvenile trees (Fig. 1*b*) and performance in small junipers is shown in Figure 3. A popular method for grubbing limited acreage of small trees is to use a 3-point hitch grubber on the rear of the tractor. Some grubber styles require the tractor to drive over the tree first while others back the tractor to the tree and use the 3-point hitch to lift the tree from the soil. Grubbing by backing into the tree averaged 155 mesquites/hour (McFarland and Ueckert 1982) while grubbing with front-mounted units on a crawler averaged 288 mesquite/hour and 432 small junipers/hour (Wiedemann et al. 1977 and Wiedemann and Cross 1981).

Selective clearing

Selective clearing is the application of equipment that treats everything in a swath and is termed "broadcast treatment." Selective clearing implies that selected areas are cleared leaving a mosaic pattern or strips of brush which can follow the contour of the land. The cleared areas should be seeded with native or introduced grasses and/or shrubs that meet multi-use goals. Treatments can involve removing all above ground growth, severing all roots at a given depth or removing root systems from the soil. Clearing usually involves a combination of methods. The main types of machines and their application are discussed in this section including new developments.

Chains. Ship anchor chain pulled between two crawler tractors is widely used for tree felling because it can open up an area quickly and is low cost. Chains vary in length from 200 to 400 feet, weight from 40 to 75 pounds per foot and are pulled in a U-shape. It is used in dense to moderate stands of trees (trunk diameters greater than 3 inches) and is most effective in uprooting when soil moisture is high. It is not effective on shrubs or small trees with limber stems. Effectiveness is short lived because of regrowth and chaining should be used in combination with other treatments for maximum effectiveness. In north Texas, mesquite is chained 2 to 3 years following aerial spraying while in south Texas, dense stands of mixed brush are chained and stacked prior to subsequent treatments (Fisher et al. 1973).

In moderate to dense stands of junipers an elevated chaining technique reduced pulling requirements by 67% to 84% compared to ground level chaining in north Texas and southern Oklahoma (Wiedemann and Cross 1996*b*). This one-way chaining method is followed by prescribed burning to achieve 98% plant kill in Ashe juniper, but redberry juniper, a sprouting species, is still under study. Elevating the chain is accomplished by attaching a rotating ball in the center of the chain pulled by two crawler tractors. A four-foot diameter ball worked best in junipers 9- to 18-foot tall while a six-foot ball performed better in trees 16- to 22-foot tall (Wiedemann and Cross 1996*a*).

Rootplows. A rootplow is a heavy-duty, V-shaped, horizontal blade, 10- to 16-feet wide that is pulled by a large crawler tractor at a depth of 12 to 14 inches (Fig. 1*d*). This operation severs roots, preventing regrowth of nearly all brush species except those with shallow root systems such as whitebrush and pricklypear. Three to five fins, 20 to 30 inches long, mounted at a 28 degree angle on the cutting blade help loosen the soil surface and destroy many of the shallow-rooted species that might

otherwise survive. Rootplowing with fins kills 80 to 99% of many-stemmed mesquite in moderate to dense stands in the Rolling Plains (Jaynes et al. 1968). Chaining following rootplowing smooths the rough soil surface left by the plow, and help to prevent injury to horses, livestock and wildlife crossing the area.

Rootplows were developed to clear dense stands of mesquite and other hard-to-kill brush species in preparation for seeding grasses or crops (Fisher et al. 1973). Rootplowing generally destroys a high percentage of perennial grasses, and reseeding is advisable unless a good supply of seed is present in the soil. The highest survival of grasses occurs from rootplowing and seeding in the winter or early spring. Success of the operation depends on favorable rainfall in the spring months. Sculpting dense brush infested areas by selective plowing and seeding with plants favorable for wildlife habitat, grazing animals and watershed management could enhance the multi-use value of depleted rangeland on fertile soils.

Stacker rakes. Stacker rakes use large, heavy-duty tines which slide on the soil surface while raking moderate to dense stands of brush following chaining (Fig. 1*f*). These 14- to 19-foot wide rakes use a 6-inch plate welded to the lower end of the tines to uproot or shear off plants during the piling of brush debris. They are used as an initial treatment to control pricklypear and small woody plants. When used alone, a follow up treatment is necessary to control deep-rooted species. Stackers are front mounted on crawler tractors or wheeled loaders. Stacker rakes without the shear plate are sometimes called brush rakes and are more apt to be used to pile large trees following chaining or grubbing when there is an absence of undergrowth.

Root rakes. Root rakes, sometimes called wheel rakes, are used to penetrate into the soil 6-10 inches to remove and pile roots and stumps following rootplowing (Fig. 1*g*). These 18- to 24-feet wide rakes are pulled behind large crawler tractors. Root raking is an excellent method to clean the land and prepare a seedbed for grasses or crops. Following root raking, rubber-tired farm tractors can be used for tilling and seeding.

Roller choppers. Large drums, 30 to 40 inches in diameter, are equipped with longitudinal blades to chop brush debris as they are pulled by crawler tractors. They are between 8- to 15-feet wide and can be pulled singularly, two in tandem or in a gang of three. Roller choppers are relatively trouble-free in operation, but do use springs in the drawbar to reduce vibration on the pulling tractor. Chopping removes only the top growth of brush and remaining stems produce a flush of regrowth. This is desirable for some browsing animals, and on selected brush species such as shin oak or guajillo. Chopping Bigelow shin oak averaged 5.3 acres per hour using a 15-foot wide unit filled with water (Wiedemann et al. 1980). Chopper are also used for seedbed preparation on log-littered sites following rootplowing.

A recent advancement in roller choppers is the use of small blades welded to the drums in a cylindrical pattern, and these units are called renovators/aerators (Fig. 1*h*) (Lawson 1994). The advantages of the renovators are that the small blades chop debris, form basins in the soil which harvest rainfall, and the cylindrical pattern prevents the vibration associated with roller choppers. Renovators are used in sparse to moderate shrub-infested rangeland or pastures to improve water harvesting and to remove top-growth of shrubs. Seedbed preparation is enhanced by the basins.

Disks. Disks used on rangeland are the heavy-duty offset style. Blade diameters range from 24 to 36 inches and units are 8 to 12 feet in width. Disks with 36-inch blades are used for brush control on undisturbed soil while units with blade diameters less the 30 inches are used for seedbed preparation following rootplowing. Whitebrush was controlled by disking in the fall (13% mortality) and then re-disking in the spring after the root crowns had sprouted (91% mortality) (Wiedemann and Cross 1980). Disking was followed by seeding to oats in the fall and buffelgrass in the spring. Seedbed prepared by disking (24-in. blade) consistently produced better grass stands than roller chopping or chaining on rootplowed sites at nine location in the Edwards Plateau and Rolling Plains (Wiedemann et al. 1979). If excessive timber prevents the use of a disk, then a disk chain can be used (see section on disk-chain-diker).

Shredders. Brush shredders are patterned after pasture and crop shredders but are much heavier duty. Width is normally seven feet but selected units are 15 feet. Brush shredding is prone to mechanical failures and usually requires extensive modification of the farm tractor which pulls the unit. Modifications include foam filling of the tires or other approaches to prevent flats and mounting front and belly-pan guards and a rear guard to protect the back of the operator from flying debris. Shredding brush leaves an aesthetically pleasing, level plant height between 3 to 6 inches depending on shredder adjustment. Regrowth is extensive following shredding. Downtime was 64% when shredding Bigelow shin oak with a 7-foot shredder in the Edwards Plateau (Wiedemann et al. 1980).

Disk-chain-diker. A new development for seedbed preparation on debris-littered land is the disk-chain-diker (Fig. 1*e*). It was designed to follow rootplowing, but it can also be use on undisturbed sites when shrubs are less than 8-feet tall. It tills, smooths the land and forms small basins all in one pass and is energy efficient (Wiedemann and Cross 1994). A disk chain is an anchor chain with disk blades welded to alternate chain links. Disking action occurs when the chain, with swivels attached to each end, rotates as it is pulled diagonally. A flexing roller holds the disk-chain gangs in place. The chain diker, which is attached to the rear of the roller, uses special shaped blades welded to opposing sides of each link of a large anchor chain. As it is pulled over tilled land, the chain rotates and the blades leave a broadcast pattern of diamond-shaped basins 4-inches deep. Pulling requirements depend on the size of each component; a standard size unit requires 515 pounds of force per blade and the usual size is 20 blades. A 20-blade unit is 35-feet wide and requires a 165 to 200 hp crawler tractor for pulling. A detail explanation of the unit is covered by Wiedemann and Cross (1990).

In seeding studies over a 3-year period, grass densities were increased 92% by the disk chain compared to seedbeds prepared by smooth chaining in clay loam soil. There was no significant differences in grass densities between seedbeds prepared by disk chaining or offset disking, but both were significantly higher than chaining alone (Wiedemann and Cross 1990). Basin prepared by the chain diker increase grass stands three fold when rainfall was 37% below normal compared to no basins, but there was no difference in the two when rainfall was 25% below normal in a 25-inch annually rainfall zone. Chain diking reduced runoff by 40% compared to non-diked treatments over a three year period on a slope of 0.3% (Wiedemann and Clark 1996).

Regrowth machines. Regrowth plows are designed to be in area where brush regrowth is present following clearing with conventional rootplows (Fig. 1*i*). They resemble conventional rootplows but have been downsized to fit D-6 crawlers, rubber-tracked Challengers or large farm tractors (Holt 1997). These 10-foot wide units use quick hitches and can plow to a depth of 12 inches.

A regrowth root rake has been designed to operate in concert with the regrowth plow. These 14-foot wide units remove roots from the soil that might otherwise sprout and pile them along with any above ground brush debris (Holt 1997). They use the same quick hitch as the regrowth plows.

Table 1. Mechanical techniques to prevent regrowth of nine different brush species.[1]

Species	Technique
Mesquite	Sever taproot below basal crown (below bud zone), 6 to 14 inch depth, depends on size of tree
Redberry juniper	Sever taproot below basal crown, 6 to 12 inch depth, depends on size of tree
Blueberry (Ashe) juniper	Sever trunk above or below ground level, does not sprout from roots
Algerita	Remove basal crown and buried stems under entire canopy area, 4 to 6 inches depth
Huisache	Sever taproot below basal crown, 6 to 12 inch depth, depends on size of tree
Twisted acacia	Sprouts from roots, remove as many as possible.
Blackbrush	Sever taproot below second lateral, 6 to 12 inches deep, depends on size of tree
Whitebrush	Remove basal crown, depth of 4 to 6 inches
Catclaw	Sever taproot below first lateral and remove all buried stem with adventitious roots

[1]Based on grubbing studies listed in Table 2.

Table 2. Performance of the low-energy grubber in Figure 1 operating in six different brush species at maximum output. Normal field efficiency is 70 to 85%.[1]

Species	% Plant kill	Trees/acre	Dollars/acre[2]
Mesquite	80	20 to 100	3.00 to 12.00
Juniper	98	30 to 175	4.50 to 27.00
Huisache	75	75 to 225	9.50 to 30.00
Algerita	93	15 to 80	5.50 to 16.50
Twisted acacia	0	30 to 250	3.50 to 16.00
Blackbrush	86	20 to 130	6.50 to 19.00
Catclaw	85	50 to 150	8.50 to 20.50

[1]Adapted from Wiedemann et al. (1977), Wiedemann and Cross (1981),Wiedemann (1982), Cross and Wiedemann (1983, 1985, 1997).

[2]Based on a contractor's cost of $45/hr to operate on a ranch site.

Figure 1 (*a*-*d*). Types of machinery used to control brush. See text for descriptions.

	
1a.	1b.

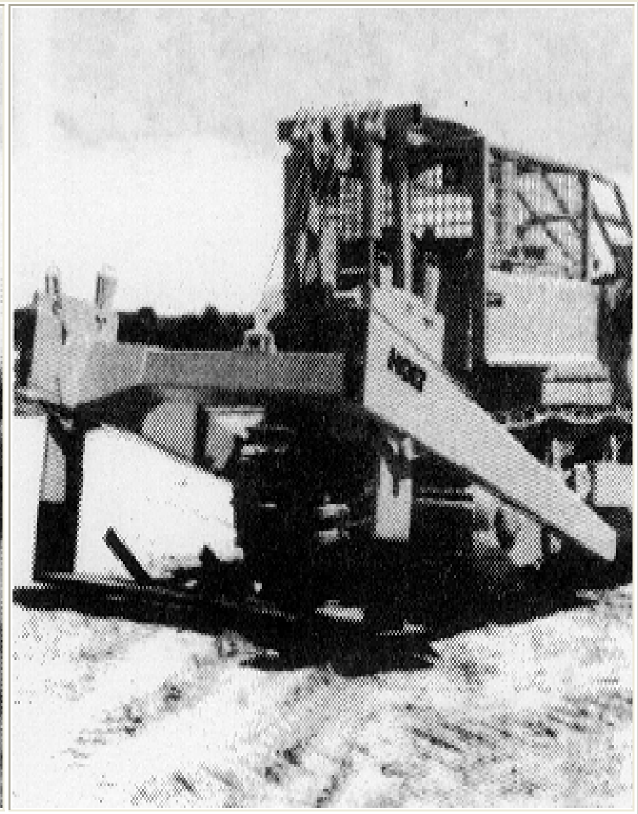
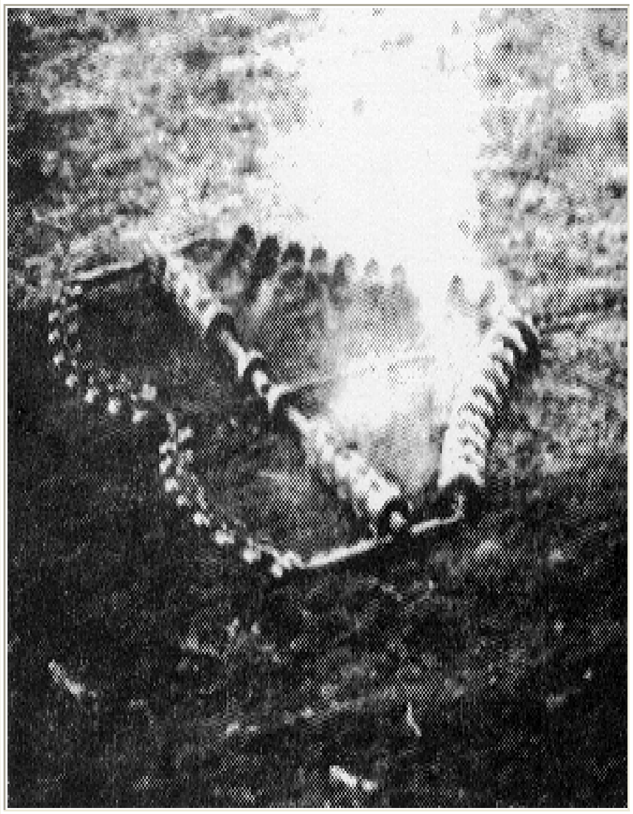
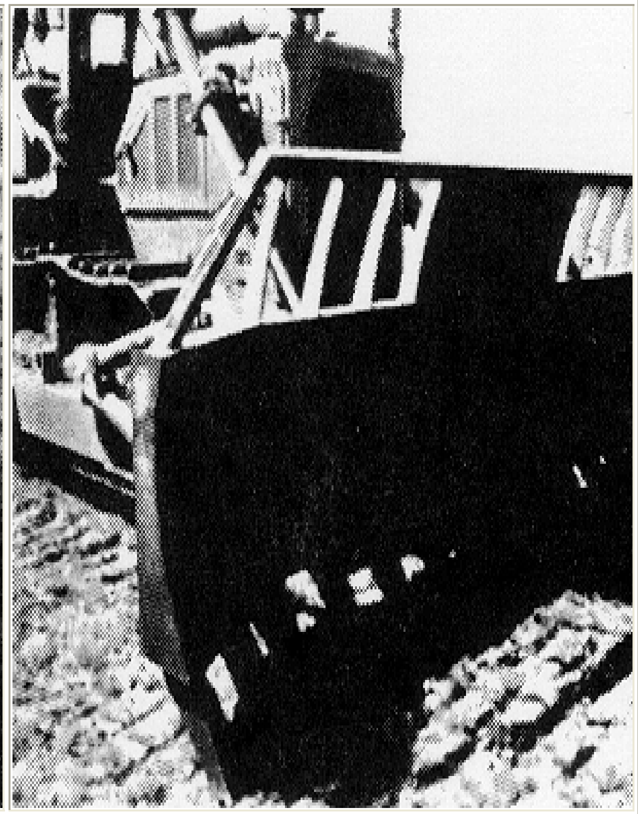
	
1c.	1d.

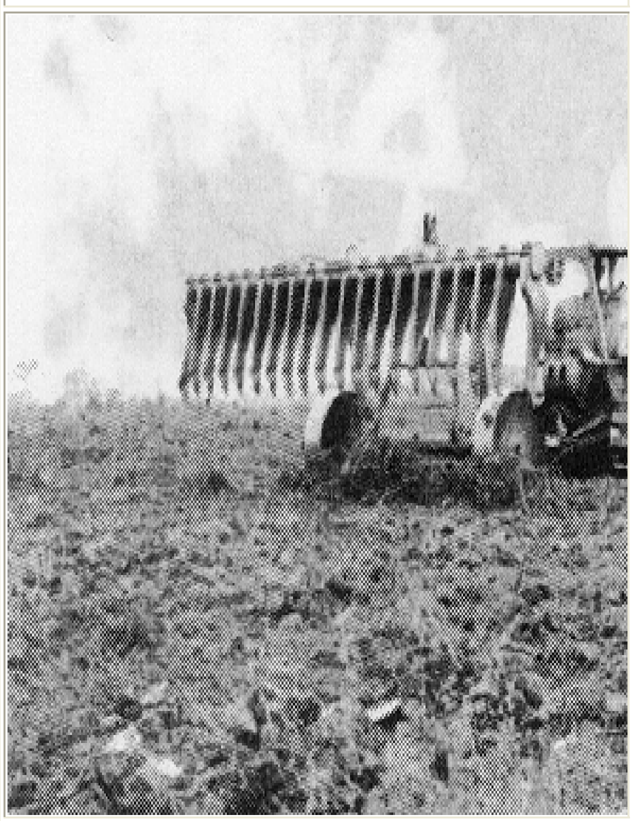
Figure 1 (*e*-*i*). Types of machinery used to control brush. See text for descriptions.



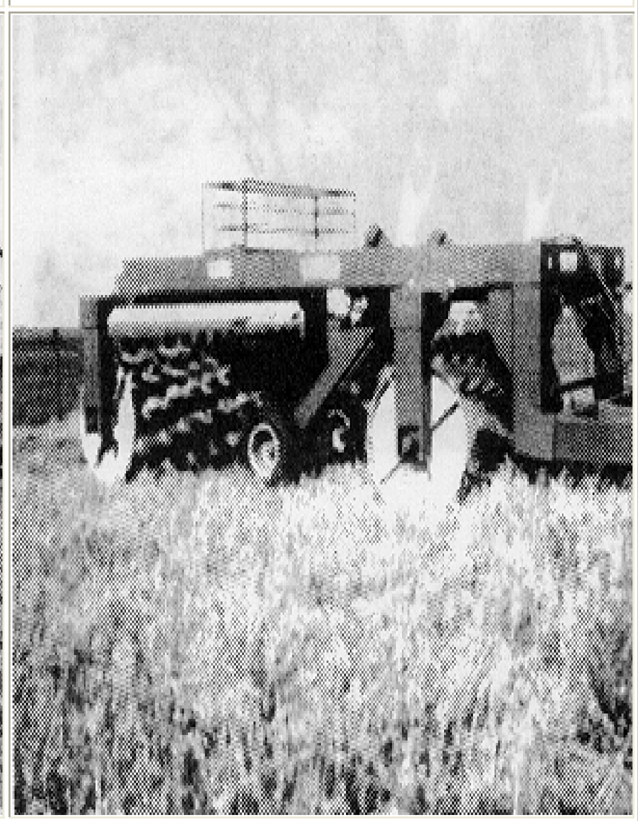
1e.



1f.



1g.



1h.

1i.

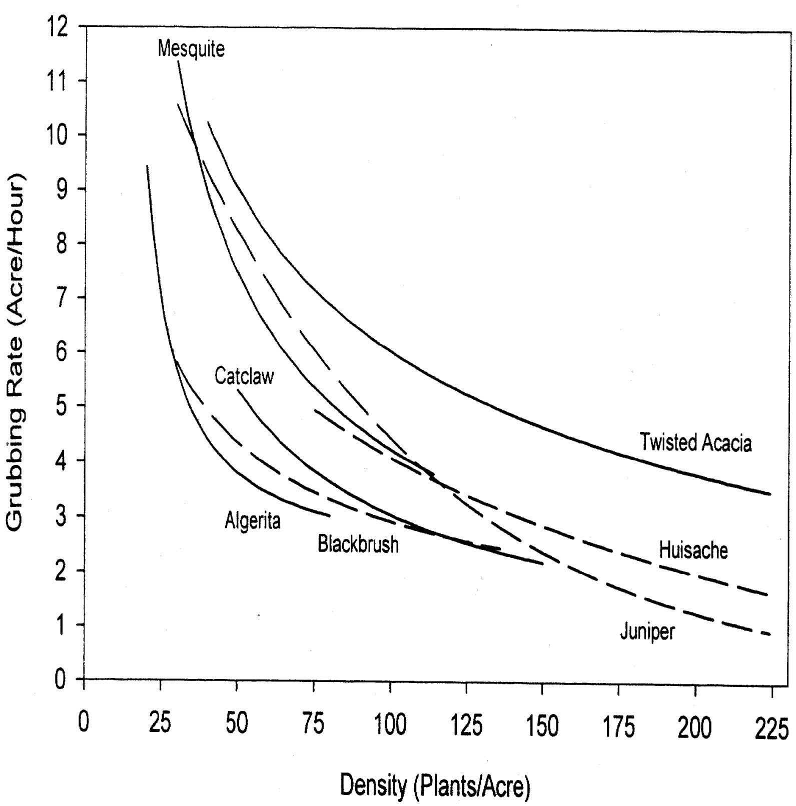

Mesquite
Catclaw
Twisted Acacia
Algerita
Blackbrush
Huisache
Juniper
Grubbing Rate (Acre/Hour)
Density (Plants/Acre)
0
1
2
3
4
5
6
7
8
9
10
11
12
25
50
75
100
125
150
175
200
225

Figure 2. Performance (acres treated per hour) of a 65-hp crawler tractor with a hydraulic assisted blade in seven different brush communities.

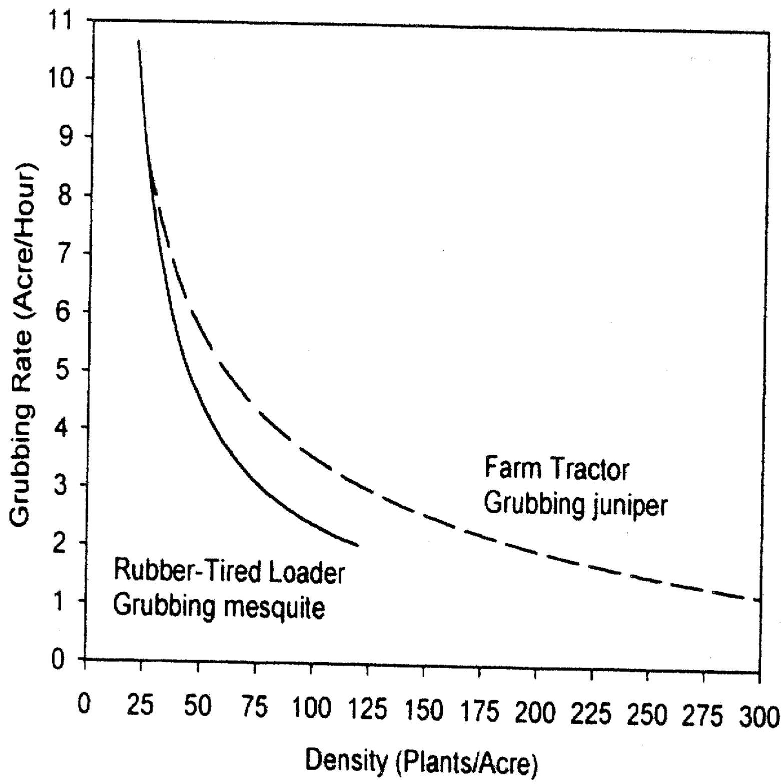


Figure 3. Performance (acres per hour) of a farm tractor for grubbing small junipers and a rubber-wheeled loader for grubbing regrowth mesquite.

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Comments: [Dale Rollins](), Professor and Extension Wildlife Specialist
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Great Trinity Forest Management Plan

Grasslands

Factors to Consider When Sculpting Brush: Chemical Treatment Options

FACTORS TO CONSIDER WHEN SCULPTING BRUSH: CHEMICAL METHODS

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Abstract: Density of brush cover sometimes limits management of rangeland animals. Herbicides have been shown to be an effective tool to manipulate brushland habitats for both wildlife and livestock as long as appropriate herbicides, patterns and rates of application are observed.

That woody plants dominate the vegetation cover of most rangelands is axiomatic. It has been estimated that more than 88% of Texas rangelands support brush densities severe enough to cause problems in effective management (Scifres 1980). As Blakey (1947) so aptly stated, "*Encroachment of brush jungle upon formerly open forest and prairie range is insidious in that it has both good and bad effects upon certain wildlife species, and in some areas has the constant potential for near total exclusion of all valuable forms*." While it is widely recognized woody cover plays a critical role in wildlife habitat, having some brush cover is becoming increasingly recognized as desirable in livestock production as well. However, it often is advantageous to manipulate the composition, height, shape, canopy cover and relative availability of different species for use by rangeland animals.

Quality of an animal's habitat is determined largely by the structure and composition of the vegetation. To benefit an animal population, the habitat must meet the needs of that animal. Quality habitat can be defined, at least in part, as a function of the interaction of woody and herbaceous components. The "domain of presence" of an animal population can be defined as the set of woody and herbaceous combinations that will support that population. Peak animal abundance theoretically occurs at the optimum mix of woody and herbaceous cover. As woody cover goes above or below optimum, animal abundance would be expected to decline until conditions are reached that will no longer support the population (Koerth 1996).

In simple form, herbaceous production is inversely related to woody cover. As woody cover increases, herbaceous cover decreases. Different animal species are adapted to exist at different levels along this woody-herbaceous continuum. Therefore, an understanding of the basic requirements of the species to be benefited must be understood. As there are limits to the amount of woody cover required by different species, it often is desirable to manipulate the habitat to favor certain populations. After years of controversy, it is becoming accepted that herbicides can be used to manage wildlife habitat as long as appropriate rates and patterns of application are used.

Herbicides, in the context of this discussion, are compounds exhibiting phytotoxic properties. In other words, a chemical used to control, suppress, kill or severely interrupt the normal growth processes of plants. While toxic to certain plants, rangeland herbicides exhibit a low order of toxicity to birds and mammals. There remains no evidence, when applied properly, that herbicides currently labeled for rangeland use will bioconcentrate and pose direct harm to rangeland wildlife or man (Johnson 1971).

Every brush management technique, including herbicides, has a unique set of strong points and associated weaknesses. The following, adapted from Scifres (1986), are the advantages and disadvantages of using herbicides to manipulate rangeland vegetation.

Advantages:

1. A variety of application methods are available ranging from individual plant treatment to broadcast application.

2. Aerial application methods are fast compared to mechanical methods and are independent of rough terrain and plant growth forms.

3. Applications result in little or no soil disturbance.

4. Stems and trunks of defoliated species and foliage of herbicide-resistant species remain to provide screening cover and shade.

5. Herbicides are effective in suppressing selected woody species.

6. Soil-applied herbicides have minimal drift and can be applied during relatively broad periods of the year.

7. Broad-leaved herbaceous plants also may be suppressed, hereby further reducing com-petition from more desirable species.

Disadvantages:

1. Many plants suppressed by herbicides are favored food plants of some wildlife species.

2. Foliar sprays are usually restricted to certain phenological stages of plants.

3. Application of foliar sprays may be hampered by environmental conditions such as wind speed and temperature.

4. The spectrum of species controlled in complex systems may not be sufficient to allow maximum production of the desired species.

5. Suppression of susceptible species may allow herbicide-resistant species to increase and ultimately form stands more difficult to manage than the original cover.

Methods of application

Methods of herbicide application basically can be categorized as aerial or ground methods. Use of a fixed-wing or rotary-wing (helicopter) aircraft is probably the most common. Aerial applications have the advantage of being able to cover relatively large areas in a short time. Also, aircraft are not limited by rough terrain or size of the woody cover to be treated. Herbicides can be applied either as a foliar spray or in a dry, pelleted form.

However, aerial application methods are not limitless. A suitable landing strip is necessary for fixed-wing aircraft. In addition, aerial applications are relatively broad-brush treatments and do not allow for much discrimination in plant treatment other than with herbicide formulation. Non-target species receive the same treatment as the species we hope to suppress.

Because herbicides do not leave an immediate physical mark on the area treated, aerial treatments are applied by flying the aircraft from point to point marked by flaggers at each end of the treatment area. Thus, aerial applications tend to be in straight lines and may not result in a physically appealing treatment pattern.

On the other hand, ground applications allow more flexibility. While broadcast treatments are an option, individual plant treatments permit the ultimate in selectivity. Particular species or even specific plants within species can be targeted for control. The trade-off being the time necessary to physically move across the area. Also, ground applications are limited by rough terrain and size of plants that may prohibit vehicle access. Ground applications are better suited to small areas than aerial methods.

Effects on wildlife habitat

The principle short-term impact on wildlife habitat is defoliation and loss of cover, browse and herbaceous food plants. However, changes with herbicide treatments are more subtle than with mechanical methods. It may take as long as two weeks for leaves to turn brown and a month or more to defoliate. With some soil-applied herbicides such as tebuthiuron, complete defoliation of susceptible species may not be complete for up to two years. Stems, trunks and all but the smallest twigs remain to provide screening cover and shade.

Because different plant species are susceptible to different herbicides and rates, only generalizations can be made about specific impacts. Predictions of future outcomes must be made on a case-by-case basis. However, there inevitably will be some loss of browse and broad-leaved plants following herbicide applications. This reduction in the potential food supply, however, is often short-lived. Restoration of herbaceous plants is seemingly largely dependent upon precipitation patterns following treatment.

The major long-term impact of herbicide applications on habitat is suppression of susceptible species, thereby reducing the complexity of the vegetation. However, changing vegetation composition is not always negative. Altering the forage composition may actually increase the diversity of the food supply compared to the untreated state. Selective treatments also can create relatively stable shrub communities and somewhat less stable herbaceous openings when interspersed within larger, mixed woodlands.

Patterns of application

Extensive coverage with broadcast herbicide applications is seldom recommended where wildlife is important. Large blocks of defoliated brush often exceed the threshold of suitability for many wildlife species (Beasom and Scifres 1977).

However, herbicide applications in patterns that retain sufficient untreated areas to provide food and cover have been used successfully in wildlife management. Probably the most commonly used practice is strip spraying. A herbicide dose is applied within the strip to provide maximum control of woody plants. Treated strips typically are alternated with untreated strips of approximately equal width. This pattern is the easiest to layout and application particulars are uncomplicated. However, while effective, the resultant pattern may be aesthetically unappealing to some.

To avoid the straight edge approach of strip spraying, Scifres and Koerth (1986) implemented and evaluated an alternative, generically called variable rate patterning (VRP).

In simplest form, a VRP is installed by applying herbicide at one half the normal dosage in treated and untreated strips in two directions. The second set of strips is applied over the same area, but perpendicular to the first. The resultant effect is not the checkerboard visualized from the treatment design, but rather a very asymmetrical pattern from responses of differing vegetation communities with different herbicide rates. This pattern provides a selection of habitats at varying levels of succession interspersed with blocks of mature, untreated areas for cover.

Whatever the treatment pattern, herbicides can be effectively used for manipulating vegetation for both wildlife and livestock. However, it is imperative to know the species composition of the proposed treatment site to predict plant and animal response. The most effective treatments maintain a high degree of structural and botanical diversity to provide requisite habitat needs for the target animal species.

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Great Trinity Forest Management Plan

Grasslands

Brush Management Methods

Brush Management Methods

Tommy G. Welch

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Brush plants now exist on more rangeland than at anytime in recorded history. Although the number of acres of dense brush has reduced since the mid-1960's, the areas supporting a thin stand of brush have increased. This indicates invasion of brush into new areas and reinvasion on acres where brush was previously controlled.

Brush has long been considered one of the major management problems confronting owners and managers of rangeland. A dense stand of brush usually minimizes grass cover. Reduced grass cover results in loss of livestock production, increased soil erosion and inefficient use of rainfall. Heavy brush infestations may significantly reduce the amount of water available from rangeland watersheds. The increased soil erosion reduces water quality and can reduce capacity of water reservoirs through siltation.

Brush also has some desirable attributes. It provides food and cover for many wildlife species. Certain livestock enterprises such as goats utilize brush as food. The presence of some brush plants also is often aesthetically pleasing. Brush plants such as mesquite may be useful for wood furniture, firewood and charcoal briquets.

Brush has both positive and negative characteristics. Thus, brush should be managed to meet the established ranch objectives.

Brush control methods are used to manage brush. Many methods have been developed in the past 50 years, and each method has applications for which it is best adapted. Seldom is there a best method for any ranch situation. Often more effective brush management may be obtained by using a combination of brush control methods in a sequence during a period of several years. An integrated management system can minimize the use of herbicides, while improving grass cover and maintaining or improving surface and subsurface water quality. Therefore, before selecting a method, evaluate feasible alternatives relative to 1) degree of expected control, 2) characteristic weaknesses, 3) expected treatment life, 4) secondary effects (i.e., release of a secondary undesirable plant), 5) application requirements, 6) effect on wildlife habitat, 7) cost and benefit and 8) safety.

For most effective brush management, a plan should be developed outlining the purpose of brush management (what is to be accomplished and why), what methods will be used where and when and what is the appropriate follow-up management (grazing and maintenance brush control). The plan must be consistent with the ranch objectives and be part of the overall ranch plan. An effective brush management plan will help meet long-term objectives for the ranch, as well as for the rangeland, livestock and wildlife resources.

Selection of brush management methods is important. Methods should be selected on the basis of ranch objectives, resources available, expected response, economics and personal preference. Brush management methods, including mechanical, chemical, biological and prescribed burning will be described here.

Mechanical Methods

Equipment used for mechanical brush management is designed to remove either the top growth or the entire plant. Methods that remove only top growth generally provide short-term woody plant control because most species will resprout. Methods that effectively remove part of the root system with the top provide longer term control (Table 1).

Hand grubbing

Hand grubbing may be effectively used as a maintenance practice for small brush plants when the number of plants per acre is small (Figure 1). This labor intensive practice may be used to control nonsprouting species and species that sprout from the stem base if they

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Table 1. Expected responses of rangeland vegetation to brush management treatments and special considerations.

Treatment	Expected Brush Responses	Treatment Life (yr)	Forage Responses	Special Considerations
Broadcast Herbicide Application				
Spike 20p	Effective control of some species (eg. oaks, white brush); little control of mesquite, Texas persimmon, pricklypear, lime prickly-ash and others	10+ (Greatly dependent on abundance of tolerant species)	Maximum release by second or third growing season, highly dependent on ratio of tolerant to susceptible species	Use decision should be based on soil texture and brush stand composition (Also see remarks for Grazon ET + Grazon PC)
Grazon ET + Grazon PC, Banvel + Grazon PC	Good to excellent topkill season of application; 50% or more plants may resprout depending on species, season and initial effectiveness.	5-7	Forage release by end of first growing season; maximum production by second or third season after application	Alternative treatment for tolerant species should be considered at outset of planning
Reclaim + Grazon PC	Effective control of mesquite; Good to excellent topkill season of application; 40% or more plants may resprout depending on species, season and initial effectiveness	5-10 (Dependent on abundance of tolerant species)	Same as for Grazon ET + Grazon PC	Same as for Grazon ET + Grazon PC
Grazon P+D	Effective control of Chinese tallowtree; generally topkills Macartney rose for at least one growing season; many species of weeds controlled; may reduce topgrowth of mesquite by >80% year of application with most plants resprouting	2-3	Forage release by end of first growing season; maximum during year after application	Provides only short-term control of brush unless followed by subsequent treatments
Banvel + Grazon ET	Mesquite topkill good to excellent year of application; responsse of other species variable	5	Same as for Grazon ET + Grazon PC	Same as for Grazon ET + Grazon PC
Reclaim, Reclaim + Grazon ET	Effective control of mesquite; good to excellent topkill season of application; 40% or more plants may resprout depending on initial effectiveness	7-10	Same as for Grazon ET + Grazon PC	Same as for Grazon ET + Grazon PC

Table 1. Continued				
Treatment	**Expected Brush Responses**	**Treatment Life (yr)**	**Forage Responses**	**Special Considerations**
2,4-D	Good control of sand sagebrush; may reduce topgrowth of Macartney rose by >80% year of application; little control of other brush species; some weeds controlled when treated at the proper growth stage	2-3 (for sand sagebrush) 1 (for others)	Forage release by end of first growing season	Repeated treatment required for sustained improvement or follow with prescribed burning
Weedmaster	Many species of weeds controlled; may reduce topgrowth of mesquite by >80% year of application with most plants resprouting	1-3	Same as 2,4-D	Repeat treatment often necessary
Grazon PC	Somewhat more effective than 2,4-D mixture on Macartney rose; effective control of pricklypear, huisache, blackbrush acacia, twisted acacia and other hard-to-kill species	Depends on species	See Grazon ET + Grazon PC	See Grazon ET + Grazon PC
Individual Plant Treatments				
Primarily as maintenance treatment after broadcast treatment; or for scattered stands of woody plants; forage release after treatment is usually minimal				
Spike 20P	Complete kill depending on dosage and brush species	Depends on brush reinvasion rate	Injures grasses in local area of herbicide deposition	Do not apply near desirable trees such as oaks
Grazon PC (high-volume foliar application)	Controls small huisache, pricklypear, twisted acacia, Macartney rose, ashe juniper, eastern redcedar, redberry juniper and many other woody plants	5+	May temporarily injure grasses in local area of herbicide deposition	May be especially useful for spot treatment following prescribed burning
Grazon ET + Grazon PC, Banvel + Grazon PC	Good to excellent topkill season of application; 30% or more plants may resprout depending on species, season and initial effectiveness	5+	See Grazpm PC	

Table 1. Continued				
Treatment	**Expected Brush Responses**	**Treatment Life (yr)**	**Forage Responses**	**Special Considerations**
Reclaim + Grazon PC	Excellent topkill of mesquite season of application; 20% or more plants may resprout depending on initial effectiveness and species	5-10 (Dependent on species)	See Grazon PC	
Reclaim, Reclaim + Grazon ET	Excellent topkill of mesquite season of application; 20% or more plants may resprout depending on initial effectiveness	7+		
Banvel + Grazon ET, Banvel, Grazon ET	Mesquite topkill good to excellent in season of application; 50% or more plants may resprout depending on initial effectiveness	5+		
Grazon P+D	Effective control of Chinese tallowtree, Macartney rose and honey locust	5+	See Grazon PC	
Grazon PC (soil application)	Controls ashe juniper and eastern redcedar	5+	May temporarily injure grasses in local area of herbicide deposition	Do not apply near desirable trees such as oaks
Velpar L	Controls acacias, hackberries, oaks, junipers and mesquite on sand-clay loams	Depends on brush reinvasion rate	Kills grasses in local area of herbicide deposition	Do not apply near desirable trees such as oaks
Grazon ET, Crossbow, Diesel (basal bark application)	Controls most species except junipers and lime pricklyash	5+	May temporarily injure grasses in immediate area of woody plant, depending on rate and carrier	
Grubbing	Control non-sprouters and basal sprouters if grubbed to first root; less effective on root sprouters	5+	Pits remove grass cover but trap water; hand seeding may be effective for grass establishment	Most effective for light to moderate stands of single-stemmed plants
Bulldozing	Effectively controls most plants that are uprooted, but many plants may be left rooted; rooted plants that are sprouters will regrow rapidly; growth form changed from single- to multi-stemmed form	2-3	Dozer blade may remove grass; seeding of grasses may be effective	Soil disturbance will be greater than for grubbing; best adapted for light to moderate stands of single-stemmed non-sprouting plants

Table 1. Continued

Treatment	Expected Brush Responses	Treatment Life (yr)	Forage Responses	Special Considerations
Broadcast Mechanical Methods				
Chaining One-way	Effectively controls most plants that are uprooted, but many plants may be left rooted; rooted plants will regrow rapidly; growth form changed from single- to multi-stemmed form	2-3	Forage released year of treatment, declines as brush regrows	Soil water must be adequate to allow uprooting of plants; chain may ride over or break off tops of small plants; pricklypear may be increased
Chaining two-ways	Generally uproots more plants than one-way chaining	4-5	See above	See above
Raking + stacking	Generally a follow-up to other treatments; some uprooting and removal of small brush and pricklypear; sometimes used for top removal of Macartney rose	1-2	See above	Effectively removes and consolidates debris resulting from previous treatment; localizes pricklypear pads
Stacking	Effective for removal of pricklypear	>5 Depending on reinvasion rate	Released year of treatment	May be used to thin heavy stands of pricklypear; also removes small- to medium-sized woody plants
Roller Chopping	Most plants regrow rapidly; growth form changed from single- to multi-stemmed form; pricklypear cover increased	2-3	See above	Can use on larger brush than with most shredders; may prepare adequate seedbed for seeding grasses
Shredding	See above	See above	See above	Generally cannot be applied when most plants basal diameter >4 inches
Rootplowing	Highly effective in killing most species if done properly. Not effective on some plants that can root from severed or broken plant parts such as pricklypear	10-20	Most existing forage plants destroyed. Most forage production year of treatment is from annuals	Should be followed by seeding
Offset disk	Effective on smaller, shallow-rooted brush species such as whitebrush	10	See above	See above

Table 1. Continued				
Treatment	**Expected Brush Responses**	**Treatment Life (years)**	**Forage Responses**	**Special Considerations**
		Biological		
Goating	Effective in combination with prescribed burning, roller chopping, shredding and other mechanical methods that stimulate basal and/or root sprouting on shin-oaks and other mixed brush	>5 Depending on continued use of goats		Goats will utilize large amounts of shinoak if stock density is high enough and goats are removed when brush is defoliated and returned when new leaves develop
		Prescribed Burning		
Prescribed burn	Controls non-sprouters such as ashe juniper, eastern redcedar and pricklypear; sprouters regrow rapidly	2-5	Forage released year of treatment, declines as brush regrows	Effectiveness depends on intensity of fire. Quantity, continuity and distribution of fine fuel (grass) as well as weather are important factors that determine fire intensity

Figure 1. Hand grubbing for complete removal of small plants.

are uprooted below the lowermost bud. Hand grubbing is best accomplished when the soil is moist.

Power grubbing

Power grubbing is effective on nonsprouting species and species that sprout from the stem base, provided they are uprooted below the lowermost bud (Figure 2). Power grubbing is most useful with scattered plants that are large enough (at least 3 feet tall) to be seen easily by the equipment operator. The size of plant that can be effectively grubbed depends on the size of tractor and grubber used.

Soil texture and water content affect grubbing efficiency. The efficiency of power grubbing decreases as soil clay content increases and water content decreases. On dry clay soils, many plants may be cut off near the ground level by the grubber blade, leaving part of the bud zone in the soil. Likewise, grubbing on deep sands may not be successful because accumulation of soil around plant bases increases the depth requirement for effective grubbing. Grubbing in shallow, rocky soils is usually hard on equipment, less effective and may leave the soil surface extremely rough.

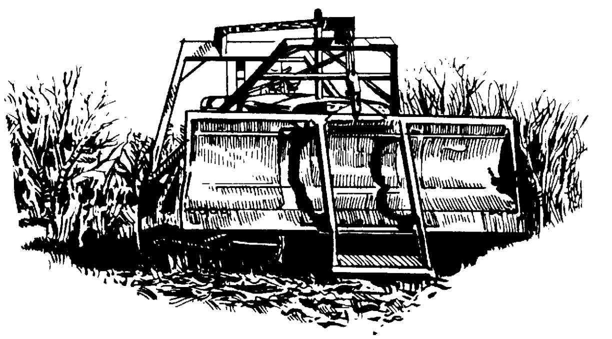

Figure 2. Power grubber for cutting roots 4 to 14 inches beneath the soil surface.

Various types of low-energy power grubbers have been developed. These grubbers are used on small crawler and rubber-tired tractors (Figure 3). Low-energy grubbers may be used to control thin stands of small brush plants. These grubbers are not recommended for plants with root diameters greater than 4 inches.

Pits are left in the soil surface where brush plants are removed. Runoff water will accumulate in these pits increasing the water infiltration. However, the soil surface may become extremely rough if high densities of brush are grubbed. The pits allow a good chance for establishing desirable grasses if seeds are scattered in the pits in early spring.

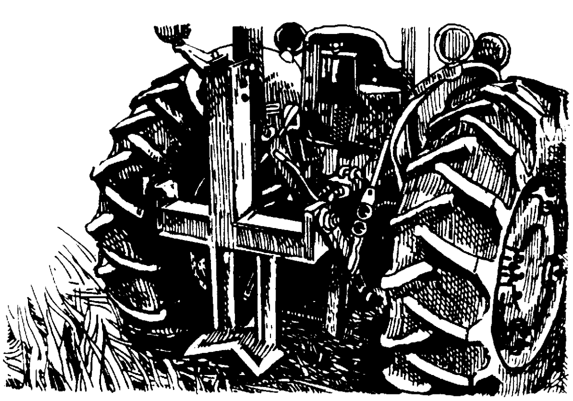

Figure 3. Low-energy power grubber for use on row crop tractors.

Bulldozing

The bulldozer (a crawler tractor equipped with a heavy-duty pusher blade) is used to sever woody stems at or below the soil surface (Figure 4). Since few plants are uprooted by bulldozing, it is best adapted for use on large non-sprouting species in scattered stands. If sprouting species are bulldozed, expect plants to resprout unless the bud zone is removed. Bulldozing may cause considerable soil disturbance.

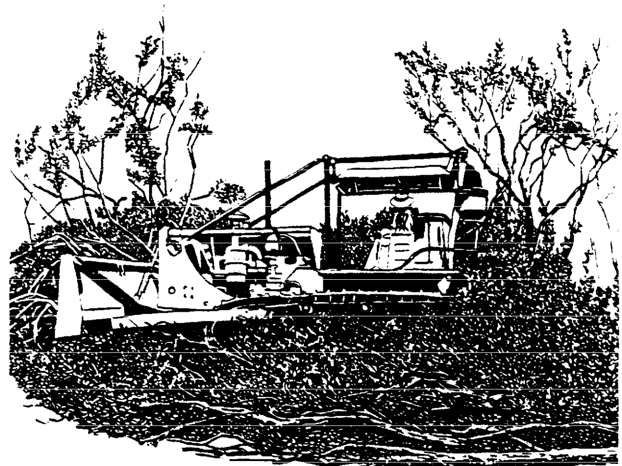

Figure 4. Bulldozer for severing woody stems at or below the soil surface.

Shredding

Shredding uniformly removes brush top growth but rarely kills woody plants, especially those capable of sprouting from roots or stem bases. Drag-type shredders (Figure 5) are most efficient on plants with stem basal diameters of less than 2 1/2 inches, although heavy-duty, hydraulically operated shredders may remove woody plants with trunk diameters of 4 inches or more.

Woody plants may regrow rapidly following shredding. For example, honey mesquite, lotebush, twisted acacia and whitebrush replace 50 percent of their original heights during the first growing season after shredding. Several other woody species replace 50 percent of their height during the second growing season. Repeated shredding generally causes the number of stems and size of the bud zone (basal stems) to increase. Plants that have been shredded repeatedly are more difficult to control with herbicides and may require more energy to remove by grubbing

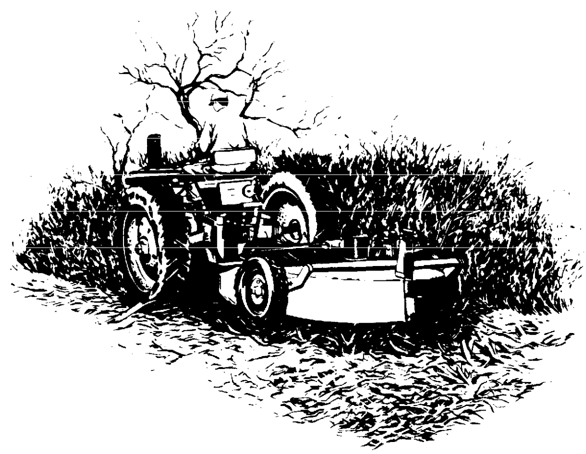

Figure 5. Drag-type shredder for removing top growth of brush plants with stems less than 2 1/2 inches in diameter.

than plants that have not been shredded. Shredding can increase the plant densities of Macartney rose and pricklypear because fragments of rose canes or pricklypear pads scattered over the soil surface may take root. Spreading of such species is minimized by shredding during hot, dry periods.

Although shredding provides only short-term control of most undesirable plants, sufficient time may be allowed for grass to grow and provide fine fuel for prescribed burning. Shredding may increase browse availability and quality by increasing the number of young, succulent sprouts. Shredding may also improve livestock handling efficiency by increasing accessibility and visibility for the manager.

Roller chopping

Roller choppers are drums with several blades running parallel to the axis of the roller (Figure 6). The drums vary in size; some types are filled with water to increase their weight. Roller choppers are more durable than shredders and can be used on larger brush and rougher topography.

Roller chopping, like shredding, kills few plants. Forage response and treatment life are similar to those described for shredding. Likewise, roller chopping Macartney rose and pricklypear may result in a significant increase in plant density as cane and pad fragments take root.

Chopper blades may penetrate the soil surface from 6 to 10 inches deep. Thus, soil disturbance may be sufficient to improve water infiltration. Seeded grass stands have been established on seedbeds prepared by offset, tandem roller choppers. Prescribed burning may be used to suppress brush regrowth in such stands. Roller chopping may also be used as a low-cost seedbed preparation following rootplowing.

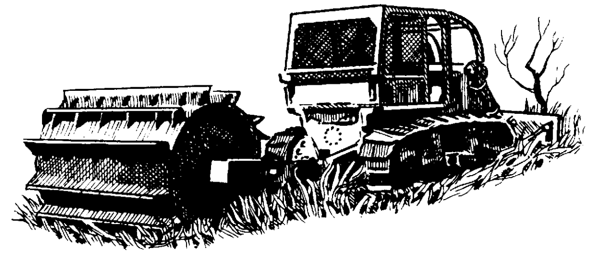

Figure 6. Roller chopper for removing top growth of brush plants.

Rootplowing

Rootplowing is a nonselective treatment used to sever woody plants in moderate to dense stands of brush. A rootplow is a V-shaped blade, 10 to 16 feet long with several short fins attached perpendicular to the blade (Figure 7). It is mounted on and pulled behind a crawler tractor with the blade 8 to 15 inches below the soil surface.

Rootplowing will control most brush species. It is least effective on shallow-rooted species such as whitebrush and cacti. However, ground cover of pricklypear and tasajillo may increase dramatically following rootplowing. By disturbing the soil surface and underlying impermeable zones, rootplowing also increases the water infiltration rate into some soils.

Although rootplowing is a highly effective brush control method, it causes considerable soil disturbance and destroys most perennial grasses and forbs. Thus, seeding is often necessary as a follow-up treatment. This is a serious limitation when used on arid rangeland in far West Texas. If a rootplowed area is not seeded, most forage production for the first several years will be from annual and other plants low on the successional scale.

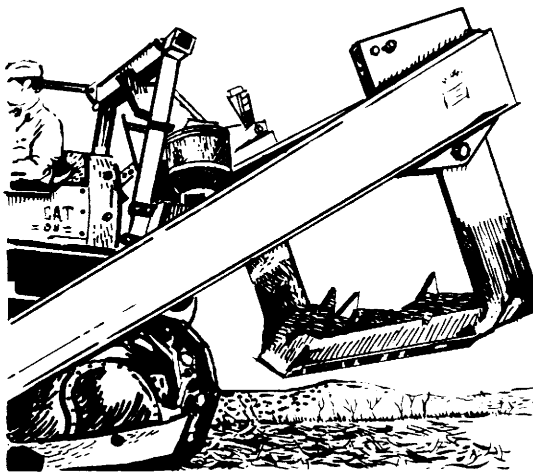

Figure 7. Rootplow for cutting roots 8 to 15 inches beneath the soil surface.

The carrying capacity for cattle is reduced until higher successional grasses become established. The flush of annual forbs on rootplowed areas may drastically improve wildlife forage supply until perennial grasses become dominant. The soil disturbance and destruction of vegetative cover on rootplowed areas may stimulate the germination of some brush species such as huisache.

Rootplowing is costly, but the benefits of the practice may exceed 20 years. Rootplowing is best suited for deep friable, fertile soils where revegetation is feasible. The effectiveness is generally reduced on shallow rocky soils and deep clay soils.

Heavy offset disk

Heavy offset disks may effectively control small, shallow-rooted brush species such as whitebrush (Figure 8). Because of the limited soil depth (6 to 8 inches) reached by the offset disk, it is generally ineffective on plants with deep bud tissues such as mesquite. Disking does not work well on rocky soils either. Disking is less effective just before or immediately after rain because many plowed plants reestablish root systems. The extreme soil disturbance and possible damage to existing perennial vegetation caused by disking make the method most applicable to deep soils that can be seeded.

Chaining

Chaining is used to knock down and thin moderate to thick stands of brush (Figure 9). Chaining alone gives only temporary control. It is most effective on trees 4 to 18 inches in diameter in a density of no more than 400 plants per acre. Small, "switchy" brush will bend under the chain or break off above the soil surface. To obtain maximum control, the soil-water content must be sufficient for plant crowns and (or) lateral roots to be pulled completely out of the soil. Chaining under these conditions, however, may increase the cover of pricklypear. Two-way chaining, covering the area twice in opposite directions, usually gives better control than one-way chaining. Chaining can be used on rough, rocky terrain with only moderate soil disturbance.

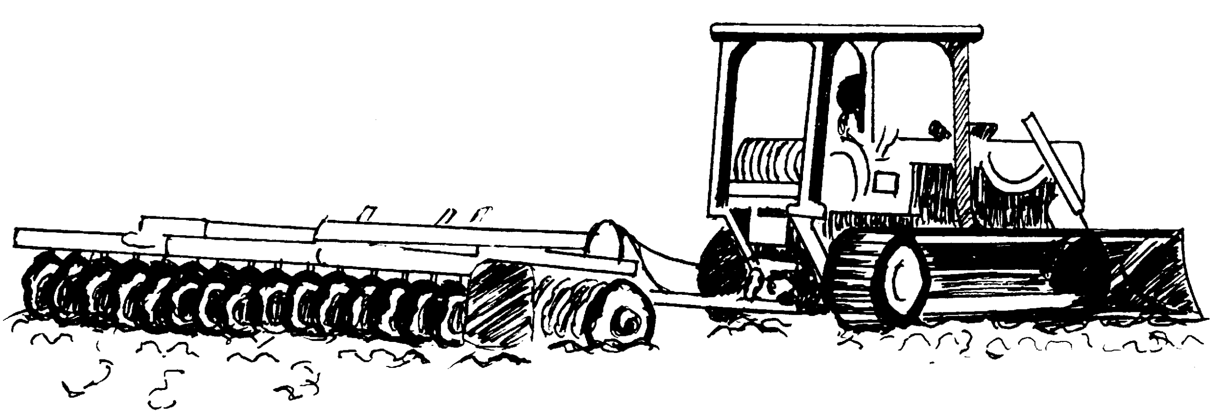

Figure 8. Heavy offset disk for control of shallow-rooted brush species.

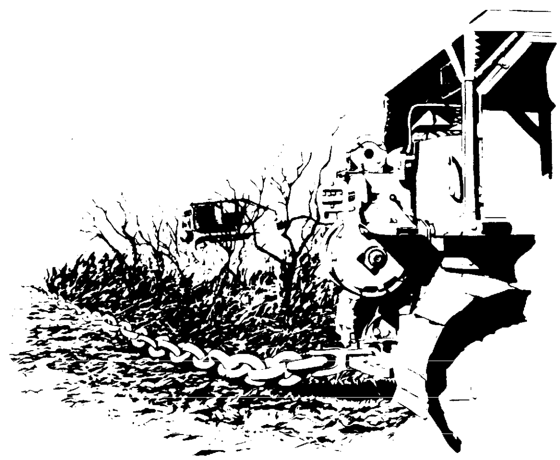

Figure 9. Heavy anchor chain pulled between two crawler tractors for knocking down trees 4 to 18 inches in diameter.

The percentage of brush plants actually killed by chaining is often low, and regrowth may be rapid. However, herbaceous production may increase the year of treatment, given average or greater rainfall. This may provide adequate fine fuel for prescribed burning to remove debris and suppress brush growth. Raking and stacking may be necessary to remove woody debris after chaining areas of heavy brush cover. Less debris allows maximum development and utilization of range forages and minimizes livestock-handling problems.

Chaining has been used successfully in combination with aerial application of herbicides. Chaining two or three years after aerial spraying reduces time required to chain and also improves brush kill by uprooting partly dead large plants.

Cabling

Cabling is similar to chaining but, because of their lighter weight (usually 2.5 to 3 inches in diameter), cables tend to ride over the tops of small brush and woody debris, leaving many plants intact. Cabling is most effective on upright, nonsprouting species of moderate size, such as ashe juniper, and when the soil moisture content is conducive to uprooting the plants.

Soil disturbance is slight. Cabling will spread pricklypear when conducted under conditions optimum for woody plant removal. However, cabling during dry periods has been used to control cholla.

Railing

Two or more railroad irons dragged in tandem may be used for control of pricklypear, other cacti and small nonsprouting woody plants. Maximum cactus control is obtained by railing when the soil surface is extremely dry, the temperature is hot and dry weather follows the treatment and desiccates the pads. Soil disturbance is minimal, so herbaceous response depends on soil moisture conditions following treatment.

Raking and stacking

Raking and stacking are used to collect and pile debris left from other mechanical treatments, such as rootplowing. Occasionally stacking is used as an initial treatment to control pricklypear and to remove the top growth of mature, dense Macartney rose.

Brush rakes used to collect and pile debris left from other mechanical treatments cause minimal soil disturbance. Stacker rakes used to remove and stack pricklypear and mature Macartney rose will disturb the soil more than a brush rake. These rakes penetrate the soil 6 to 10 inches deep and are used to control whitebrush and to prepare a clean, firm seedbed after rootplowing. The following implements are used in raking and/or stacking operation:

Root rake - a drag-type rake (Figure 10) pulled behind a crawler tractor to remove debris on and beneath the soil surface following rootplowing. The primary purpose of this implement is to clean and smooth the land surface for seedbed preparation. By removing woody plant crowns and root tissues from the soil, root raking reduces the probability of resprouting.

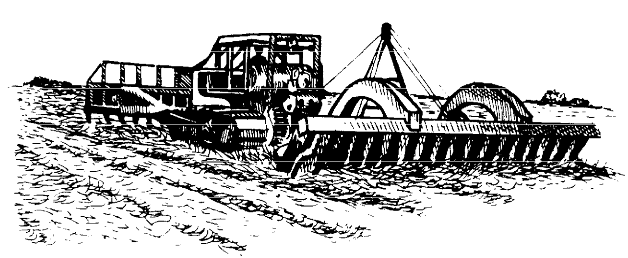

Figure 10. Root rake for removing debris on and beneath the soil surface.

Brush rake - a front-end rake (Figure 11) pushed by a crawler tractor to pile debris left by a previous practice. Brush rakes have open tines that gather debris without major accumulations of soil. They may be used on either disturbed or firm soil surfaces.

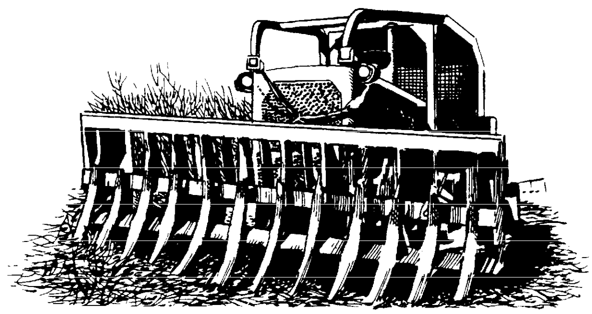

Figure 11. Brush rake for piling debris left by a previous practice.

Stacker - a special front-end rake (Figure 12) modified with closed tines near the soil surface. It uproots or shears off woody plants at ground level and gathers them with less debris loss than the brush rake. Modifications include turned-in ends (V-shaped) and a steel plate across the tines near the soil surface. Additional pads may be added to the bottom tines to support the stacker's weight and hold it in the correct position for the soil surface. The implement works on a firm soil surface and is especially effective for removal of pricklypear.

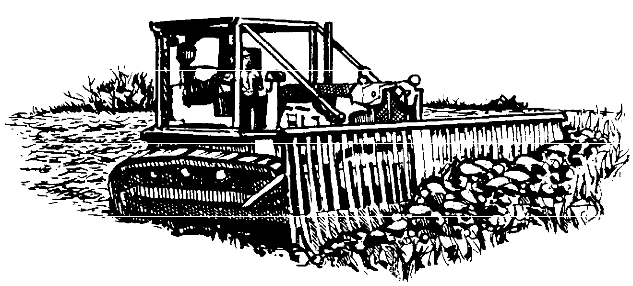

Figure 12. Stacker for uprooting or shearing off woody plants at ground line and gathering debris with minimum loss.

Chemical Methods

Herbicides used on rangeland may be formulated as liquids or pellets and applied by broadcasting or to individual plants. These herbicides include Grazon ET (triclopyr), Banvel (dicamba), Grazon PC (picloram), Reclaim (clopyralid), Crossbow (1:2 mixture of triclopyr and 2,4-D low volatile ester), Grazon P+D (1:4 mixture of picloram and 2,4-D amine), Weedmaster (1:3 mixture of dicamba and 2,4-D amine), Velpar L (hexazinone) and Spike 20P (tebuthiuron). Degree of brush control with herbicides depends largely on species susceptibility, rate of application and method of treatment (Table 1). Consult *Chemical Weed and Brush Control Suggestions for Rangeland* (B-1466) by the Texas Agricultural Extension Service for specific recommendations on each problem situation. The following descriptions are intended as general information only.

Broadcast application

Liquid herbicides are usually applied aerially in 2 to 5 gallons per acre of an oil:water carrier (Figure 13). When applied with ground equipment (cluster nozzle or boomsprayer), the herbicide-carrier volume is 10 to 30

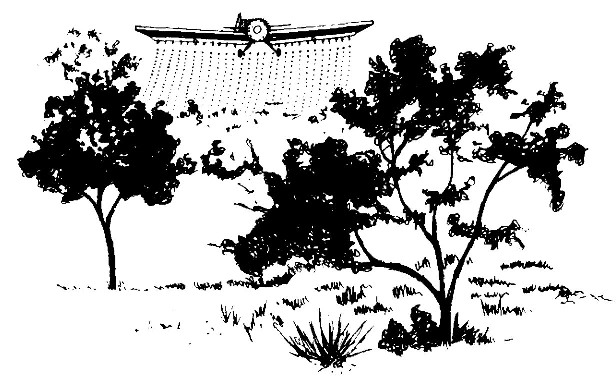

Figure 13. Aerial herbicide application for brush control.

gallons per acre (Figure 14). Pelleted herbicides may be applied aerially with special applicators. They may also be broadcast by ground equipment, such as backpack-airblast applicators and whirlwind-type spreaders.

For best results, liquid herbicides must be applied when growing conditions optimize herbicide absorption by the plant. For example, foliar-applied herbicides usually should be

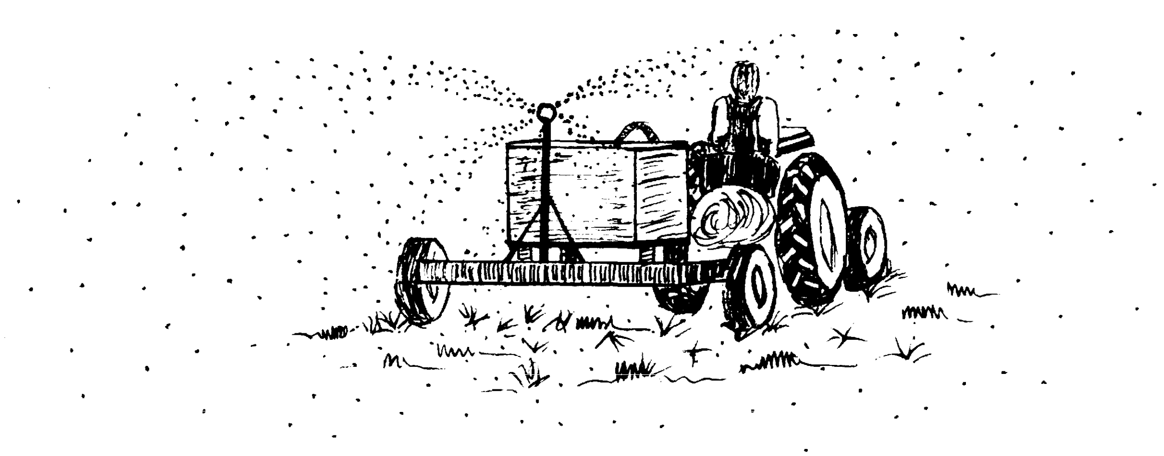

Figure 14. Cluster nozzle used for ground broadcast application of herbicides.

applied to mesquite after the leaves have matured in the spring and the soil temperature at 12 inches of depth is 75°F or more. Macartney rose, blackbrush acacia and huisache may be sprayed during spring or fall. Generally, best results are obtained when growth conditions allow development of full foliage and the plants are not water stressed or damaged by insects, leaf diseases, hail or frost. Climate and growth conditions often limit the use and effectiveness of liquid herbicides.

Conditions for application of the pelleted herbicide are less restrictive than for liquid herbicides. The best time for application is before periods of expected rainfall and plant growth. Movement of herbicide into the soil by rainfall followed by a period of active plant growth allows maximum uptake and translocation of the herbicide by the plants. Thus, applications in fall or late winter/early spring are most common. Low drift potential and the lengthy time for application are major advantages of the pelleted herbicide. Effectiveness of Spike 20P is affected by clay and organic matter content of the soil. To achieve a given level of brush control, the herbicide rate must be increased as clay and (or) organic matter content increases.

Forage production may increase significantly during the first growing season after a liquid herbicide is applied. When Spike 20P is used, the greatest increase generally occurs two or more growing seasons following application. Abundance and diversity of herbaceous plants may be reduced by some herbicides. The degree of forage response is influenced by species, quantity and vigor of herbaceous plants present at the time of application, as well as by rainfall and management following treatment. In time, grass production generally declines as woody plants reestablish and canopies are replaced. The length of time before grass production returns to pretreatment levels varies considerably depending on the herbicide and brush species treated (Table 1). Some foliar-applied herbicide treatments may regress to pretreatment forage production within three to five years. However, some soil-applied herbicide treatments have a projected treatment life of over 20 years.

Individual-plant treatment

Herbicides used for broadcast application may also be used for treatment of individual plants. In addition, some herbicides are labeled for individual-plant treatment only. Individual-plant treatments are usually more effective than broadcast treatments with the same herbicide when plant kill is the evaluation criterion.

Individual-plant treatment is best suited for control of thin stands of brush. Thus, it is ideally used as a maintenance treatment following broadcast treatment to extend treatment life. Individual-plant treatment may also be used to selectively thin a brush stand and to control brush in selected areas while leaving brush in other areas. It may also be effectively used for control of brush along fencelines, around watering areas and around corrals.

Individual-plant treatment methods include cut-stump, basal bark, soil, high-volume foliar and carpeted roller applications. Cut-stump treatment uses diesel fuel oil, kerosene or a herbicide applied to the surface of a freshly cut stump and the basal plant parts below the cut. Application is continued until runoff occurs and the liquid begins to puddle at the soil surface (Figure 15).

Three types of basal bark methods are available. Conventional basal treatment is the application of diesel fuel oil, kerosene or a herbicide/diesel fuel oil mixture (2 to 4 percent herbicide) to the lower 12 to 18 inches of the trunk of a brush plant (Figure 16). The solution is applied completely around the trunk with sufficient volume to allow runoff and puddling at the soil surface near the plant base.

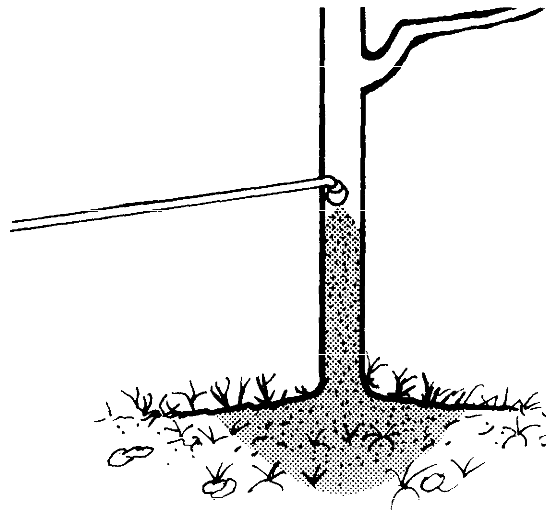

Figure 16. Conventional basal bark application of herbicide for maintenance control.

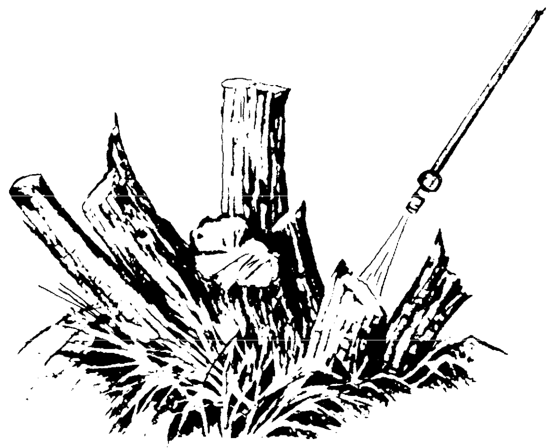

Figure 15. Cut-stump herbicide application for maintenance control.

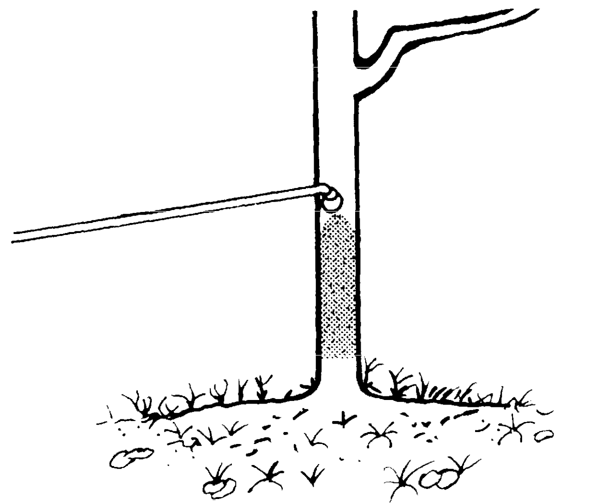

Figure 17. Low-volume basal bark herbicide application for maintenance control.

Low volume basal treatment uses a mixture containing 25 percent herbicide and 75 percent diesel fuel oil. The mixture is applied to the lower 12 to 18 inches of the trunk to wet the trunk but not to the point of runoff (Figure 17). The higher herbicide concentration allows for more penetration of herbicide through the bark of the plant.

Streamline basal treatment is the application of a mixture of 25 percent herbicide and 75 percent diesel fuel oil or 10 percent penetrant and 65 percent diesel fuel oil. The mixture is sprayed in a band (3 to 4 inches wide) completely around the trunk near ground level or at the line dividing young (smooth) and mature (corky or rough) bark (Figure 18). A straight stream nozzle gives the band width required. Addition of a penetrant improves ease of coverage around the trunk and may increase penetration of the herbicide through the bark.

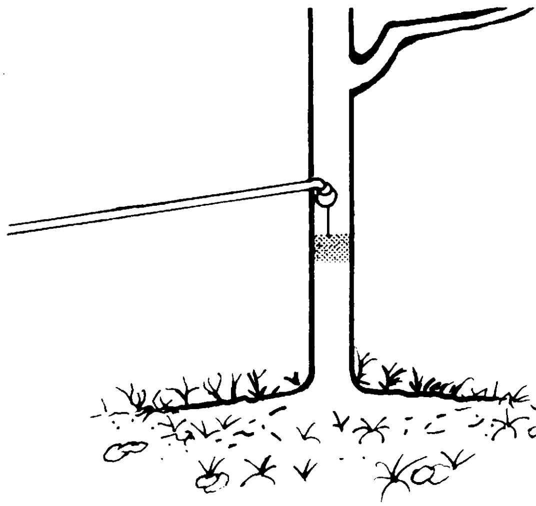

Figure 18. Streamline basal bark herbicide application for maintenance control.

Figure 19. Basal bark pour application for maintenance control

Best results with low-volume basal and streamline basal applications have been obtained on plants with trunks less than 4 inches in diameter and with smooth bark. Conventional basal treatment works well on single-stemmed plants or plants with few trunks. If the trunk diameter is greater than 5 inches, it should be frilled (axe cuts through the bark spaced no more than 4 inches apart around the mainstem) and the herbicide mixture applied to the frilled area.

Best results are obtained with conventional basal treatments of Grazon ET in diesel fuel oil or kerosene, diesel fuel oil alone or kerosene alone when the soil is dry. Low-volume and streamline basal applications may be made almost anytime; the optimum time of application is during the growing season when the plants have mature leaves.

Backpack sprayers and small "pump-up" (compressed air) sprayers work well for the basal bark treatment techniques. The conventional basal treatment may be accomplished by pouring from a can with a long spout (Figure 19).

Liquid herbicides used for broadcast application may also be applied to individual plants in a high-volume foliar application. The herbicides are usually mixed with water as the carrier. The mixture is sprayed to thoroughly wet the foliage (until the mixture begins to drip from the leaves of the treated plant). A power sprayer, backpack sprayer or a "pump-up" sprayer may be used (Figure 20).

Figure 20. Handgun on a power sprayer used for high-volume foliar application of herbicides.

A mechanical device for use on rubber-tired farm tractors applies herbicide to individual plants in a high-volume foliar application (Figure 21). The equipment, available under the tradename Brush Robot™, sprays only when the unit is in contact with a brush plant. Thus, an area with a thin stand of brush may be treated with the speed of a broadcast treatment but without broadcasting herbicide over the entire area. This usually results in less herbicide used per acre. The treated plants receive a volume similar to that from a power-handgun sprayer, which results in a higher degree of brush control than broadcast treatment. The Brush Robot™ uses the same herbicide mixtures used for high-volume foliar application. It is best suited for thin stands of brush having a stem height (usually 1 1/2 to 6 feet tall) and flexibility that effectively triggers the spray nozzles and also allows the tractor to pass over without breaking the plant's mainstem.

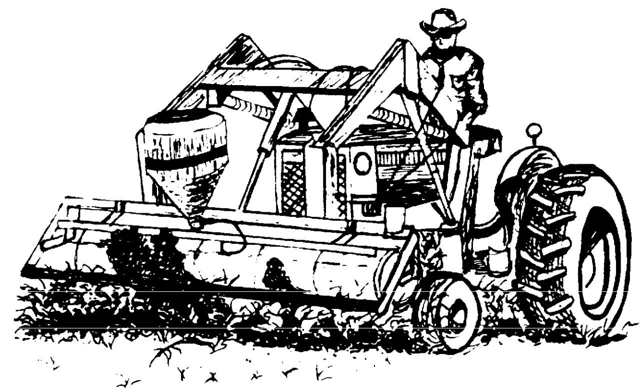

Figure 22. Carpeted brush roller used to wipe herbicides onto brush plants.

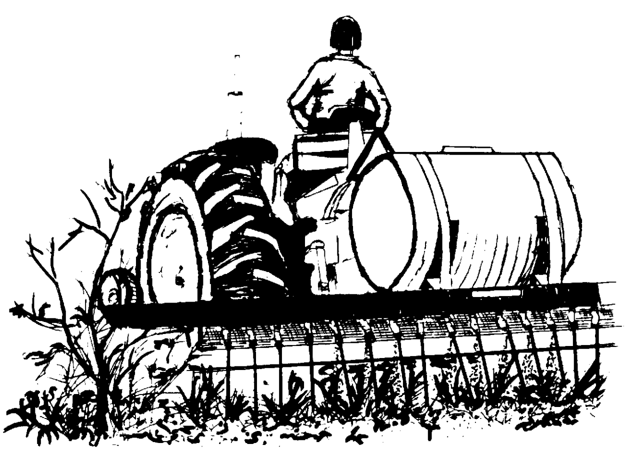

Figure 21. Brush Robot™ for mechanically applying herbicides to individual plants.

Liquid herbicides may be wiped onto brush plant leaves with the carpeted brush roller (Figure 22). It utilizes a 10-inch-diameter rotating cylinder covered with carpet that is kept wet with a herbicide mixture. The roller is mounted on the front of a farm tractor. The herbicide solution is wiped onto leaves and twigs as the rotating cylinder passes over the plant, usually at 1 to 2 feet of height (depends on height of brush plant). The roller applies herbicide to individual plants; thus, it is effective for maintenance control and for treatment of selected brush plants. Herbicides are mixed with water at ratios of 1:7 to 1:8. Individually treated plants usually receive a higher concentration of herbicide than from a broadcast treatment, so the degree of kill is greater. The carpeted brush roller is most effectively used on thin stands of brush with flexible stems that are 1 1/2 to 6 feet tall. The carpeted brush roller must be custom-made. Plans for the roller are available from the county Extension office or from the Extension Range Office, Department of Rangeland Ecology and Management, Room 225 Animal Industries Building, Texas A&M University, College Station, Texas 77843-2126.

Environmental and plant conditions for foliar applications to individual plants are similar to those for broadcast application. However, the effective spray period may last longer into the growing season than for broadcast application.

Soil-applied herbicides are available in liquid and pelleted formulations. Apply measured quantity of pelleted herbicide, determined by plant size, species and soil type on the ground under the plant canopy (Figure 23) of individual brush plants. No special equipment is generally required for individual plant applications. Rainfall is necessary for dissolving the pellets and moving the herbicide into the soil.

Figure 23. Hand application of pelleted herbicide for maintenance control.

Liquid herbicides for soil application are applied undiluted, in measured quantities, to the soil under the target plant. Some type of metering device (exact-delivery spotgun) is required to dispense the herbicide (Figure 24). Since these herbicides are liquid, they move into the soil immediately. However, rainfall is necessary to move the herbicide into the plant's root zone.

When using soil-applied herbicides, apply the herbicide to the soil inside the dripline (Figure 25) of the plant at the rate specified on the label. The dripline is at the edge of the plant canopy. After the herbicide moves into a plant's root zone, it is taken up by the roots with soil water. Death (or killing of the target species) occurs slowly over one to three years. The treated plant may defoliate and releaf several times before it is killed. Grass may die for one to several years in a small circle under each treated plant. The best time to apply these herbicides is before periods of expected rainfall and plant growth. This allows movement of herbicide into the soil followed by a

Figure 24. Soil application with an exact delivery spotgun for maintenance control.

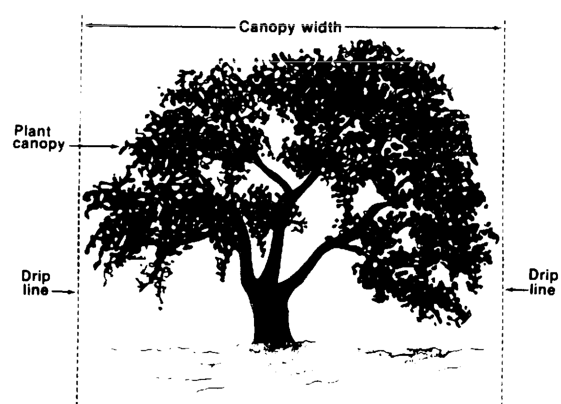

Figure 25. Dripline of a brush plant.

period of active root uptake as the plants grow.

Care must be taken when applying soil-active herbicides near desirable trees and shrubs. To prevent injury to desirable plants, these herbicides should be applied no closer than three times the canopy diameter of the desirable plant and never uphill where water may carry lethal amounts to the vicinity of desirable plants.

Prescribed Burning

The primary goal of prescribed burning is to suppress brush. Fire usually does not kill many woody species because most woody plants are capable of resprouting. Most Texas brush species resprout from buds on the stem base and below the soil surface on roots or on rhizomes. Thus, the effect of fire on these plants is similar to that of any method of top removal, such as mowing or shredding.

Prescribed burning has the following advantages over other brush management techniques:

1. Increased palatability, utilization and availability of forages
2. Improved distribution of grazing animals
3. Satisfactory results on soils and terrain where other methods may not succeed
4. Minimal soil disturbance
5. Absence or reduced amount of herbicide
6. Compatibility with wildlife habitat requirements of many game species
7. Suppressed parasite populations
8. Lower costs (compared with other methods)

A major constraint to effective prescribed burning is the amount and distribution of fine fuel required to carry the fire. Generally, from 2,500 to 3,000 pounds per acre of evenly distributed grass, dead leaves and litter are needed.

Grazing deferment during the growing season before burning is normally required to achieve an adequate fine fuel load. In many situations, the degree of brush infestation limits the area's capability to support a fire. Some brush control treatment before burning may be required to produce adequate amounts and distribution of fine fuel. Therefore, prescribed burning often is used in combination with other brush management practices and as a maintenance measure. Pricklypear control is accomplished with a reduced rate of Grazon PC when used following a prescribed burn.

Biological Methods

Biological brush control is appealing, but because natural enemies (such as insects or diseases) must attack only the target plant species and are difficult to control, few successful methods have been used in Texas. The most successful has been the use of goats. Because they are browsers, goats can control plants such as oaks, greenbriar, sumac, hackberries and several of the South Texas mixed brush species. When browse availability is limited, however, goats will consume significant quantities of forbs and grasses. Thus, careful grazing management is necessary to provide brush control and prevent damage to desired forbs and grasses. Using goats after mechanical treatments or burning may greatly extend the life of the treatment even to the point of completely removing some species such as shinoak. Although goats have been used extensively in Texas to control brush, problems with predators have restricted their use in many parts of the state.

Summary

Brush may be efficiently managed by utilizing these methods in a planned approach. An effective brush management plan may be developed by following these steps:

1. Establish objectives for the ranch that include rangeland, livestock and wildlife resources.
2. Conduct inventory of resources (determine brush problem and potential response to brush management).
3. Identify feasible brush control alternatives.
4. Estimate treatment costs and responses.
5. Conduct economic analyses.
6. Select brush control alternative.
7. Implement plan and monitor results (replan and revise plan as needed).

Acknowledgment

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10M-8-91 **RS**

Great Trinity Forest Management Plan

Grasslands

Common Brush and Weed Management Mistakes

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Texas Agricultural Extension Service
THE TEXAS A&M UNIVERSITY SYSTEM

Common Brush and Weed Management Mistakes

Allan McGinty, Larry D. White and Lindi Clayton
Professors and Extension Range Specialists, and Extension Graduate Assistant; The Texas &M University System

Texas rangelands support many species of brush and weeds. The plant species that occur on rangeland change over time with natural plant succession. On land that is overgrazed, the amount of brush and weeds will increase. To effectively manage brush and weeds, managers must select appropriate treatments and determine the best timing for them. They must know how to manage the land before and after treatment, and plan for monitoring the land's response to the treatment and carrying out a maintenance control program. They must also know how to gauge the effects of brush and weed management on other uses of the land (such as wildlife habitat) and on its real estate value. Finally, they must be able to analyze the financial risks associated with any brush management investment.

The following list of common myths and mistakes associated with brush and weed management can help you determine how to approach this management activity.

1) **All brush and weeds are bad.**
Attempting to control undesirable weeds and brush for livestock production can cause significant damage to desirable plants that wildlife need. Wildlife depend on woody and broadleaf plants for food and cover. The importance of wildlife to the ranch business must be considered before weed or brush management practices are implemented. You will want to protect key plant species and habitat "honey holes" that wildlife depend on. Learn to identify your desirable plants and their values to livestock and wildlife. Select the management approach that allows you to achieve your combination of goals, understanding that it is impossible to maximize production for all enterprises, but it is possible to optimize benefits.

2) **Weed and brush control always produces more grass.**
Weeds and brush compete with other vegetation for soil moisture, nutrients and space. However, controlling weeds and/or brush does not guarantee increased production of more desirable plants. There must be at least a remnant seed bank of desirable plants remaining before the treatment. Also, post-treatment management (grazing, maintenance treatments, etc.) must allow desirable plants to recover and sustain production over time. If the area has had a history of abuse and overgrazing, this seed bank will not be present and undesirable plants may flourish following treatment.

3) **Weed and brush control increases ranch profit.**
Weed and brush control treatments are expensive and their costs and benefits must be evaluated ahead of time. Consider not only the cost of the initial treatment, but also the life of the treatment, the costs and frequency of maintenance treatments, the projected forage response, the effect on other ranch enterprises (wildlife, recreation, etc.), and the risk involved.

4) **One treatment will do it!**
Weed and brush control treatments are not permanent; in fact, many are very short-lived. To recover the cost of the initial treatment and prolong its effect, it is usually necessary to make periodic, low-cost maintenance treatments as part of a comprehensive, long-term weed and/or brush management plan.

5) **A little more will do it!**
Using more herbicide than the recommended rate will not kill more brush and weeds. In fact, increasing the rate may rapidly defoliate plants but kill significantly fewer roots, and at a higher cost. Recommended rates are based on research that determines the rates that will achieve the best results, at the least cost, while protecting the environment. Read herbicide labels carefully and follow the directions explicitly. Contact your county Extension agent or Natural Resource Conservation Service (NRCS) personnel for specific information on the use of herbicides in your area.

6) **My neighbor told me - - -!**
Many home-concocted weed and brush control treatments are passed through the grapevine. BEWARE!!! Most are not as effective as recommendations you will receive from the Extension Service, NRCS, or the herbicide label. In fact, some untested recommendations may be dangerous to you, to livestock and wildlife, and to the environment. Many may be illegal. When a neighbor or salesperson at the local feed store suggests a specific treatment, check the label and ask the experts to make sure it is accurate, safe and legal.

7) **Wait until the brush gets big and thick and then kill it.** It is much easier and less expensive to kill seedlings and saplings than to kill mature brush. Small brush plants that don't grow too densely can be treated with individual plant treatment techniques, which usually kill more plants than broadcast applications. However, the cost of using individual plant treatments increases as the number and size of the plants increase, which is not true of most broadcast treatments. Thus, it is important to treat brush problems early. The deterioration of desirable vegetation can be prevented if brush is controlled before it becomes large.

8) **Treat from fenceline to fenceline.** Some range sites do not have the potential to produce enough more forage to justify the expense of a weed or brush control treatment. Weed and brush control efforts are best targeted to sites with deep soils that receive runoff from adjacent upland areas. Shallow ridges, slopes and hilltops are usually best left as wildlife habitat, or given a much lower priority for treatment than more productive areas.

9) **After I get that bulldozer or airplane in here, this place will turn into a sea of grass.** Weed and brush management is not a miracle cure for rangelands. Treatments do not have the same results every time. Most herbicide treatments are greatly affected by climate and plant characteristics, which are not very predictable. To achieve the best results and really accomplish your goals, the overall management of the rangeland must also improve. The treated area must be given time to establish a desirable cover of vegetation before it is put to "normal" use. Proper livestock stocking rates are critical to both the success and longevity of the treatment. Desired results will not occur overnight. Long-range planning, careful monitoring and sound management are required.

10) **Herbicides are unhealthy for the environment and humans.** Herbicides can harm organisms directly exposed to them. They can also alter the habitat in ways that may be harmful to some species. However, herbicides are invaluable for controlling undesirable plant species. Their toxicity to humans and wildlife has been evaluated and is detailed on product labels. Labels identify the proper rates and timing of herbicide applications; following these directions minimizes risk to wildlife, humans and the environment.

11) **Fire destroys the pasture!** Rangeland vegetation is adapted to periodic burning and properly planned prescribed fires are very beneficial in many situations. Some fires can be very destructive if proper management is not carried out before and after the fire. Livestock and wildlife are attracted to recently burned areas and can overgraze them if allowed. Burned areas must be given time to recover before they are grazed.

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United States Grasslands and Related Resources:

An Economic and Biological Trends Assessment[1]

Prepared by:[2] **Richard Conner**, Texas A&M University

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[1] Financial support of this report was provided by the National Cattlemen's Beef Association, The Nature Conservancy, and Ducks Unlimited.

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United States Grasslands and Related Resources: An Economic and Biological Trends Assessment

Executive Summary

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

Where are the grasslands?

Historically, grasslands occupied approximately one billion acres in the US—about one half of the landmass of the 48 contiguous states. The vast majority of the grasslands were found west of the Mississippi River. However, some native grasslands were scattered throughout the Midwestern and Southeastern States.

Most existing privately owned grasslands are in the Central Plains region between the Mississippi River and the foothills of the Rocky Mountains. At pre-settlement, 64% of the US grasslands were east of the Rocky Mountains. Grasslands west of the Rocky Mountains (approximately 332 million acres) were largely retained under federal management, while more than 90% of those lands east of the Rockies (approximately 565 million acres) were placed under private ownership.

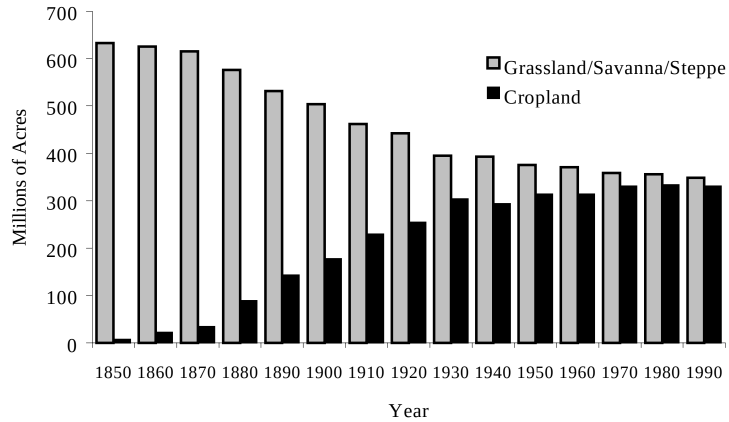
Over 80% of the pasture and rangeland in the 22 western states is in operations whose owners are sole proprietorships, partnerships, or family-held corporations and are operated by persons over 45 years of age. Approximately 90% of the pasture and rangeland is in farms or ranches that contain 6,000 or more acres and have operators who own either all or part of the land they operate.

Why are grasslands important?

Grasslands provide both ecological and economic benefits to local residents and society in general. The importance of grasslands lies not only in the immense area they cover, but also in the diversity of benefits they produce.

Ecological Significance

Grasslands provide valuable ecological services such as nutrient cycling and storage of substantial amounts of atmospheric carbon. In general, these ecological functions can be sustained under moderate to light grazing. However, following cultivation grassland soils are likely to lose up to 50% of their original carbon within the first 40 to 50 years.



Estimated land coverage by native grassland/savanna/steppe *versus* croplands in the US west of the Mississippi River, 1850-1990.

Grasslands are key to an efficient hydrologic cycle. The quality and quantity of water runoff and infiltration is dependent upon the quality of ground cover. Converting grasslands to other uses, like cropping, results in increased soil erosion and decreased water quality through increases in sedimentation, dissolved solids, nutrients, and pesticides.

The biotic diversity of North American grasslands is probably the most altered by human impact of any of the continent's terrestrial ecosystem. The ecological status of many existing grassland systems are heavily influenced at the local level by combinations of habitat fragmentation, undesirable habitat changes due to fire exclusion, declining range conditions due to improper grazing management, and loss of habitat values due to the spread of invasive and non-native plants. Further complications arise from demographic trends related to changes in land ownership. As a result, many species endemic to grasslands have declined substantially in the recent past.

Economic importance of grasslands

Native grasslands and rangelands directly support the livestock industry. Over 86% of the breeding sheep in the US are located west of the Mississippi River along with numerous domestic goats and horses whose main feed source is derived from grasslands. The January 1 inventory of cows that have calved in states west of the Mississippi River have averaged over 25 million head this past decade. Grasslands make up over 95% of the deeded acreage it takes to maintain beef cattle in the Great Plains and Western US.

Grasslands also support recreational based activities. According to the US Fish and Wildlife Service, more than 27 million people in the states west of the Mississippi participated in fishing, hunting, and wildlife observation in 1996. Expenditures related to these activities exceeded $37 billion.

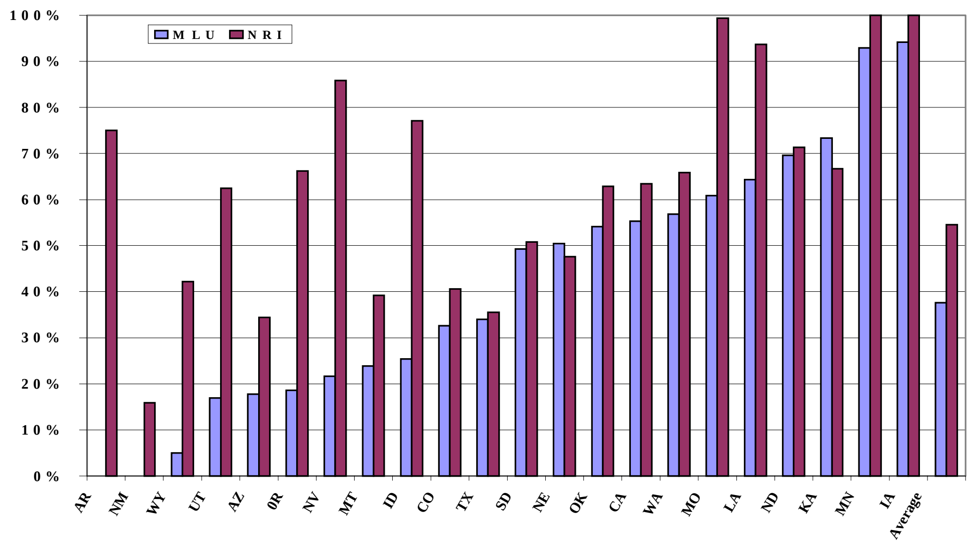
The benefits of open space and scenic amenities afforded by private grasslands are increasingly recognized. Land prices bordering open space have been found to be 7 to 32% higher than those not bordering open space. Large working farms and ranches also make fewer demands on community services than the rural residential development that often replaces them.

Trends in grasslands

In the 100 years from 1850 to 1950, grasslands west of the Mississippi River declined by 260 million acres as shown above, with the majority converted to cultivated cropland. In the 40 years from 1950 to 1990, another 27.2 million acres of grassland was lost. About 36% (9.8 million acres) of these recent losses were conversions of grasslands to uses other than cropland.

Differences in the definition of grasslands make estimating current acreage difficult. The following figure compares the percent of potential grassland acres lost as indicated by the 1997 Major Land Use (MLU) and 1997 National Resources Inventory (NRI) reports. Federal grasslands are included in the estimate of potential grassland acreage and in the MLU data, but excluded in the NRI data. The MLU and, to some extent, the NRI include non-native seeded pastures. Thus, the NRI will underestimate the area of remaining grasslands for states with federal lands, while the MLU, and possibly the NRI, will overestimate remaining native grasslands in states with relatively more non-native pasture. Despite these discrepancies, it is clear there are few native grasslands remaining in Arkansas, Iowa, Louisiana, Minnesota, and Missouri. Many other western states still have significant acreage of native grasslands remaining, much of which is under private ownership. By 1997, USDA reported 402 million acres of "rangeland" in the 22 states west of the Mississippi River, excluding federal lands.

Examination of areas in Colorado, Idaho, Montana, North Dakota, South Dakota, and Texas not only supported a general decline in grasslands, but also showed the dynamics involved. While 4 to 9% of the land classified as rangeland in each state was converted to other uses (mostly cropland, pastureland or urban land) between 1982 and 1997, in aggregate, loss in rangeland was less because of land being converted back to rangeland. While this reversal softens the total loss in rangeland, the ecological function of re-converted rangeland is reduced compared to undisturbed native grasslands. Converted rangeland is also more likely to be in smaller, discontinuous parcels, reducing its value as wildlife habitat relative to native grasslands. A variation in loss of rangeland within areas of each state also existed, with some areas experiencing a greater than 20% loss in rangeland and pastureland.



Percent of potential grasslands lost as indicated by 1997 Major Land Use (MLU) report of grassland pasture and range and National Resources Inventory (NRI) report of non-federal rangelands for the 22 western states.

Factors influencing grassland use

Pressure from growth in human population and per capita income, and the resulting demand for property and services, is an ever-increasing threat to the traditional use of grasslands. Between 1990 and 2000, the 22 states west of the Mississippi River gained more than 16.5 million people—a 17.3% increase. This growth was achieved in spite of nine Great Plains states growing by less than 10%.

In general, the policy of the federal government has been to support US production agriculture through protection or subsidization. A common, unintended result of many agricultural support policies has been to provide incentives to convert grasslands to crop production and/or to thwart the re-conversion of cropland back to grass. These "perverse" incentives are provided anytime a policy is the cause of land being more profitable if used as cropland in lieu of grassland. The Federal Estate Tax has also been cited as a cause of fragmentation of rural landholdings, although the presence of this tax creates incentives to retain lands in agriculture using perpetual conservation easements.

Many of the remaining grasslands are located in areas with high natural amenities. Low direct economic incentives to an aging population of grassland owners, combined with the longest economic boom in US history, advances in telecommunications and other socio-economic changes, contribute pressure to convert grasslands into large lot, rural or x-urban homesites.

Between 1990 and 2000, the market price of agricultural land increased 66% in the western US, indicating a significant increase in the demand for land. Most of this demand originated from non-agricultural interests as prices notably exceeded the productive value of the land.

Conclusions

Historically, the greatest threat to grasslands in the US has been the plow. While the trend of converting rangeland to cropland is still important in some areas, during the past several decades other trends have arisen that continue to threaten the existence and health of grasslands. Among these are relatively low returns to the ranching industry, coupled with an increased demand for grasslands for development purposes. Unless abated, these demands will not only continue to remove grasslands from their historical uses, but will continue to fragment that land so that the remaining grasslands may not be of sufficient size to support their natural biodiversity. One way to abate these pressures for fragmentation is to develop government programs to provide mechanisms and financial incentives to private grassland owners to facilitate grassland retention and restoration (e.g., conservation easements).

Revising government policies to ensure that they do not provide incentives to retain marginal cropland, or convert grassland to cropland, would enhance retention and restoration of grasslands under private ownership. Expanding programs that provide incentives to retain or restore wildlife habitat and encourage wildlife-based land use enterprises could also benefit the restoration and retention of grasslands (e.g., USDA-NRCS's Environmental Quality Incentives Program).

United States Grasslands and Related Resources:
An Economic and Biological Trends Assessment

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

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United States Grasslands and Related Resources: An Economic and Biological Trends Assessment

Chapter 1: Why are grasslands important?

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

Vast expanses of prairies, savannas, and steppes once dominated much of the current arable land in the US. These were grasslands, the largest vegetation formation in North America. During settlement and subsequent development, these grasslands represented a substantial ecological resource that sustained a large portion of the US economy. Through time, the ecological and economic functions of these lands have changed. Much of the historical grassland area has been converted to other land use – perhaps irreversibly. Much of the remaining historical grassland area is degraded to the point that it can no longer support the same level of ecological and economic services. However, many natural grassland systems are resilient, and they may recover much of their ecological and economic potential following restoration efforts.

The interaction among climate, soils, and terrain mainly establishes the potential productivity of grasslands. However, it is ultimately the influence of grazing animals, fire, vegetation management, economic land use, and other human activities that largely determine the realized productivity of grasslands. Of the historical grasslands in the US, those with the greatest potential for productivity are on private lands. As a result a national grasslands conservation strategy must include programs designed to gain conservation benefits from private resource stewardship.

Scope of this report

The purpose of this report is to provide an assessment of economic and biological trends of US grasslands, focusing on private lands. Our goal is to provide the background and context for policy-makers to design an effective set of incentive-based programs for conserving natural grasslands. As such, we focus the assessments in this report on those areas that are at present, or were once, in a state of natural grassland. In particular, we examine land use trends across landscapes dominated by private and other non-federal ownerships.

What distinguishes grasslands?

Prevailing climate is the largest controlling factor in the development of natural grasslands (Lauenroth 1979). In the US, grasslands generally occupy areas receiving between 10 and 40 inches of annual precipitation, with both a wet and dry season; and having mean annual temperature of 32-79^{o}F, with seasonal extremes (Lieth 1975). Grassland development is more specifically controlled by complex climatic factors such as the ratios between precipitation and evaporation and the seasonality of precipitation in relation to the temperature regime (Risser *et al.* 1981). Although trees can, and do, grow in many grassland systems, the seasonal variability in precipitation in most grassland areas generally precludes full forest development.

In this assessment, we distinguish between *natural grasslands* – those that are climatically controlled; and *derived grasslands* – those that are created as a product of human management. We recognize two types of derived grasslands: successional grasslands and agricultural grasslands. Successional grasslands are a product of forest or shrub removal and subsequent maintenance of a grassland condition by combinations of burning, mowing, or grazing (Lauenroth 1979). Successional grasslands can be highly productive (at least initially), due to the high precipitation that sustained the previous forest. Agricultural grasslands are a result of intensive agronomic practices, usually including cultivation and planting of improved or introduced grasses and maintained by irrigation, mineral fertilization, or both (Lauenroth 1979). Many areas of potential natural grasslands are now converted to agricultural grasslands.

US grasslands: Global context, distribution, and classification

Global context

Grasslands (prairies, savannas, steppes, shrub steppes, desert grasslands, and alpine meadows) are, potentially, the naturally occurring vegetation on almost 13 million square miles (>8 billion acres) of the Earth's surface (Table 1.1), accounting for approximately 25% of the global land area (Shantz 1956; Risser *et al.* 1981; Ramankutty and Foley 1999). Major concentrations of the world's grasslands are located in tropical Africa, the Newly Independent States of the former Soviet Union, tropical South America, China, and Western North America.

Global trends

Between 1700 and 1992, approximately 20% of the world's grasslands were converted to other land use and cover. Conversion rates in the US were substantially greater than the cumulative global average during this period. Over that period, almost 50% of US grasslands were converted to other land uses – mostly cropland (Ramankutty and Foley 1999). Post-settlement conversion of grasslands in the US has outpaced the conversion rates in most major temperate grassland systems of the world (Figure 1.1). The former Soviet Union has lost 381 million acres of its grasslands, compared to 339 million acres converted in the US. However, a higher proportion of the former Soviet Union's grasslands remain compared to the US.

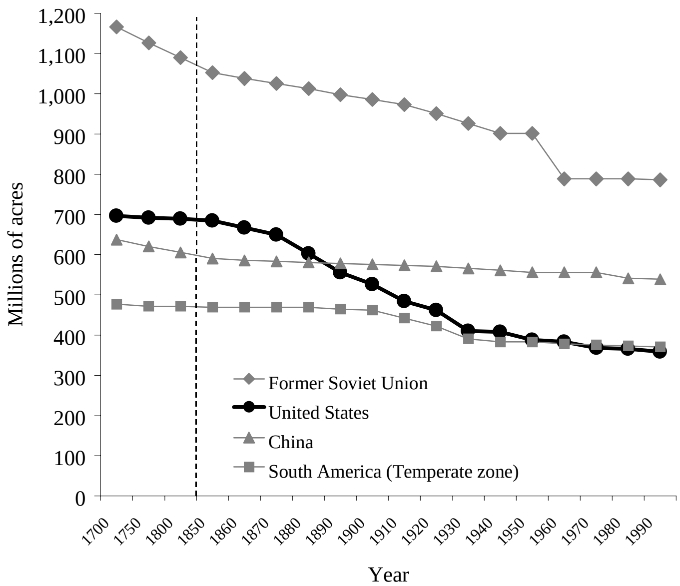

Figure 1.1. Estimated trends in coverage by native grassland/savanna/steppe in 4 major temperate zones, 1700-1990. Note that intervals prior to 1850 are at 50-year increments, and 10-year increments thereafter. Data source: Ramankutty and Foley (1999b)

US distribution

The potential natural grasslands of the United States occupied portions of six major physical provinces (Figures 1.2-1.5, maps and associated information adapted from Kuchler 1974, Omernick 1986, and Ricketts *et al.* 1999). From east to west, these are the Central Lowlands, the Coastal Plains, the Desert Southwest, the Great Plains, the Great Basin, and the Central Valley of California. These grasslands can be divided into 2 major biomes: the Central Plains and Western Grasslands, which are separated from north to south by the Rocky Mountains (Figure 1.2). The Western Grasslands and those of the Central Plains differ greatly in their terrain, climate, predominant land use, and ownership status.

Central Plains. – Of the historical grasslands throughout North America, those of the Central Plains are the most extensive, dominating a region of about 688 million acres (Figure 1.3, Table 1.2). The terrain of the Central Plains slopes gently from the base of the Rocky Mountains to the banks of the Mississippi River. Along that west to east transition, annual precipitation gradually increases, and grassland ecosystems correspondingly shift from shortgrass prairie, to mixed-grassed prairie, tallgrass prairie and, finally, savanna (Figure 1.3). Thus, four major grassland regions are generally identified with the Physical Provinces of the Central Plains: 1) shortgrass prairies of the Great Plains; 2) mixed-grass prairies of the Great Plains; 3) tallgrass prairies of the Central Lowlands and Coastal Plains; and 4) the savannas of the Central Lowlands and Coastal Plains (Table 1.2).

At 424 million acres, the Great Plains is the largest grassland province in North America. From the west, the boundary of the Great Plains begins at the base of the Rocky Mountains and terminates, as a general rule, between the 95th and 100th Meridian (Figure 1.3). At its the southern boundary, the Great Plains converges with the Cross-timbers of Oklahoma and Texas as well as the more dissected terrain of the Edwards Plateau.

In the Central Lowlands, and Coastal Plains east of the Great Plains, tallgrass prairies and savannas were the dominant vegetation across 260 million acres. In many areas along its eastern edge, the tallgrass prairies graded smoothly into tallgrass savannas with oaks as an overstory, and the latter gradually merging into oak forest. A “prairie peninsula” once extended eastward through Illinois and Indiana, with some tallgrass prairie extending as far as central Ohio (Benninghoff 1964; Oosting 1956; Harrington and Harmon 1985). Fire probably played a critical role in maintaining the tallgrass prairies and savannas, especially in the areas of transition with oak woodland (Harrington and Harmon 1985). Tallgrass prairies and savannas were once scattered throughout several states east of the Mississippi River. Important and notable occurrences of natural grasslands are documented in Wisconsin, Michigan, Illinois, Indiana, Ohio, Kentucky, and Tennessee (Figure 1.5). A large majority of these Eastern Grasslands have either been converted to other land uses or have been transformed to woodland by virtue of fire exclusion. Conservation of those Eastern Grasslands that do remain would seem to be a critical component of an overall grassland conservation strategy.

Western Grasslands. – The Western Grasslands dominate the US landscape west of the Rocky Mountains and east of the Cascades. Western Grasslands lie in 2 major physical provinces, the Great Basin and the Desert Southwest, and spread across a region of 386 million acres (Table 1.2). The grassland area within this region is dissected by mountainous terrain and intermingles with various forest types (Figures 1.4-1.6). The Mediterranean Grasslands in California’s Central Valley are also part of the Western Grasslands.

Much of the western landscape classified here as “grassland” falls more comfortably under a broader definition of rangeland. That is, those areas “which by reason of physical limitations – low and erratic precipitation, rough topography, poor drainage, or cold temperatures – are unsuited to cultivation…”(Stoddard *et al.* 1975). Grasses might not always dominate much of that which is considered western rangeland. In fact, much of the land identified here as Western Grassland is naturally occupied by shrub-dominated ecosystems, as well as sparsely vegetated desert terrain.

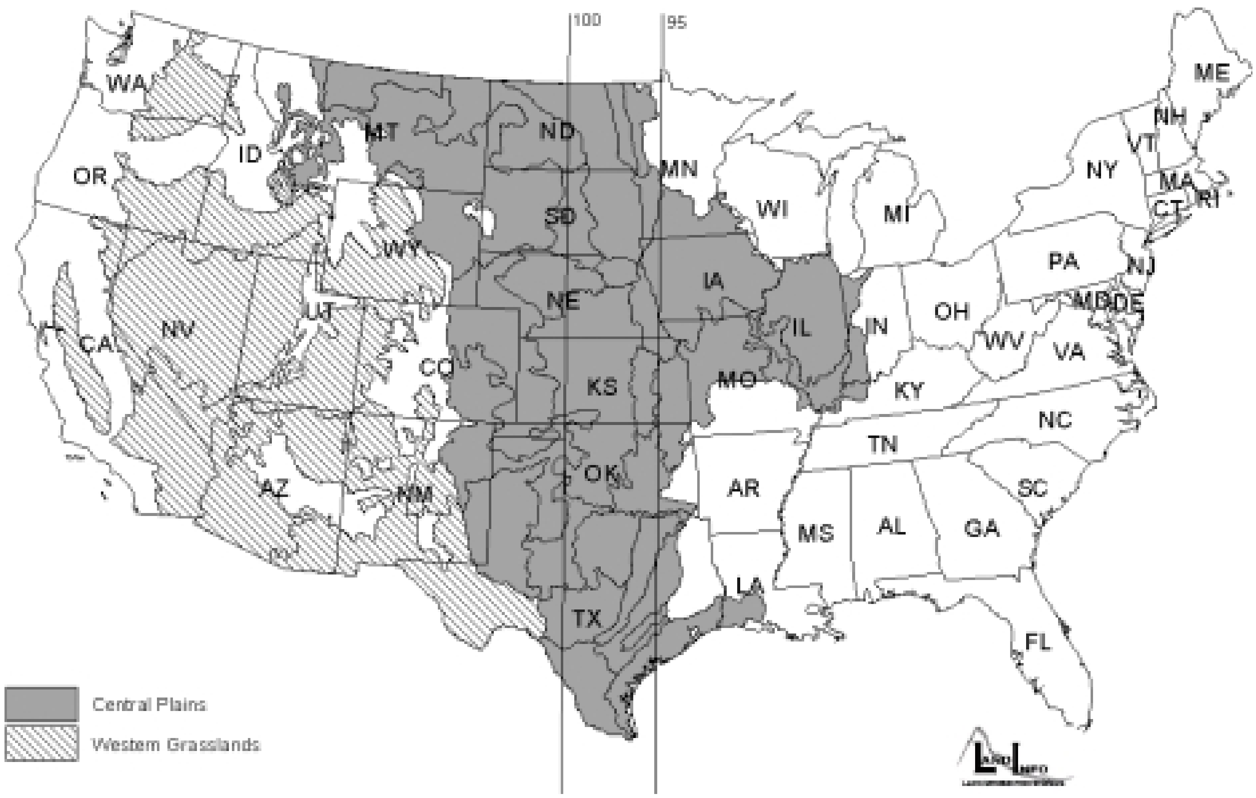

Figure 1.2. The 2 major grassland biomes of the contiguous US, the Central Plains and Western Grasslands.

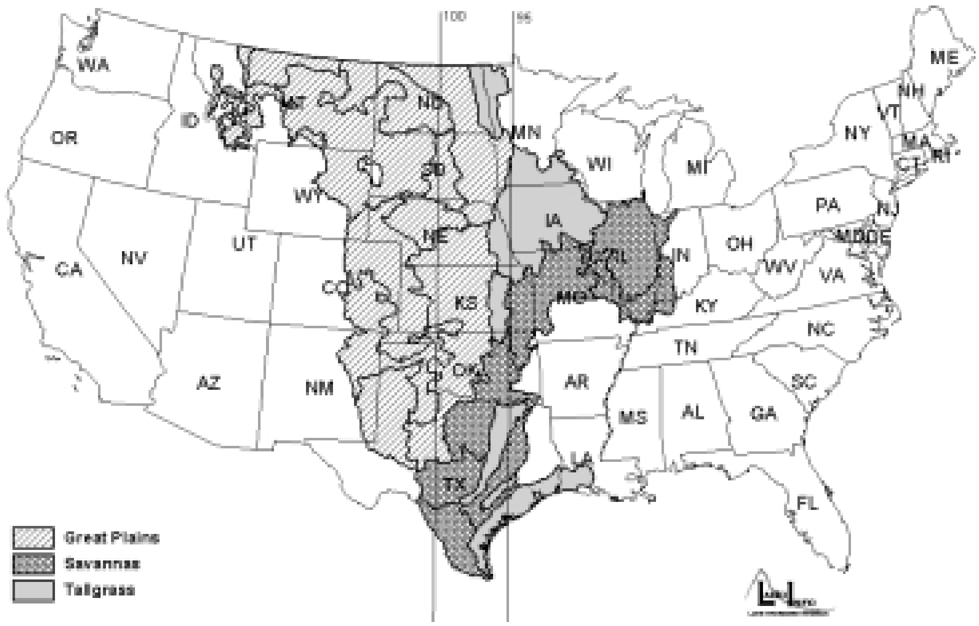

Figure 1. 3. The Great Plains and 2 adjacent grassland types (savannas and tallgrass prairies), together constituting the Central Plains of the US. The vertical lines represent the 100th and 95th Meridians.

Figure 1. 4. Grassland provinces of the Western US.

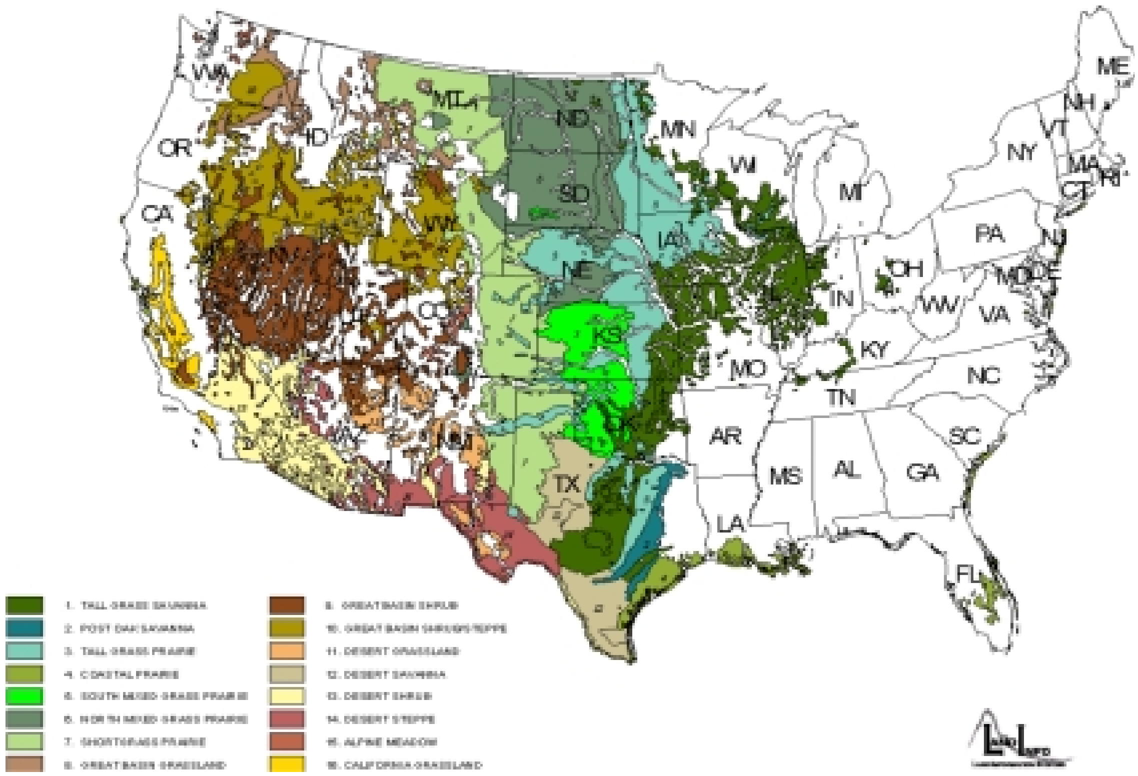

Figure 1. 5. Coverage of pre-settlement grasslands in the contiguous US, by type. Adapted from Kuchler (1974).

Extent of US grasslands: State-level

Pre-settlement. – As depicted in Figure 1.5, we estimate the total extent of potential grassland in the US at about 923.1 million acres. We assume this to be the extent of grasslands prior to Euro-American settlement. Historically, about 29 million acres of grassland occurred east of the Mississippi River, or about 4% of the grasslands in the US. About 25 million acres of this area were tallgrass savanna located in Illinois, Indiana, Ohio, and Kentucky, which is now, largely, under cultivation or converted to other land uses. The remaining four million acres includes small, scattered pockets of tallgrass prairies and savannas, as well as a belt of Coastal Prairie through the Southeastern US (Figure 1.5).

Within those states west of the Mississippi, the pre-settlement extent of grasslands was approximately 882.9 million acres (Table 1.3). Together, Texas and Montana account for about 23% of the potential grassland in the contiguous US. The cumulative acreage found in Nevada, California, Arizona, New Mexico, and Wyoming account for another 27% of the potential. The smaller Great Plains states of Kansas, Nebraska, South Dakota, and North Dakota were almost completely dominated by natural grasslands prior to settlement (Figure 1.5).

Ownership status. – In contrast to the private farmlands and ranchlands in the Central Plains, the majority of Western Grasslands are under federal ownership (Figure 1.6). Notable exceptions include the California Grasslands, the desert steppes and grasslands of Trans-Pecos Texas, and the Great Basin shrub/steppe and grasslands of eastern Washington (Figure 1.5). The US Bureau of Land Management (BLM) administers most Western Grasslands.

Compared to those in the west, federal parcels in the Central Plains are small and scattered (Figure 1.6). Federal ownership of grasslands in the Central Plains amounts to about 18 million acres. The BLM administers about 8.8 million of these acres. The USDA Forest Service manages about 7 million acres, 4 million of which are in the National Grasslands System. The USDI Fish & Wildlife Service manages about 1.6 million acres, and the National Park Service manages about 330,000 grassland acres. Combined federal management accounts for approximately 4.2% of the pre-settlement grasslands of the Central Plains (Licht 1997). However, about 84% of these federal lands are in the more arid shortgrass prairies, leaving the mixed-grass and tallgrass systems with more limited federal administration.

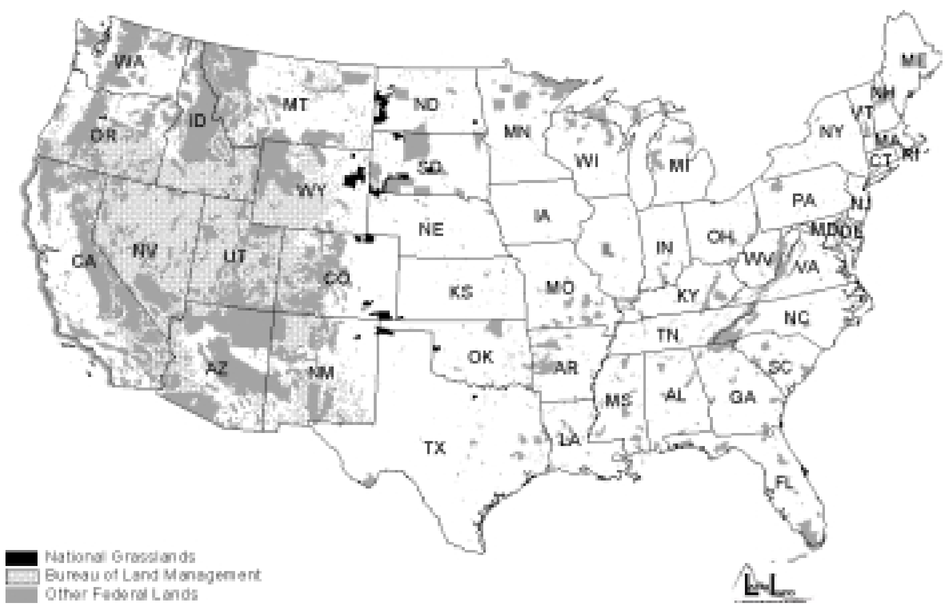

Figure 1. 6. Federal ownership of lands in the contiguous US.

For each state west of the Mississippi, the area of pre-settlement grassland in regions dominated by non-federal ownerships was estimated (Table 1.3). Using these figures, we estimate that approximately 582.5 million acres of grasslands once occupied those landscapes that are now dominated by non-federal management, primarily private ownership. Nationwide, this accounts for about 63% of the pre-settlement grasslands. When ranked by our non-federal grassland estimates, the 13 states of the Central Plains (still including only those west of the Mississippi) rise to the top of the list of non-federal grasslands. The combined non-federal land in these 13 states account for about 93% (about 541 million acres) of the pre-settlement grassland acreage across those areas dominated by private ownership (Table 1.4).

Trends in land use

Post-settlement trends--Very little conversion of native grasslands had occurred west of the Mississippi River prior to 1850. However, in the 100 years from 1850 to 1950, the area of cultivated cropland west of the Mississippi expanded by nearly 3.1 million acres/year (Figure 1.7). As a direct result, grassland area declined 2.6 million acres/year on average over the period. Most of this plow-up was concentrated in the Central Plains. The tallgrass prairies and savannas were the earliest to be converted to cropland, now representing the bulk of the western Cornbelt. Most cropland conversions in the drier mixed- and shortgrass prairies were not undertaken prior to major Federal encouragements. In the 1880s, booms in homesteading and wheat farming in the shortgrass prairies followed passage of the Homestead and Timber Culture Act (Helms 1981). Successive droughts, commodity price fluctuations, speculation, and agricultural productivity encouragements (associated with both World Wars), all combined with the economy of a growing nation, resulted in continued conversion of Great Plains grasslands well into the middle of the 20^{th} Century (Helms 1981; Laycock 1987; and Willson 1995). Much of the plow-up in both the 1920s and 1940s included several millions of acres that soil erosion experts considered unsuitable for cultivation. As a consequence, the relatively moderate droughts in the decade following each of these plow-ups resulted in the “dust bowl” of the 1930s and the “Filthy Fifties” (of the 1950s).

All told, about 50% of the pre-settlement grasslands in the US have been converted to cropland or land cover other than native grasses. Notably, the grassland types in the Central Plains have suffered disproportionately relative to their pre-settlement area. Some estimates suggest that the tallgrass prairies and savannas of several mid-western states have declined by as much as 99% (Sampson and Knopf 1994). Likewise, the mixed-grass prairies have declined by an estimated 30-81% and shortgrass prairies by an estimated 20-80%, with estimates varying by state (Sampson and Knopf 1994).

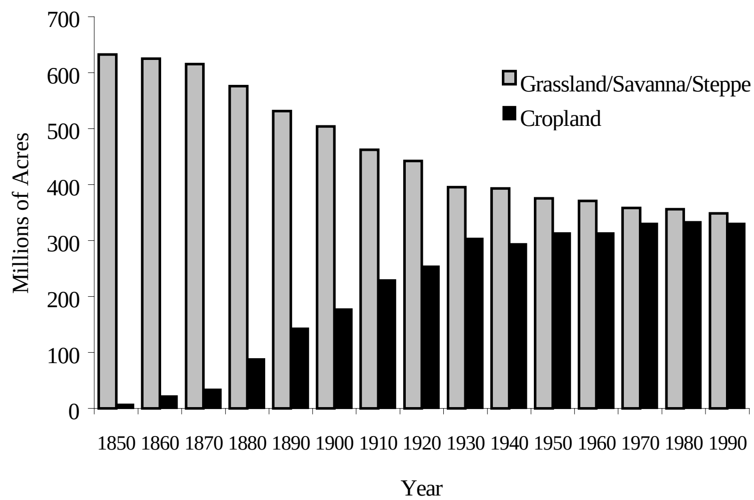

Figure 1. 7. Estimated land coverage by native Grassland/Savanna/Steppe versus Croplands in the US west of the Mississippi River, 1850-1990. Data Source: Ramankutty and Foley (1999b).

***Note**: Although Ramankutty and Foley (1999b) also based their analyses on the designations of Kuchler (1975), their overall total for pre-settlement grassland falls approximately 245.38 million acres short of our estimates (see Table 1.3). By visual inspection of Ramankutty and Foley's maps, it appears they <u>did not</u> include Desert Steppe, Desert Savanna, Desert Shrub, Great Basin Shrub, and Post Oak Savanna in their analyses – these types account for 246.67 million acres. We attribute the additional 1.2 million acre disparity to mapping errors and rounding errors in acreage calculation.*

In addition, several types of Western Grasslands have suffered disproportionate losses, primarily on privately-owned landscapes. For example, more than 99% of Great Basin (Palouse) grasslands have been lost to agricultural use (Ricketts *et al.* 1999). Likewise, land use conversions and exotic introductions have left most of the grasslands of California's Central Valley with less than 1% of their native flora (Ricketts *et al.* 1999). The fact that other Western Grassland types may have escaped large-scale conversion should not be taken to mean that they remain unaltered. In fact, the flora and fauna of many Western Grassland types have undergone dramatic changes since pre-settlement, while remaining as native grassland

Recent trends—Market incentives and farm policies have frequently encouraged the cultivation of millions of acres of grasslands that are unable to ecologically or economically sustain intensive farming practices. While the amount of grassland acreage in the US continues to vary with the economic and political ebbs impacting agriculture, the grassland conservation programs started in the 1950s and continued today may have tempered the damage incurred by successive cycles of drought and cropland plow-up. In the 40 years from 1950 to 1990, net gains in cropland were about 432 thousand acres/year (Figure 1.7). However, the loss of grasslands during this period was about 680 thousand acres/year –

suggesting that as much as 36% of the losses of grasslands over the last 50 years may be attributed to conversion to uses other than cropland.

Trends according to land use— Statistical surveys and studies conducted by agencies within the US Department of Agriculture help to provide a current and more spatially detailed look at trends in the uses of grasslands and former grasslands. The three major sources available to examine current trends in land use are Major Land Use (MLU) reports, the National Resource Inventory (NRI) and the Census of Agriculture. Although all three data sources are differ in their spatial and temporal coverage, as well as in the ownership of the land included in their designations, they all classify land by its use and, to some extent, ground cover. While these data sources don't define "grasslands" as such, they all focus on land that is used for grazing, land that is not in forest and land that is not part of a rotational cropping system (see Appendix A).

According Major Land Use[3] statistics, all but approximately 29 million acres, or 95%, of the nation's private and public grasslands (i.e., pasture and rangeland used for grazing) are located in the 22 contiguous states west of the Mississippi River (Vesterby and Krupa 2001). Over 606 million acres of grasslands in private and public ownership existed in this area in 1945. Currently, 551 million acres of grasslands are in private and public ownership, amounting to a loss of over 1 million acres per year. Most of this decline occurred by 1969, after which the rate of decline slowed (Figure 1.8). Some of the decreases in grassland pasture and range in western states can be attributed to an increase in wilderness areas that are not used for grazing or an increase in land that was reclassified as unsuitable for grazing (Vesterby and Krupa 2001). Declines in grassland pasture and range are generally associated with an increase in cropland conversion, especially during periods when the demand for crop products is high (Vesterby and Krupa 2001). Land use also may change to recreational, wildlife or environmental uses or it may revert to forested lands.

[3] The Economic Research Service publishes Major Land Use statistics at intervals coinciding with the US census of agriculture. Data from census, public land management agencies, conservation agencies and other sources are synthesized to estimate a consistent time series of public and private land uses for each state. Approximately 61% of total acreage classified by MLU statistics as grassland pasture and range in the US is in private holdings.

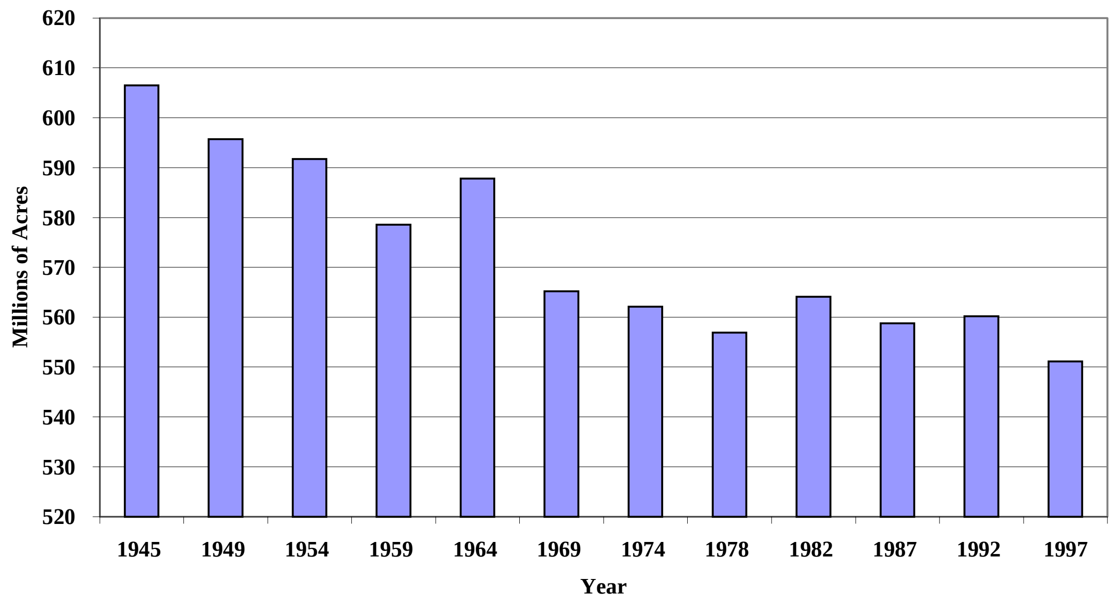

Figure 1. 8. Major Land Use estimates of trends in grassland pasture and range in the 22 contiguous states west of the Mississippi River, 1945 to 1997. Source: Vesterby and Krupa 2001.

The decline in grassland pasture and range has been most notable in many midwestern and western states. Iowa (-74.35% change), Minnesota (-59.62% change), Kansas (-38.17% change), Missouri (-37.17% change) and Utah (-33.01% change) experienced the largest decline in grassland pasture and range from 1945 to 1997 (Figure 1.9). A few states had a slight increase in grassland during this period, including Texas (+8.07% change) and Louisiana (+5.26% change).

Perhaps the most scientifically based inventory of the nation's land cover/use is the National Resource Inventory[4]. There was a 3.8% decline in what the NRI classifies as total rural land from 1982 to 1997. This downward trend was manifest in cropland, pastureland and rangeland. Over one half of the total rural land in the 22 contiguous states west of the Mississippi River was classified in 1997 by the NRI as rangeland (44%) or pastureland (7%) (Figure1.10). Cropland (27%) and forest land (16%) are the two other major components of total rural land (USDA/NRCS 2000).

[4] The National Resources Inventory (NRI) is conducted by the US Department of Agriculture's Natural Resources Conservation Service in cooperation with the Iowa State University's Statistical Laboratory (USDA/NRCS 2000). Data are collected at scientifically selected sample sites throughout the United States, Puerto Rico and the Virgin Islands. Data collection methods include photo-interpretation and other remote sensing methods, USDA field records, soil survey and wetland inventory maps and reports, plus other ancillary materials. Land is identified in the NRI by the type of land cover and land use. Land cover refers to the type of vegetation or kind of material that covers the land surface, while land use is the type of human activity that is centered on the land (USDA/NRCS 2000).

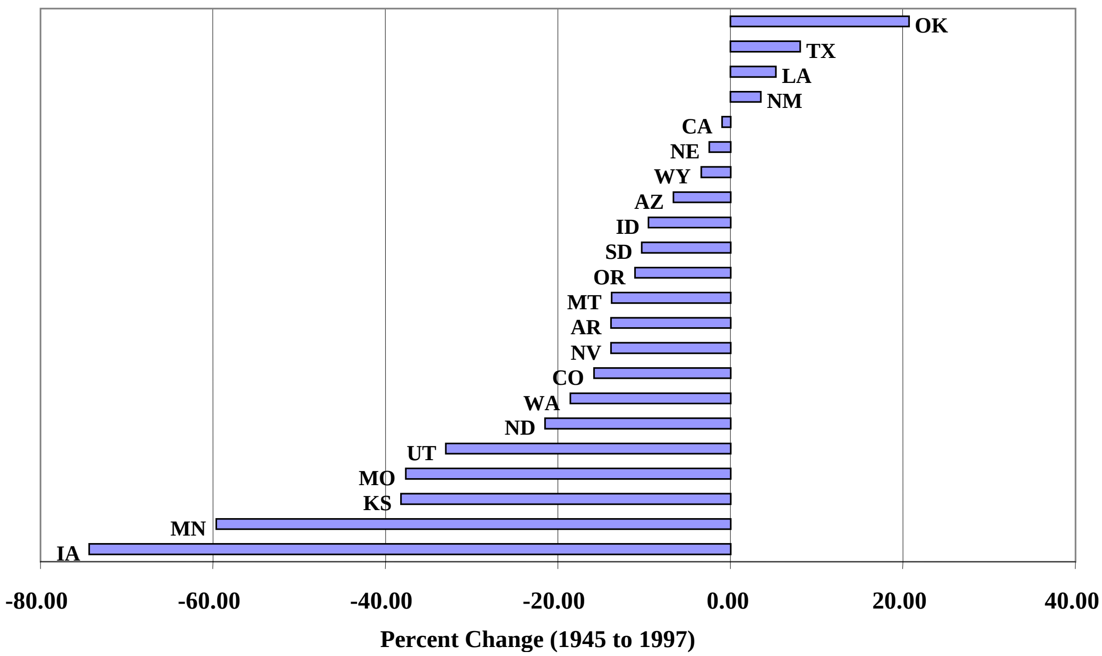

Figure 1. 9. Percentage change in grassland pasture and range for each of the 22 contiguous states west of the Mississippi River as determined by Major Land Use inventory estimates, 1945 to 1997. Source: Vesterby and Krupa (2001).

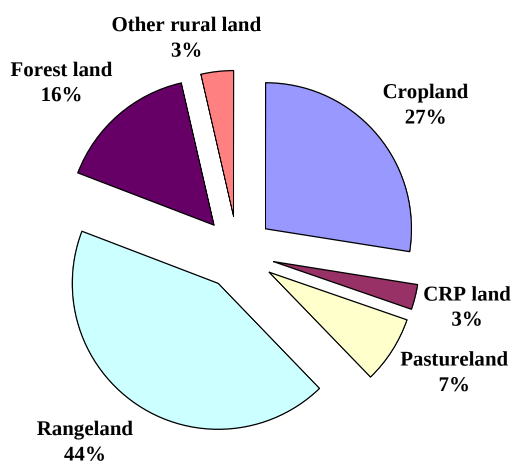

Figure 1. 10. Allocation of rural land in the 22 contiguous states west of the Mississippi River as determined by the National Resource Inventory, 1997. Source: USDA/NRCS 1997.

The movement of land in and out of different classifications is a dynamic process, with land cover/use continually changing. The NRI provides an estimate of how land changes between classifications for the 48 contiguous states, Hawaii and the Caribbean (Table 1.5). In 1982, there were 549 million acres in rangeland and pastureland over this area. By 1997, acreage in rangeland and pastureland had declined to 526 million acres. While this represents a net loss of 23 million acres, 62 million acres were actually removed from rangeland and pastureland between 1982 and 1997 (mostly to cropland) and 39 million acres was converted to rangeland or pastureland (Table 1.5).

Nationwide, most acreage enrolled in the CRP was previously classified as cropland (30.4 million acres), followed by pastureland (1.3 million acres), rangeland (0.7 million acres) and forest land (0.1 million acres) (Table 1.5). Much of the CRP acreage will be reclassified by 2007, as most of the CRP contracts are expected to expire between 2001 and 2006 (FSA/USDA 2001). In the 22 states under primary consideration, over 26 million acres were enrolled in the Conservation Reserve Program (CRP) as of 1997 when the last NRI was conducted (USDA/NRCS 2000). Texas (3.9 million acres), Kansas (2.8 million acres), North Dakota (2.8 million acres) and Montana (2.7 million acres) had the greatest number of enrolled acres (Table 1.6).

According to NRI statistics, the overall change in an individual state's rangelands was generally less compared to changes recognized in the MLU inventory. Iowa witnessed a –22% change in rangeland and pastureland from 1982 to 1997. The next highest changes occurring in Missouri (-14%) and Minnesota (-11%, Figure 1.11). Five states (Louisiana, Nevada, Utah, Wyoming and Arizona) experienced a slight increase in land classified as pasture or range.

A third source that can be used to examine trends in grassland acreage is the US Census of Agriculture (USDC/BC various years, USDA/NASS 2000). For the 22 states examined, 370,068 farms reported acreage in what the census terms "other pastureland and rangeland"[5]. In contrast 406,657 farms reported other pastureland and rangeland in 1978.

States with a large proportion of grazing on federal lands had a disproportionate decrease in other pastureland and rangeland, as defined by the census, compared to the acreage in grassland pasture and range obtained from the MLU reports. For example, Nevada and Utah had 46.3 million and 23.7 million acres in grassland pasture and range according to MLU statistics, which include public lands, but showed only 5.2 and 9.2 million acres classified under the US Census of Agriculture (see Tables 1.7 and 1.8).

[5] Because of inconsistencies in definitions, pastureland and rangeland data collected prior to 1978 are not presented.

Acreage in other pastureland and rangeland, as reported by the census, decreased between 1978 and 1997 in each state except for Utah and Missouri (Figure 1.12). Nevada had the largest decrease (-41.85% change) followed by Idaho (-32.32% change), Arizona (-25.47% change), California (-3.61% change) and Minnesota (-21.54% change). Most of the reduction in other pastureland and rangeland occurred between 1978 and 1982 and can probably be attributed to an increased demand for cropland commodities.

All three inventories (NRI, MLU and census) show a slight decline in total rangeland/pastureland from 1982 to 1997 (Figure 1.13 and Table 1.9). The MLU classification of grassland pasture and range gave the largest estimate of acreage. This was expected because federal and state lands were included in their inventory.

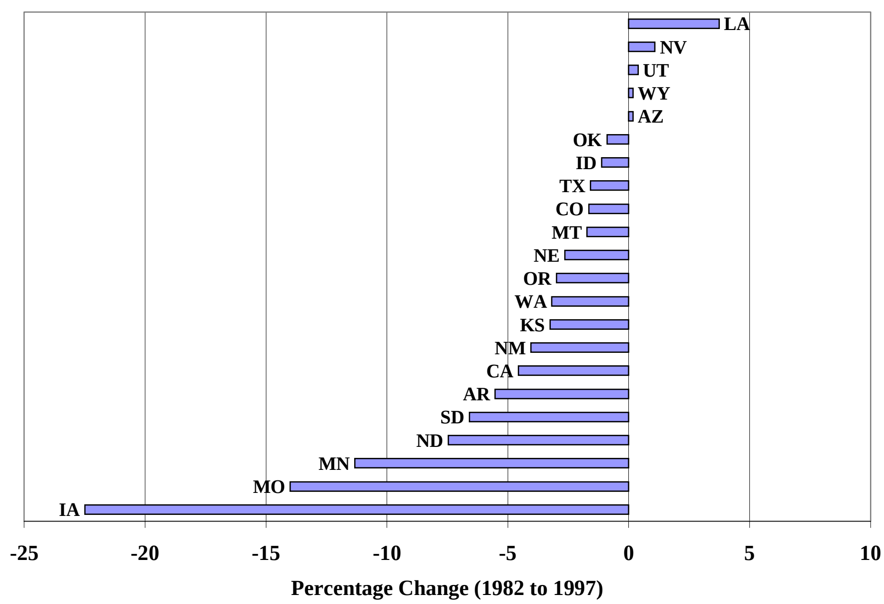

Figure 1. 11. Percentage change in rangeland and pastureland for each of the 22 contiguous states west of the Mississippi River as determined by the National Resource Inventory, 1982 to1997. Source: USDA/NRCS 1997.

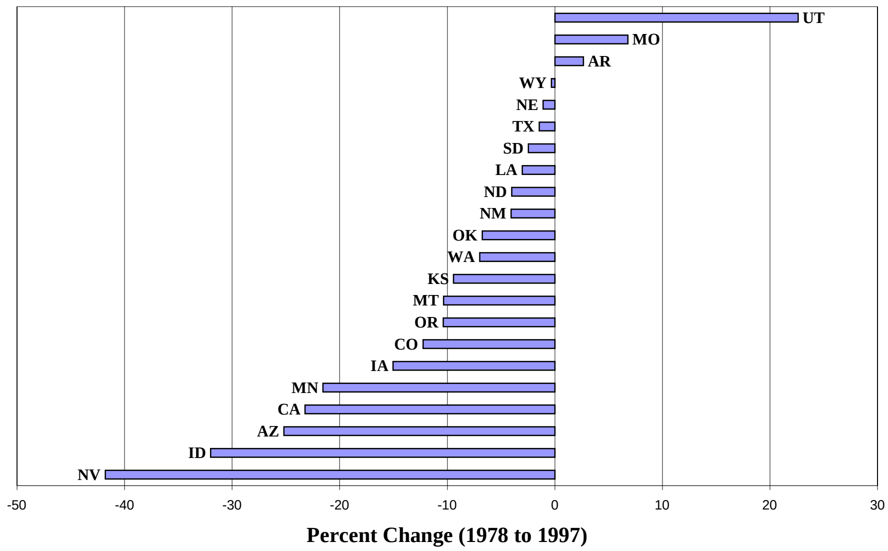

Figure 1. 12. Percentage change in rangeland and pastureland acreage for each of the 22 contiguous states west of the Mississippi River as determined by US Census of Agriculture inventory estimates, 1978 to 1997. Sources: USDC/BC various years, USDA/NASS 1997

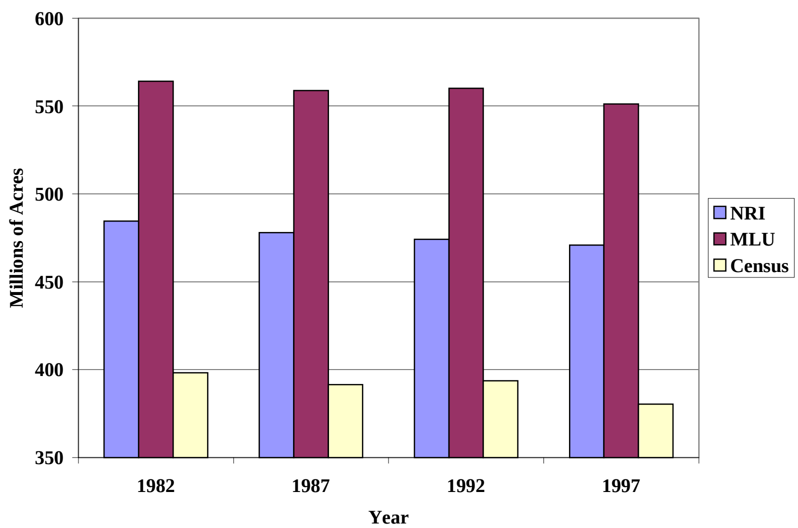

Figure 1. 13. Acres in rangeland/pastureland in the 22 contiguous states west of the Mississippi River as defined by the National Resource Inventory (NRI), Multiple Land Uses (MLU) and US Census of Agriculture. Sources: USDA/NRCS 1997; USDC/BC various years; USDA/NASS 1997; Verterby and Krupa 2001.

In general, current land use statistics show that grazing lands are mostly declining over time. Land classifications are dynamic, however, with land use and cover moving in and out of the different categories. Land reported to move back into rangeland from another category will not immediately provide the same ecological functions as the same, or similar, land that had been allowed to continuously remain as a grassland.

Ecological importance of grasslands

Ecological services/functions

Grassland ecosystems can be viewed as two related, but different, physiological processes: energy flows and chemical (nutrient) cycles (Briske and Heitschmidt 1991). The sun is the source of energy, which must first be utilized by plants via photosynthesis. The energy can then be stored in plant tissue and made available to grazing animals (herbivores). Animals convert the plant material to useable energy through the digestive process. Some of the herbivores are, in turn, consumed by carnivores or utilized by humans. Throughout this process some energy is dissipated by respiration. In addition, some of the plants and animals simply die and decompose and dissipate heat through microbial respiration. Once dissipated as heat, the energy cannot be recovered and reused. The energy flow through the ecosystem is thus dependent on the continuous supply of energy from the sun to be sustained.

Nutrient cycling

A second essential function of grassland ecosystems is to provide and transfer nutrients including carbon (C), nitrogen (N), and phosphorus (P), which are critical components of the biochemical processes of plant and animal life. Unlike energy, nutrients cycle from their reservoir within the soil, or atmosphere, through the plants and animals and then back into the soil or atmospheric reservoir. Plants initially assimilate many of the essential nutrients from the abiotic environment. Some nutrients become available for absorption by plants from weathering of soil parent material (eg. rock). Others, including nitrogen, must be converted into usable forms for plants by symbiotic microorganisms, in spite of the fact that they exist in large quantities in the atmosphere. Animals use the nutrients in their organic form (amino acids and proteins) by consuming the plants (herbivores) or other animals (carnivores). Some of the nutrients are then converted back to inorganic forms through the byproducts of digestion and respiration. This "mineralization" process is critical to grassland ecosystems because a large part of the essential nutrients in the system are bound with organic matter within the soil and cannot be absorbed by plants until they are transformed to inorganic forms through microbial decomposition (Briske and Heitschmidt 1991).

Some studies have shown that moderate to light grazing of grasslands with domestic herbivores does not increase nutrient losses from the system (Wilkinson and Lowery 1993; Woodmansee 1978; Floate 1981). In these cases, it appears that atmospheric nitrogen inputs and the increased cycling rates induced by the herbivores offset the losses due to human off-take of the animals. Heavy grazing of domestic animals results in nutrient losses to the system as animals removed for human consumption. Any grazing of domesticated animals on formerly native grassland changes the distribution of some nutrients via concentrating animal feces near watering and loafing areas (Holechek et al. 1995).

Carbon

General concern over the rapid rate of increase in CO_2 in the atmosphere has heightened during the past two decades. Grasslands, because of their natural capacity to create soil organic matter, and the natural occurrence of many US grasslands on highly basic soils formed on calcium (Ca) rich parent material, are capable of sequestering relatively large amounts of carbon. The carbon is held both in organic (SOC) and inorganic (SIC) forms. According to Lal et al. (1999), soil productivity decreased by 71% in the 28 years of cultivation following grassland sod breaking in the semi-arid Great Plains. Grassland soils are likely to lose between 20 and 50% of their original SOC within the first 40 to 50 years under cultivation.

In another report, Follett et al. (2001) estimate that reconverting cropland back to grassland can result in SOC sequestration rates ranging from 400 to 1,200 kg C/ha/yr. They further estimate that this rate could be maintained for approximately 25 years before the reconverted grasslands would reach a steady state where the annual soil output of C to the atmosphere would equal its input.

Recent international climate change discussions and proposed changes in US agricultural policy could result in incentives to landowners to adapt C-sequestering management practices (SWCS 2000). These incentives might be in the form of marketable C-credits or annual payments for participation. Regardless, one likely result of such a policy would be the re-conversion of additional acreage from cropland back to grassland.

Water

On most grasslands in the United States water is the most limiting factor to plant production. From a global perspective, however, there is a constant amount of water. Its specific form and location are regulated by the water (hydrologic) cycle. The hydrologic cycle is the continuous process whereby water is transported from the oceans to the atmosphere, then to the land and back to the oceans (Schuster 1996). Evaporation of water from the surface of oceans, lakes and streams lifts water as vapor into the atmosphere where it forms clouds. The clouds are moved across the earth by wind currents. Soil, plants, animals, factories and motorized vehicles also contribute to this vapor. When sufficiently concentrated, the water vapor condenses and falls to earth as precipitation. Some of the precipitation, however, evaporates before it reaches the Earth's surface and returns to the atmosphere as vapor. About 70% of the precipitation that falls on grasslands evaporates (Holechek *et al.* 1995). The remaining precipitation infiltrates the soil, or moves laterally off the site as runoff into streams and lakes. Plants and animals use part of the water that infiltrates the soil or runs off, returning it to the atmosphere as vapor through transpiration and respiration. The remainder of the water that infiltrates the soil percolates through the soil profiles and accumulates in ground water aquifers. The water in aquifers may remain there, be pumped out through wells, or may move laterally across impermeable strata and emerge as spring flow into streams and other water bodies. Because of this interaction, land use actions that impact runoff and infiltration commonly impact the quality and/or quantity of both surface and ground water.

Quantities of water runoff and infiltration are dependent on land use, land cover, soil type, slope, and a number of other factors, in addition to the amount and intensity of precipitation. The grasslands in the US experience average annual precipitation ranging from about 10 inches in the West to 40 inches in the East (NOAA 2000). Consequently, average annual runoff in the region ranges from less than one inch per unit area in the drier areas to almost 20 inches in the wetter eastern portions (Holechek *et al.* 1995).

According to the USGS (2000) about 80% of all the water used by humans in the US comes from surface-water sources. However, more than 50% of our people, including almost everyone who lives in rural areas, use ground water for drinking and other household uses. Some ground water is also used by about 75% of US cities. Surface water use by the states west of the Mississippi River and the percent of total withdrawals from surface sources for 1990 are shown in Table 1.10. Fresh surface water uses in the US are in the power generation industry (50%), irrigation (33%), public/municipal (9%), industry (6%) and other (2%). These surface water sources, such as rivers and lakes, are supplied almost entirely by runoff from precipitation.

When other factors are held constant, land use and land cover, as influenced by human management, can have large impacts on infiltration and runoff. High infiltration results in a larger percent of precipitation being stored in the soil for plant use and for recharging groundwater aquifers. Alternatively, high rates of surface runoff may result in increased soil erosion and flooding. On grasslands, the primary factor influencing infiltration is vegetative cover. Welch et al. (1991) illustrate that, with a ground cover of bunch grasses, soil loss (erosion) from a 10 cm rain in 30 minutes was only 200 kg/ha with 24% of the precipitation running off. Alternatively, with the same rainfall, soil loss was 1,400 kg/ha and 45% runoff with sod grass ground cover and 6,000kg/ha soil loss and 75% runoff for land with no vegetative cover.

Human activities, such as the conversion of grassland to cropland, result in reductions in vegetative cover and dramatically increase the potential for soil loss due to wind or water erosion. Average annual soil loss differences of 10 to greater than 60 times have been measured for similar watersheds with perennial grass cover versus continuous cropping (Krishna et al. 1988; Richardson 1988).

In addition to increasing the potential for erosion, the conversion from grassland to cropland also increases the likelihood that runoff water will carry excess chemical constituents that may impair water quality and negatively impact aquatic life and/or the use of surface water for public water supply. The chemical constituents are commonly grouped as dissolved solids, nutrients, pesticides and sediment (Huntzinger 1995).

Inorganic compounds such as sodium, calcium, and sulfate comprise the dissolved solids commonly found in surface water. While some of the excessive concentrations of these compounds result from the natural dissolution of rocks (e.g., sodium), agricultural activities, such as irrigation return flows, are a primary source in some areas.

Large concentrations of nutrients such as nitrogen and phosphorus in runoff water often result from the use of these nutrients as fertilizers on cropland. Elevated concentrations in surface water stimulate production of aquatic plants, depletion of oxygen and impairment of aquatic habitat.

The use of pesticides in agriculture has become pervasive over the past century and is part of the reason for the dramatic increases in agricultural productivity. In recent years, however, concerns about the potential effects of pesticides on humans and aquatic organisms have also heightened. According to Huntzinger (1995) several studies of large numbers of water samples from across the US have detected pesticides in less than 2% of the samples with the exception of Atrazine. One of the studies found several herbicides (most often Atrazine) in concentrations exceeding the USEPA maximums in spring and summer months in about half of the streams tested in the northern and central Great Plains.

Sediment is primarily the product of erosion and consists of solid materials suspended in and transported by water. Just as conversion of grasslands to cropland increases average annual soil loss, it elevates the quantities of sediment in the runoff water, which supplies our streams and lakes. Transport of sediment can result in its deposition in stream and lakebeds, thus decreasing their ability to convey or store water and altering the associated aquatic habitat.

The estimates by Ramankutty and Foley (1999b) (Figure 1.7) indicate that almost half of the US grasslands were converted to cropland between 1850 and 1990. The accompanying increased exposure to soil erosion and deterioration in surface water quality in the region are immense.

Wildlife and Biodiversity

The biotic diversity of North American grasslands is probably the most altered by human impact of any of the continent's terrestrial ecosystem. The ecology of grassland ecosystems is dominated by the influence and interactions of human activities, herbivores, drought, and fire. The fauna and flora of North American grasslands has been altered and transformed by human activities for thousands of years. In fact, at the time of Euro-American arrival, the biological resources of most North American grasslands was already dramatically different than that experienced by earlier human occupants.

Impacts of early humans – Paleo-Indians arrived in North America a little less than 12,000 years ago. At that time, the Great Plains were occupied by a diverse assemblage of large-bodied herbivores, including horses, camels, rhinoceros, bison, tapirs, and elephants (Benedict *et al.* 1996). Skilled Paleo-Indian hunters occupied the Plains for approximately 3,000 years, contributing to the extinction of 32 genera of mammals – the peak of which was between 9,000 and 10,000 years ago (Flores 1995). Humans essentially abandoned the Plains about 6,000 years ago, due to the Altithermal, a 2,000 year drought that reduced plant diversity in the Plains by as much as 50% (Flores 1995).

Endemic species. – Endemic species are those that are naturally confined to a particular habitat type, likely owing to the fact that the species evolved there. Due to their close association with particular ecosystems, the population trends of narrow endemic species are likely to serve as indicators of ecosystem conditions (Knopf and Samson 1997). In the case of grasslands, monitoring those species that are least resilient to degradation and loss of native grasslands may provide the useful index to long-term changes in the overall ecological conditions of grassland systems.

Although grasslands provide habitat to a diverse assemblage of species, it appears that only a small proportion of the contemporary North American grassland fauna actually evolved in grassland regions. Most species presently occupying the grasslands were derived in other North American ecosystems and colonized grasslands from surrounding habitats. In one inventory of 138 mammals in the north-central prairie states, 11.6% of the species were thought to have actually evolved in the Great Plains (Benedict *et al.* 1996 and citations therein). Of the grassland bird fauna, a minority are thought to be endemic to grasslands; 9 of 29 widespread "grassland birds" were classified as endemics by Knopf (1996) and Biddy *et al.* (1992). Likewise, of 124 species of reptiles and amphibians occupying the Central Plains, 15 are distributed primarily in the prairies (Corn and Peterson 1996).

Large mammals. – Large free-ranging herbivores continued to exert influence on the continent's grasslands through the mid-1800s. According to Shelford (1963:332), bison and pronghorn each numbered about 45 million in the grasslands of North America at the turn of the 17^{th} century. While bison primarily dominated the Central Plains, pronghorn ranged much further into the arid Western Grasslands. These immense herds of grazing animals supported a large population of Gray Wolves, once conservatively estimated at 80,000 (Licht 1997), which are now largely extirpated.

By 1889, massive hunting efforts had reduced the Great Plains' bison herd to 541 individuals (Shelford 1963), virtually eliminating a major ecological driver of the biological development of grassland ecosystems. Likewise, pronghorn numbers were reduced to about 30,000 animals by 1924 (Shelford 1963). Through conservation efforts, bison and pronghorns had recovered to about 11,000, and 350,000 individuals, respectively by 1969 (Grossman *et al.* 1969). Populations have continued to increase, but there is no reasonable expectation that the full ecological functions of these species will be restored throughout significant portions of their former range in no small part due to the now pervasive influence of incompatible human activity in the region.

Bison were once an integral part of the various functions provided by native grasslands, including the development and maintenance of certain habitats for other species. In the absence of wild free-ranging grazing animals, managed grazing with domestic livestock seems to be a reasonable alternative in spite of the fact that native species, traditional and modern domestic livestock grazing regimes may differ substantially. Sims *et al*. (1978a) found that the biotic processes on grazed grasslands were more closely linked to abiotic variables than on ungrazed grasslands. This led them to propose that the consideration of grasslands without the interactions of large herbivores is an unnatural situation. However, the potential for long-term ecological damage from overgrazing by domestic livestock poses substantial management challenges on remaining grasslands that are not easily addressed by generalizations.

Prairie dog associates. – Prairie dogs (5 species) were estimated at 5 billion animals in the 1870s, and their colonies occupied between about 100-250 million acres of short- and mixed-grass prairies at the turn of the century (Bonham and Lerwick 1976; Miller *et al*. 1994). A single colony in Texas once occupied almost 16 million acres (Merriam 1902). The combined effects of land use conversion and eradication programs have reduced prairie dogs to as little as 2% of their former range (Miller *et al.* 1994). The absence of prairie dogs from a large portion of their previous range may have implications for numerous other species that prey on prairie dogs and use the unique habitats created by prairie dog grazing and their burrows.

Through their grazing and burrowing actions, prairie dogs can actually influence nutrient cycling and change the character of the surrounding prairie habitat. Grassland bird diversity and numbers can be locally increased in the area of prairie dog colonies (Agnew *et al.* 1986). In the shortgrass prairie, grassland birds such as burrowing owls, mountain plover, and horned lark tend to prefer grassland vegetation modified by prairie dogs, whereas some species such as grasshopper sparrows may favor grassland habitats undisturbed by prairie dogs (Baker and Sedgewick, Unpublished Report). As prairie dog numbers have drastically declined, the numbers of several species known to be associated with the habitats created by prairie dog activities have also declined. Thus, prairie dogs are frequently cited as a "keystone" species in maintaining the biotic diversity of prairie ecosystems (e.g., Miller *et al.* 1994).

While declining prairie dog numbers may be detrimental to several important species, the "keystone" role of prairie dogs might only apply to a subset of grassland species. Kotliar *et al.* (1999) critically reviewed a list of 208 vertebrate species that have been cited as being associated with prairie dogs and finally concluded that a tight dependence on prairie dogs was supportable for 9 of the cited species – these include the black-footed ferret, burrowing owl, mountain plover, ferruginous hawk, golden eagle, swift fox, horned lark, deer mouse, and grasshopper mouse. The federally endangered Black-footed ferrets prey upon prairie dogs, and prairie dog eradication efforts are directly implicated in the extirpation of that species throughout much of its former range in Great Plains. Kotliar *et al.* (1999) concluded that several of the other species closely dependent on prairie dogs are likely to suffer population declines with continued declines in prairie dog colonies.

Grassland birds. – Endemic grassland birds appear to be among the most rapidly declining groups of birds in North America (Knopf 1995). The North American Breeding Bird Surveys (BBS) supplies an extensive database for tracking changes in bird populations by species for various regions (Sauer *et al.* 2000). BBS trend data for 31 species of grassland birds in the contiguous US for the period 1966-1999 were reviewed (Table 1.11). The populations of 12 (39%) of the 31 species were found declining; 4 (13%) species were increasing; and the statistical significance of the remainder was too weak to draw a conclusion (Table 1.11). Of particular note, 7 of 9 species of grassland sparrows were in decline. Two declining sparrow species (Cassin's and Baird's) are endemic to grasslands.

When trends were examined separately for 16 Central Plains states (we included Idaho and 2 states east of the Mississippi in this analysis), some distinct regional trends emerged among the most northerly states of the Central Plains (Table 1.12). For several grassland birds, declining populations were most apparent in the Tallgrass Savanna/Prairie dominated states of Minnesota, Wisconsin, and Illinois; while several states in the northern Great Plains actually had increasing populations of several species.

While BBS data can be used to determine overall trends in numbers of relatively common and widespread species, there are several other species of grassland birds that are declining. Some declining bird populations are probably not the result of an overall loss of grassland area, but rather a long-term change in grassland habitat associated with land use. These changes are often the result of fire exclusion and unmanaged grazing, at times resulting in brush encroachment and other changes in vegetation structure. As a result, many of the former grassland habitats are increasingly colonized by eastern species that are more adaptable to increasingly woody vegetation. Species that rely on open grassland habitats have had diminishing habitat alternatives.

Implications for other species. – While large mammals, prairie dog associates, and grassland birds represent only a fraction of the native biotic diversity of grasslands, their status may hold implications for other species, and may well represent an overall loss in native biodiversity of grasslands. Grassland birds, due to their wide geographic range, but relatively narrow habitat affinities, may gauge the status of grassland species in other taxa. For example, Swengel and Swengel (1999) demonstrated that three grassland bird species (Henslow's sparrow, grasshopper sparrows, and Dickcissels) were correlated with five species of prairie butterflies across 109 sites in tallgrass prairie regions, suggesting that a trend in these bird species might indicate a trend in a close habitat associate.

Economic importance of grasslands

Land uses – Direct

Forage for grazing animals - Grassland forage is considered an intermediate good whose demand is derived from the demand of a final output, such as livestock or wildlife (Bartlett 1986). There are few estimates of the total forage consumed by livestock on grasslands. Researchers have typically relied upon estimates of livestock numbers to examine the trend in the use of grazed forages (Gee *et al.* 1992).

The inventory of cows that have calved in the 22 contiguous states west of the Mississippi River peaked in 1975 at almost 34 million head and followed a downward trend until the early 1990s (Figure 1.14). The inventory of heifers 500 lbs and over essentially follows the same general trend as cows that have calved, with some lags due to cattle cycle effects.

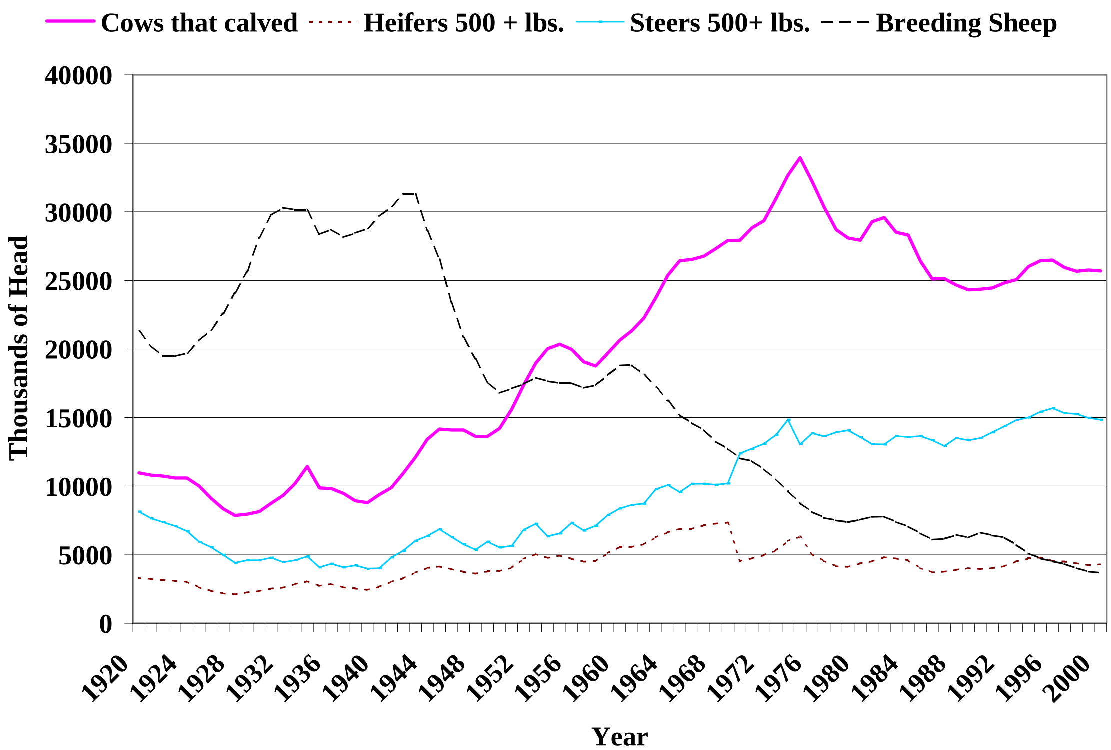

Figure 1. 14. January 1 inventory of cows, heifers, steers, and breeding sheep in the 22 contiguous states west of the Mississippi River, 1920 to 2000. Source: USDA/NASS 2000.

The inventory of steers 500 lbs and heavier have continued a steady increase for the last several decades (Figure 1.14). While many of these cattle will depend primarily on grazed forage as a feed source before entering a feedlot, the weight at which they enter the feedlot is dependent upon the cost of gain and the price of the animals. The increase in retention of stocker cattle for grazing forages can be due to feedlots reducing feeding costs and the desire of cow-calf operators to retain ownership of the calves longer to capture potential profits from additional growth (Gee and Madsen 1988).

In 1980, Gilliam (1984) examined the acreage of various forage sources grazed on cow-calf farms and ranches. In the Great Plains (North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Texas and the front range parts of Montana, Wyoming, Colorado and New Mexico), dry range made up over 96% of the 13.48 acres it took to maintain a cow, excluding Bureau of Land Management (BLM) and US Forest Service (USFS) leases. In the remaining Western States not included in the Great Plains, almost 95% of the 20.44 acres required to maintain a cow, excluding BLM and USFS permits, were comprised of dry rangeland.

The direct economic returns to cattle production are usually the sole income generated from pasturelands used by ranchers. In 1999, pasture costs accounted for 14 to 33% of the estimated $408 to $486 per bred cow in operating costs for the typical cow-calf operation in the states west of the Mississippi (ERS/USDA 2000). These cost were separate from the costs associated with grazing cropland pasture and public land costs. When only operating costs were accounted for, profit (loss) averaged -$191.67 to 79.14 per bred cow. Subtracting overhead costs (e.g., capital recovery of equipment and opportunity cost of land) placed producers in a precarious economic situation with losses averaging between -$351.98 and -$667.36 per bred cow.

Sheep constitute the second most important rangeland dependent livestock industry in the United States. Over 86% of the breeding sheep in the United States are located in the 22 states being examined. The inventory of breeding sheep in these states peaked in 1943 at over 31 million head and has steadily declined to 3.7 million head in 2000.

According to Gee and Madsen (1988), the main source of grazed forages for beef cattle and sheep is deeded non-irrigated grazing land. In 1985, they conduced a study using livestock inventory numbers and survey data to estimate feed requirement for beef cattle and sheep on an animal unit month (AUM) basis. In the Pacific Northwest (PN), California (CA), Southwest (SW), and Northern Rockies (NR), cattle obtained 74%, 79%, 64% and 81% of their grazed forages from deeded non-irrigated land. This amounted to 9.9, 12.1, 8.3, and 95.7 million AUMs in the four regions. Sheep obtained 31%, 52%, 59% and 31% of their grazed forages from deeded non-irrigated land in the PN, CA, SW and NR regions. This accounted for 0.3, 1.1, 0.8, and 2.4 million AUMs in the PN, CA, SW and NR regions. Sheep obtained the majority of AUMs from public land grazing in the PN and NR regions.

Other types of livestock depend upon grassland for feed to differing degrees, including horses and goats. The amount of grazed forages consumed by horses and goats is small in comparison to sheep and cattle.

The number of horses on farms peaked at 20 million in the 1920s and has steadily declined since that time, in part due to the introduction of tractors. In the 22 states considered in this study, numbers of horses on farms (Figure 1.15) steadily increased from 1974 to 1987 before declining in 1997 (USDA/NASS 2000, USDC/BC various years). The National Agricultural Statistical Service (USDA/NASS 1999) inventoried the total population of horses in 1998 and 1999 and found that approximately the same number of horses existed off-farm as on-farm.

According to the US Census of Agriculture (USDA/NASS 2000, USDC/BC various years), goat numbers, in the 22 states under consideration, most recently peaked in 1992 at just over 2 million head, but declined in 1997 to less than 0.9 million head (Figure 1.15). This inventory includes both milking and angora goats.

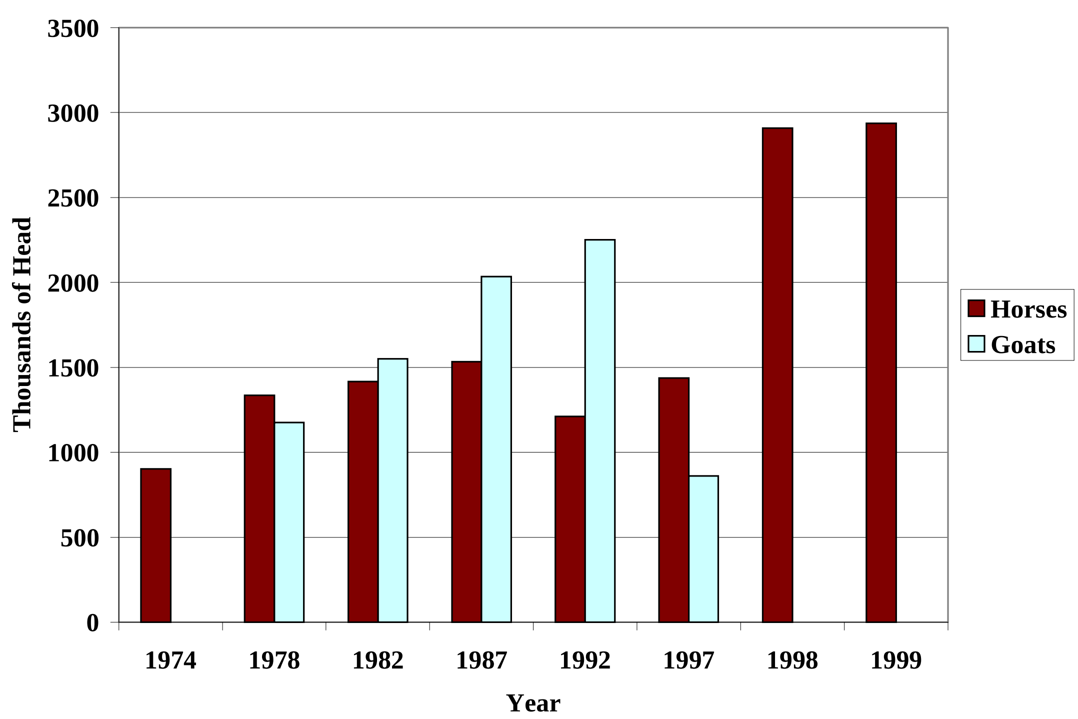

Figure 1. 15. US Census of Agriculture estimates of on-farm goat and horse inventories for the 22 contiguous states west of the Mississippi River, 1974 to 1997, plus the 1998 and 1999 National Agricultural Statistical Service estimates of total horses**.** Sources: USDC/BC various years, USDA/NASS, 1997 USDA/NASS 1999.

Economic importance of grassland-based fish and wildlife - Fish and wildlife are the basis for significant recreational activities and expenditures. According to the US Fish and Wildlife Service (2001) nearly 77 million people in the US participated in fishing, hunting, and wildlife observation, feeding and photography in 1996. Expenditures related to these activities were in excess of $100 billion.

Number of participants and expenditures in 1996 for the states west of the Mississippi River are reported in Table 1.13. For these states, there were a total of more than 27 million participants and $37 billion in expenditures for outdoor recreational activities on both private and public lands. It should be noted that these are statewide statistics and do not allow for the partitioning of the recreational activities related to grasslands from those related to other land types (e.g., mountains). Not only are the number of participants and levels of expenditure significant, but they also appear to be growing rapidly, as expenditures nationwide increased by over $40 billion between 1991 and 1996.

Community economic impacts of ranchette development

Low, or negative, direct economic benefits to aging pastureland, rangeland and grassland owners combined with the longest economic boom in US history, recent advances in telecommunications and the coming “geezer” boom (baby boom + 40 yrs) contribute to the pressure to convert lands into large lot, rural or x-urban homesites. Beyond the now familiar “trophy home,” this continuing trend has spawned a number of new terms in the American lexicon including: “rurban development,” “starter castles,” and “McMansions.”

The private decision to sell range and grasslands for higher density uses has important public finance impacts. Research on the cost of rural land development shows that residential development requires more expenditures than the revenues it generates for county government. County revenues are stretched to pay for service and infrastructure demands as rural populations grow (Burchell and Listokin 1992). Service demands by ranchette owners tend to cost more than do larger scale working ranches (Taylor *et al.* 1997). The American Farmland Trust studies indicate that agriculture asks for 37 cents of government services for every dollar of revenue contributed. Rural residences ask for $1.15 in government services for every dollar contributed (AFT, 1999).

Using the AFT methodology, Peters (1990) estimated that relatively high density ranchettes converted from large ranches generated $1.36 in costs for every dollar of revenue. Similarly, Taylor *et al.* (1997) estimate county government cost to county government revenue ratios for different rural Wyoming households. Rural residential ratios ranged from a high of $2.35 assuming minors and no job to $1.27

with one person employed and $0.92 with two working adults. Smith *et al.* (1991) estimated significant cost increases relative to tax revenue increases when specific parcels of private open space were converted to rural residential uses. Moreover, pastureland and grassland conversion trends have important consequences for ranches in terms of production and income, the viability of input suppliers and the economic base of rural regions.

Indirect economic values

Pasturelands and grasslands are not only production inputs, but provide other benefits. The nonagricultural amenities that rural citizens value are not traded in markets. The development of grasslands and pasturelands into rural residences has adverse consequences for wildlife habitat and migration patterns, local water supplies, the amount of scenic lands, access to public lands and the rural sense of community. Residents of rural communities enjoy a particular quality of life arising from the pasturelands and grasslands surrounding their communities. Benefits of these lands include income from extractive or recreational industries, wildlife enjoyment and scenic viewing. Different land use patterns may give rise to distinct social arrangements and community ties. Rapid rural growth through the conversion of ranches to residential or commercial development tends to diminish local social networks and identification with community.

Landscape fragmentation occurs as pasturelands and grasslands are diverted from historical uses to residential developments. Fragmentation adversely impacts wildlife habitat and migration corridors (Theobald *et al*. 1997). Ranches become isolated, reducing the operation's viability and re-investment incentives while the operator awaits a real estate offer (Zollinger 1998). Housing construction reduces scenic values along valley floors and mountain ridges. This is particularly the case as ranches are subdivided into ranchettes or rural subdivisions (Knight *et al.* 1995). In addition, arable soils and water resources are lost to development as increased density of habitation leads to increased demand for water and land.

Private and public land management practices impact the flows of public goods originating from both private and public lands. Residential development adjacent to public land impacts strategies for wildlife and fire management. Public land regulations may also affect rancher viability (and development attitudes) through diminished access to public grazing. Several factors (scenery, wildlife habitat, on-parcel recreation opportunities, distance from incorporated areas, proximity to public lands) potentially increase the likelihood that pasturelands and grasslands will be converted to residential uses.

Policy makers are increasingly recognizing the public goods aspects of private pastureland and grassland. Environmental benefits, open space, and scenic amenities are viewed as valued reasons for living in a community (Inman and McLeod 2000; Loomis *et al.* 2000; Power 1996; Rudzitis 1993). Residential and community attachment affects support for land preservation (Fortmann and Huntsinger 1989; Green *et al.* 1996; McLeod *et al.* 1998). Community ties generate shared knowledge, ideas, and values that can build trust and support for collective decisions, but can also build the opposite (Portes and Sensenbrenner 1993). Social cohesion is adversely affected by greater population turnover, as the formation and duration of social ties is reduced (Sampson 1991).

Spahr and Sunderman (1995) use Wyoming ranchland sales data to model the contribution of scenic and recreational quality to land price. Low, medium and high quality, based on the judgment of area appraisers, are represented by dummy variables in their statistical model. These variables are statistically significant with high scenic quality contributing to higher sale price. Weicher and Zeibst (1973) found that land prices bordering open space were 7-23% higher than those not bordering open space and Correll et al. (1978) found a 32% increase for similar land attributes. Loomis et al. (2000) employ a hedonic approach to identify the implicit valuation of 36 rural land attributes cited in more than 200 conservation easements in Colorado. They find, for example, that open space, rural lifestyle, carbon sequestration, and flood control attributes of agricultural lands contribute to the value of conservation easements purchased by governmental agencies and through public-private partnerships in Colorado (Loomis et al. 2000). Ready *et al.* (1997), Bergstrom *et al.* (1985), Beasley *et al.* (1986), Willis *et al.* (1993), Willis and Garrod (1993), Bateman *et al.* (1994), and Drake (1992) all find positive public willingness to pay for the maintenance of traditional agricultural enterprises in a community.

Summary

In this chapter the importance of grasslands to economic and biological system functions in the United States is explored. Grasslands are defined and their historical extent worldwide was established. Global trends in land use related to grasslands were explored and the US distribution of grasslands was established in this context. This Chapter identifies several data issues and definitional concerns regarding pasture and grassland trends and then identifies some of the nationwide and state level trends in grassland conversion over the past century. Chapter 1 demonstrates that:

1. Historically, grasslands are of great global and national importance and that the amount of grassland in the world and the nation is diminishing;

2. Nutrient cycling, water quality and quantity, biodiversity conservation, terrestrial and aquatic wildlife habitat are among the important ecological services that grasslands provide.

3. Grasslands provide important direct and indirect economic benefits to the nation including: livestock, hunting fishing, wildlife viewing and other forms of outdoor recreation, and open space, for example.

Detailed accounts of the status and drivers of change for US grasslands at the national, state and local levels will be explored in subsequent chapters.

Table 1.1. Estimated global coverage of potential grassland types (Shantz 1954)

Grassland Type	km^2 (millions)	mi^2 (millions)
High Grass Savanna	7.25	2.80
Tallgrass Savanna	10.10	3.90
Tallgrass Prairie	4.09	1.58
Shortgrass Prairie	3.11	1.20
Desert Grass Savanna	5.96	2.30
Mountain Grassland	2.05	0.79

Table 1.2. Approximate area of 7 grassland forms of the contiguous US separated by major biome and region -- see Figures 1.2-1.4. Adapted from Omernik (1986) and Ricketts et al (1999).

Biome / Region / *Grassland Form*	Area (acres)
Central Plains	
Great Plains	
Mixed-grass Prairies [a]	316,811,605
Shortgrass Prairies	107,526,553
Central Lowlands and Coastal Plains	
Tallgrass Prairies [a]	120,985,102
Savannas	143,120,814
Western Grasslands	
Great Basin	
Shrub Steppe	181,066,479
Desert Southwest	
Shrublands	80,650,969
Desert Grasslands	111,897,505
Mediteranian Grasslands	
California Grasslands	12,099,252

[a] Portions extend into Canada

Table 1.3. Area (Millions of acres) of potential grassland by state; and potential grassland in non-federal landscapes, by state for the United States west of the Mississippi River (designations per Kuchler 1975).

Grassland Type	AZ	AR	CA	CO	ID	IA	KA	LA	MN	MO	MT	NE	NV	NM
Tallgrass Savanna	.	~~0.16~~	.	.	.	~~9.32~~	~~6.43~~	.	~~5.82~~	~~15.36~~	.	~~0.04~~	.	.
Post Oak Savanna	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tallgrass Prairie	.	.	.	~~2.18~~	.	~~16.13~~	~~12.73~~	.	~~16.04~~	.	.	~~26.10~~	.	1.56
Coastal Prairie	.	.	0.58	.	.	.	.	~~4.43~~	.	.	.	.	.	.
Northern Mixed-grass Prairie	.	.	.	1.23	.	.	~~0.86~~	.	.	.	~~6.78~~	~~12.44~~	.	0.36
Southern Mixed-grass Prairie	.	.	.	0.07	.	.	~~22.23~~	.	.	.	.	~~0.35~~	.	.
Shortgrass Prairie	.	.	.	~~26.30~~	.	.	~~4.93~~	.	.	.	~~39.08~~	~~5.12~~	.	~~12.75~~
Alpine Meadow	.	.	0.82	3.51	0.11	.	.	.	.	.	~~1.01~~	.	0.00	0.15
California Grassland	.	.	~~13.95~~	.	.	.	.	.	.	.	.	.	.	.
Great Basin Grassland	.	.	.	.	~~2.72~~	.	.	.	.	.	11.16	.	0.30	.
Great Basin Shrub/Steppe	.	.	3.63	3.94	23.56	.	.	.	.	.	2.44	.	10.98	.
Great Basin Shrub	6.58	.	5.80	4.10	1.97	.	.	.	.	.	.	.	42.28	3.27
Desert Savanna	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Desert Grassland	6.91	.	.	.	.	.	.	.	.	.	.	.	.	~~12.02~~
Desert Steppe	10.60	.	.	.	.	.	.	.	.	.	.	.	0.00	13.45
Desert Shrub	25.17	.	25.17	.	.	.	.	.	.	.	.	.	5.52	3.98
Potential Grassland	49.26	0.16	49.96	41.34	28.36	25.45	47.18	4.43	21.86	15.36	60.47	44.05	59.07	47.55
Non-federal potential grassland [a]	0.00	0.00	13.95	28.48	2.72	25.45	47.18	4.43	21.86	15.36	46.87	44.05	0.00	24.77

[a] Area totals designated as non-federal landscapes are the cumulative state-level totals of grassland types land dominated by non-federal ownerships (>50% of Grassland type within a state).

Table 1.3 (continued). Area (Millions of acres) of potential grassland by state; and potential grassland in non-federal landscapes, by state for the United States west of the Mississippi River (designations per Kuchler 1975).

ND	OK	OR	SD	TX	UT	WA	WY	Total
~~0.86~~	~~15.31~~	.	.	~~26.39~~	.	.	.	79.69
.	.	.	.	~~10.59~~	.	.	.	10.59
~~3.33~~	~~6.81~~	.	~~7.39~~	~~15.45~~	.	.	~~0.00~~	107.72
.	.	.	.	~~8.01~~	.	.	.	13.02
~~33.12~~	.	.	~~36.48~~	.	.	.	~~4.59~~	95.87
.	~~13.06~~	.	~~0.65~~	~~1.50~~	.	.	.	37.86
.	~~2.57~~	.	.	~~22.58~~	.	.	~~14.42~~	127.74
.	.	0.31	.	.	0.27	1.66	0.97	8.83
.	.	.	.	.	.	.	.	13.95
.	.	~~4.92~~	.	.	0.36	~~6.82~~	0.44	26.73
.	.	19.84	.	.	4.53	~~8.70~~	24.55	102.17
.	.	2.43	.	~~0.25~~	23.32	.	2.24	92.24
.	~~0.01~~	.	.	~~41.12~~	.	.	.	41.14
.	.	.	.	~~3.73~~	.	.	.	22.67
.	.	.	.	~~17.42~~	.	.	.	41.47
.	.	.	.	1.29	0.11	.	.	61.24
37.31	37.76	27.51	44.51	148.33	28.59	17.18	47.21	882.90
37.31	37.76	4.92	44.51	148.33	0.00	15.52	19.01	582.49

[a] Area totals designated as non-federal landscapes are the cumulative state-level totals of grassland types land dominated by non-federal ownerships (>50% of Grassland type within a state).

Table 1.4. Area (Millions of acres) of potential grassland (Kuchler 1964); potential grassland in non-federal landscapes; and land classified as Pasture and Range (NRI Data), by state for the 13 States of the central plains west of the Mississippi River.

Grassland Type	CO	IA	KA	MN	MO	MT	NE	NM	ND	OK	SD	TX	WY	Total
Tallgrass Savanna	.	9.32	6.43	5.82	15.36	.	0.04	.	0.86	15.31	.	26.39	.	79.53
Post Oak Savanna	.	.	.	.	.	.	.	.	.	.	.	10.59	.	10.59
Tallgrass Prairie	2.18	16.13	12.73	16.04	.	.	26.10	1.56	3.33	6.81	7.39	15.45	0.00	107.72
Coastal Prairie	.	.	.	.	.	.	.	.	.	.	.	8.01	.	8.01
Northern Mixed-grass Prairie	1.23	.	0.86	.	.	6.78	12.44	0.36	33.12	.	36.48	.	4.59	95.87
Southern Mixed-grass Prairie	0.07	.	22.23	.	.	.	0.35	.	.	13.06	0.65	1.50	.	37.86
Shortgrass Prairie	26.30	.	4.93	.	.	39.08	5.12	12.75	.	2.57	.	22.58	14.42	127.74
Alpine Meadow	3.51	.	.	.	.	1.01	.	0.15	.	.	.	.	0.97	5.64
California Grassland	.	.	.	.	.	.	.	.	.	.	.	.	.	0.00
Great Basin Grassland	.	.	.	.	.	11.16	.	.	.	.	.	.	0.44	11.60
Great Basin Shrub/Steppe	3.94	.	.	.	.	2.44	.	.	.	.	.	.	24.55	30.93
Great Basin Shrub	4.10	.	.	.	.	.	.	3.27	.	.	.	0.25	2.24	9.87
Desert Savanna	.	.	.	.	.	.	.	.	.	0.01	.	41.12	.	41.14
Desert Grassland	.	.	.	.	.	.	.	12.02	.	.	.	3.73	.	15.75
Desert Steppe	.	.	.	.	.	.	.	13.45	.	.	.	17.42	.	30.87
Desert Shrub	.	.	.	.	.	.	.	3.98	.	.	.	1.29	.	5.27
Potential Grassland	41.34	25.45	47.18	21.86	15.36	60.47	44.05	47.55	37.31	37.76	44.51	148.33	47.21	618.38
Non-federal potential grassland [a]	28.48	25.45	47.18	21.86	15.36	46.87	44.05	24.77	37.31	37.76	44.51	148.33	19.01	540.94
1997 Pasture	1.21	3.57	2.32	3.43	10.85	3.44	1.80	0.23	1.13	7.96	2.11	15.91	1.15	55.12
1997 Range	24.57	.	15.73	.	0.09	36.75	23.09	39.99	10.69	14.03	21.88	95.74	27.30	309.86

[a] Area totals designated as non-federal landscapes are the cumulative state-level totals of grassland types land dominated by non-federal ownerships (>50% of Grassland type within a state).

Table 1.5 Changes in land cover/use between 1982 and 1997, 48 contiguous states, Hawaii & Caribbean.

Land cover/use in 1982	Land cover/use in 1997								
	Cropland	CRP land	Pastureland	Rangeland	Forest land	Other rural land	Developed land	Water areas & federal land	1982 total
			- - - - - - - - - - - - - - 1,000 acres - - - - - - - - - - - - - -						
Cropland	350,265.30	30,412.10	19,269.40	3,659.20	5,606.50	3,158.90	7,097.50	1,485.10	420,954.00
Pastureland	15,347.00	1,329.60	92,088.30	2,567.90	14,091.40	1,619.00	4,230.00	732.8	132,006.00
Rangeland	6,967.50	728.5	3,037.20	394,617.40	3,021.60	1,702.70	3,281.30	3,383.20	416,739.40
Forest land	2,037.10	128.8	4,168.20	2,098.80	380,343.30	1,754.80	10,279.20	2,528.00	403,338.20
Other rural land	1,386.80	93.1	1,013.60	719.1	2,767.70	42,713.30	726.9	227.8	49,648.30
Developed land	196.7	1.2	78.6	110.8	227	12	72,618.70	0.8	73,245.80
Water areas and federal land	797.5	2.7	336.6	2,204.00	897.7	180.8	18.1	443,760.60	448,198.00
1997 total	376,997.90	32,696.00	119,991.90	405,977.20	406,955.20	51,141.50	98,251.70	452,118.30	1,944,129.70

Source: Summary Report 1997 National Resources Inventory Revised December 2000, USDA, NRCS, ISU Statistical Laboratory, p.35.

This table contains both the 1982 and the 1997 land cover/use and the change in acreage that occurred between the two. For example, the 1982 total for rangeland acreage (1,000 acres) was 416,739.4 and the 1997 total was 405,977.2, with 394,617.4 acres that did not change classification during the time period. Reading along the rangeland row gives the number of acres that were removed from rangeland between 1982 and 1997. Reading along the rangeland column gives the number of acres that were converted to rangeland between 1982 and 1997.

Table 1.6 Conservation reserve program (CRP), pastureland and rangeland acreage in 1997 and the percentage change in rangeland and pastureland from 1982 to 1997 according to the National Resource Inventory.

	CRP land	Pastureland	Rangeland	Pastureland	Rangeland
	- - - - - - - - - - - 1,000 acres	- - - - - - - - - - -		- - % change: 1997-1982 - -	
Arizona	0.0	72.6	3,2323	-19.06	0.23
Arkansas	230.4	5,351.4	37.9	-5.44	-17.25
California	172.8	1,048.8	18,269.3	-22.23	-3.30
Colorado	1,889.9	1,211.0	24,574.1	3.98	-1.91
Idaho	784.8	1,314.8	6,500.5	2.82	-1.88
Iowa	1,739.4	3,572.0	0.0	-22.49	0.00
Kansas	2,849.0	2,321.9	15,727.9	7.50	-4.66
Louisiana	140.3	2,385.3	277.2	3.88	2.51
Minnesota	1,544.0	3,434.3	0.0	-11.32	0.00
Missouri	1,606.1	10,848.7	87.5	-13.71	0.00
Montana	2,720.7	3,442.5	36,750.9	11.98	-2.85
Nebraska	1,245.1	1,800.5	23,089.1	-9.03	-2.11
Nevada	2.4	279.0	8,372.4	-10.75	1.53
New Mexico	467.1	230.8	39,989.5	28.72	-4.18
North Dakota	2,802.3	1,128.8	10,689.4	-12.48	-6.90
Oklahoma	1,137.7	7,962.7	14,032.8	10.41	-6.34
Oregon	482.6	1,960.7	9,286.3	-4.52	-2.66
South Dakota	1,685.9	2,108.2	21,876.4	-22.23	-4.74
Texas	3,905.5	15,914.4	95,744.7	-6.97	-0.62
Utah	216.2	694.9	10,733.4	29.00	-1.03
Washington	1,016.8	1,193.2	5,856.9	-8.35	-2.06
Wyoming	246.7	1,145.6	27,302.4	50.50	-1.21
Total	26,885.7	69,422.1	401,521.6	-5.64	-2.29

Source: USDA/NRCS 1997.

Table 1.7 Major Land Use classifications of other grassland pasture and range by state, 1945 to 1997.

	1945	1949	1954	1959	1964	1969	1974	1978	1982	1987	1992	1997
	- - - - - - - - - - - - - - - - 1,000 acres - - - - - - - - - - - - - - - -											
Arizona	43,365	46,763	44,838	42,455	41,169	41,354	40,941	41,506	41,565	41,504	40,641	40,509
Arkansas	2,328	1,585	2,298	3,463	2,373	2,895	2,559	2,055	2,948	2,950	2,532	2,006
California	22,555	27,544	26,661	22,621	23,280	22,856	23,910	22,890	22,580	21,833	24,434	22,343
Colorado	33,096	32,073	33,237	29,436	29,017	29,711	29,274	28,731	28,198	27,898	28,087	27,867
Idaho	23,386	24,505	25,766	22,289	22,352	22,073	20,840	21,004	20,407	19,943	20,219	21,165
Iowa	5,759	3,731	3,799	5,153	3,248	2,089	2,152	1,755	2,065	1,882	1,518	1,477
Kansas	20,315	17,378	17,796	17,907	18,524	15,453	15,950	15,995	13,907	13,255	13,880	12,560
Louisiana	1,503	2,152	2,721	2,760	3,343	2,674	2,270	1,866	2,073	2,070	1,619	1,582
Minnesota	3,825	2,618	2,722	3,321	3,354	2,311	1,954	1,590	1,689	1,661	1,673	1,544
Missouri	9,637	6,036	6,625	8,100	7,718	4,833	6,610	5,812	6,540	6,465	6,478	6,010
Montana	53,386	53,296	54,742	50,641	50,558	49,873	49,465	48,869	48,395	47,139	47,364	46,039
Nebraska	22,373	22,154	22,542	22,266	23,731	22,179	22,137	22,133	21,232	20,435	20,917	21,828
Nevada	53,714	56,218	46,070	48,510	48,231	48,638	46,673	45,976	45,909	45,735	46,061	46,278
New Mexico	50,417	51,801	50,178	48,446	51,471	51,025	50,525	51,382	51,217	51,818	52,478	52,188
North Dakota	14,425	13,121	13,300	13,457	12,988	11,278	10,528	10,888	11,028	11,187	10,951	11,329
Oklahoma	14,347	13,744	16,203	15,022	18,449	16,599	16,235	17,549	18,396	17,754	17,364	17,314
Oregon	25,176	24,340	25,561	23,217	22,709	22,756	23,172	23,119	22,011	22,913	22,456	22,395
South Dakota	25,182	24,402	24,764	26,113	25,432	24,030	24,670	24,192	23,529	22,261	23,947	22,594
Texas	90,739	80,318	88,150	94,217	99,929	94,750	95,803	93,928	103,890	104,656	101,301	98,059
Utah	35,433	34,850	27,577	24,665	25,775	24,893	23,711	23,503	23,238	23,080	23,760	23,737
Washington	9,093	8,666	7,628	8,127	8,318	6,982	6,679	6,586	7,705	7,235	7,590	7,406
Wyoming	46,446	48,355	48,484	46,390	45,826	45,911	46,016	45,537	45,594	45,146	44,905	44,873
Total	606,500	595,650	591,662	578,576	587,795	565,163	562,074	556,866	564,116	558,820	560,175	551,103

Table 1.8: Number of farms reporting acreage in other pastureland and rangeland[1], by state, according to the U.S. Census of Agriculture, 1978 to 1997.

	1978	1982	1987	1992	1997
Arizona	2,338	2,163	2,399	2,385	2,203
Arkansas	13,390	11,827	12,936	10,642	12,288
California	12,056	13,463	14,211	11,949	12,952
Colorado	12,685	11,872	11,875	11,949	12,952
Idaho	7,689	6,744	6,923	6,247	6,517
Iowa	25,868	24,254	22,415	20,629	18,756
Kansas	38,748	34,510	32,362	29,949	29,854
Louisiana	6,141	5,996	6,419	5,656	6,380
Minnesota	20,134	19,794	18,166	15,969	15,503
Missouri	29,480	30,729	32,093	28,224	28,740
Montana	14,230	13,237	13,675	13,129	13,941
Nebraska	28,279	24,997	24,299	21,554	22,460
Nevada	962	1,010	1,034	1,024	1,027
New Mexico	6,789	6,424	6,803	6,767	6,570
North Dakota	19,285	15,644	16,025	14,565	14,541
Oklahoma	41,903	36,590	36,122	33,391	36,763
Oregon	9,215	8,546	9,178	8,621	9,415
South Dakota	20,392	18,474	17,957	17,326	16,858
Texas	79,178	78,443	83,251	78,805	84,875
Utah	4,576	4,096	4,502	4,391	4,619
Washington	8,257	7,600	7,994	6,934	6,886
Wyoming	5,062	5,381	5,467	5,453	5,968
Total	406,657	381,794	386,106	355,559	370,068

[1] Excludes pastureland that is classified in cropland and woodland pasture.

Table 1.9 Percentage change in grasslands/rangelands as classified by the National (NRI), Major Land Use (MLU) and US Census of Agriculture classifications of acreage pasture and range by state from 1982

	NRI	MLU	Census
Arizona	0.17	-2.54	-24.91
Arkansas	-5.53	-31.95	-2.56
California	-4.56	-1.05	-19.99
Colorado	-1.65	-1.17	-5.90
Idaho	-1.12	3.71	-24.44
Iowa	-22.49	-28.47	-9.46
Kansas	-3.25	-9.69	-0.16
Louisiana	3.47	-23.69	-1.50
Minnesota	-11.32	-8.58	-16.03
Missouri	-14.00	-8.10	5.72
Montana	-1.73	-4.87	-6.95
Nebraska	-2.64	2.81	6.52
Nevada	1.08	0.80	-38.96
New Mexico	-4.04	1.90	-3.11
North Dakota	-7.46	2.73	6.04
Oklahoma	-0.90	-5.88	1.58
Oregon	-2.99	1.74	-4.79
South Dakota	-6.59	-3.97	0.84
Texas	-1.58	-5.61	0.01
Utah	0.39	2.15	33.14
Washington	-3.18	-3.88	-1.68
Wyoming	0.17	-1.58	0.28
Total	-2.80	-2.31	-4.44

[1] Excludes pastureland that is classified in cropland and woodland pasture.

Table 1.10 Total surface water withdrawals and percent of total for states west of the Mississippi River, 1990 (Mgal/d – million gallons per day)

State	Surface water withdrawals, in Mgal/d	Percent of total withdrawals	State	Surface water withdrawals, in Mgal/d	Percent of total withdrawals
Arizona	3,830	58.3	Nebraska	4,147	46.4
Arkansas	3,128	39.9	Nevada	2,279	68.0
California	31,920	68.2	New Mexico	1,722	49.4
Colorado	9,915	78.0	North Dakota	2,535	94.7
Idaho	12,125	61.5	Oklahoma	760	45.7
Iowa	2,369	82.7	Oregon	7,661	90.9
Kansas	1,719	28.3	South Dakota	341	57.6
Louisiana	8,013	85.7	Texas	17,341	68.8
Minnesota	2,477	75.7	Utah	3,506	78.3
Missouri	6,203	89.5	Washington	6,493	81.7
Montana	9,098	97.7	Wyoming	7,199	94.7

Source: USGS

Table 1.11 Estimated average annual rates of change (percent increase or decrease) for grassland bird populations in the contiguous US for 1966-79, 1980-99, and 1966-1999.

Species	No. Routes [a]	Relative Abundance [b]	Trend Estimates [c] 1966-79	1980-99	1966-99
Grassland Endemics					
Ferruginous Hawk	176	0.3	5.4	2.9 *	3.4 ***
Mountain Plover	37	0.3	2.2	8.6 *	-0.9
Long-billed Curlew	183	1.4	2.3	-1.7	-1.5
Sprague's Pipit	37	0.7	-7.0 **	1.8	0.8
Cassin's Sparrow	224	15.8	0.5	-1.0 **	-2.3 ***
Lark Bunting	304	47.2	-3.5 *	-0.3	-2.7
Baird's Sparrow	52	1.8	-2.9	-3.3	-3.4 **
McCown's Longspur	39	2.0	2.3	6.7	5.4
Chestnut-collared Longspur	97	10.3	2.5	-2.9 *	-2.0
Widespread Grassland Associates					
Mississippi Kite	151	0.7	-0.2	-1.2	-0.3
Northern Harrier	676	0.5	-1.6	0.0	-0.6
Swainson's Hawk	508	0.8	-0.2	-0.4	0.0
Prairie Falcon	140	0.1	6.7 **	2.2	1.9
Sharp-tailed Grouse	77	0.8	0.9	-0.1	1.2
Greater Prairie-Chicken	33	1.0	16.0 ***	-5.3	1.1
Upland Sandpiper	447	2.7	2.6 **	-1.5 **	0.9 **
Burrowing Owl	271	0.6	-0.3	2.9	-0.7
Short-eared Owl	110	0.2	17.6	-1.9	-0.5
Horned Lark	1619	26.5	-0.4	-2.2 ***	-1.6 ***
Clay-colored Sparrow	226	3.0	-1.8 **	3.6 ***	0.6
Vesper Sparrow	1191	8.8	-1.4 **	-0.3	-1.1 ***
Lark Sparrow	974	4.5	-5.3 ***	-2.5 ***	-3.3 ***
Savannah Sparrow	1085	5.2	-1.0 *	0.4	-0.7 *
Grasshopper Sparrow	1362	4.7	-4.3 ***	-2.4 ***	-3.5 ***
Henslow's Sparrow	147	0.2	-5.7 **	-6.6 *	-7.8 ***
Dickcissel	826	15.1	-5.5 ***	0.2	-1.5 ***
Bobolink	871	5.1	-1.7 **	-1.3 **	-1.2 ***
Le Conte's Sparrow	53	0.5	-7.2	9.9 **	6.1 **
Sedge Wren	266	1.5	-3.3 **	1.7 *	2.6 ***
Eastern Meadowlark	1845	21.1	-1.6 ***	-3.1 ***	-2.8 ***
Western Meadowlark	1311	53.2	-1.2 *	-0.2	-0.5 **

Data Source : Breeding Bird Surveys (Sauer et al. 2000); designation of grassland birds follows Knopf (1996) with additions of grassland breeding birds from Sauer et al. (2000).

[a] Number of routes in which the respective species occurred during 1966-1999.

[b] Relative abundance expressed as an average number of individuals recorded per BBS route 1966-99.

[c] Statistical sigificance indicated by asterisks; * = P<0.10, ** = P<0.05, *** = P<0.01.

Table 1.12. Estimated annual rates of change in grassland bird populations in the contiguous US and in 16 grassland states, 1966-1999.

Species	State-level Trends [a]																US Trends [b]
	MN	WI	IL	IA	MO	ND	SD	NE	KS	OK	MT	WY	CO	TX	NM	ID	
No. Species [c]	13	13	10	8	7	19	13	12	9	8	18	11	12	9	7	7	31
Grassland Endemics																	
Ferruginous Hawk	.	.	.	.	.	.	.	.	.	.	**7.1**	.	.	.	.	.	**3.4** ***
Mountain Plover	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-0.9
Long-billed Curlew	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**6.6**	-1.5
Sprague's Pipit	.	.	.	.	.	.	.	.	.	.	**8.5**	.	.	.	.	.	0.8
Cassin's Sparrow	.	.	.	.	.	.	.	.	.	.	.	.	-5.4	-2.8	.	.	-2.3 ***
Lark Bunting	.	.	.	.	.	-4.2	.	.	.	.	**4.3**	.	-2.2	.	.	.	-2.7
Baird's Sparrow	.	.	.	.	.	-3.7	.	.	.	.	.	.	.	.	.	.	-3.4 **
McCown's Longspur	.	.	.	.	.	.	.	.	.	.	.	**9.3**	.	.	.	.	5.4
Chestnut-collared Longspur	.	.	.	.	.	.	-7.1	.	.	.	.	.	.	.	.	.	-2.0
Widespread Grassland Associates																	
Mississippi Kite	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-0.3
Northern Harrier	.	**2.1**	.	.	.	.	.	-8.0	-8.5	-15.3	.	.	.	.	.	.	-0.6
Swainson's Hawk	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.0
Prairie Falcon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.9
Sharp-tailed Grouse	.	.	.	.	.	**5.5**	.	.	.	.	.	.	.	.	.	.	1.2
Greater Prairie-Chicken	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.1
Upland Sandpiper	.	-3.3	.	.	.	**1.7**	.	**2.6**	**1.8**	.	.	**19.4**	.	.	.	.	**0.9** **
Burrowing Owl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-0.7
Short-eared Owl	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-0.5
Horned Lark	.	.	-0.8	.	-2.8	-2.2	.	.	.	.	-2.3	.	.	-3.2	-3.4	-4.3	-1.6 ***
Clay-colored Sparrow	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.6
Vesper Sparrow	-3.0	-4.4	.	-3.1	.	**2.2**	.	.	.	.	-1.5	.	**3.9**	.	-3.9	.	-1.1 ***
Lark Sparrow	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-3.3 ***
Savannah Sparrow	.	-1.7	-6.2	-3.5	.	.	.	.	.	.	**3.8**	.	.	.	.	.	-0.7 *
Grasshopper Sparrow	-7.2	-8.7	-6.8	-6.4	-2.0	-5.6	-3.4	.	-2.0	.	.	.	.	.	.	.	-3.5 ***
Henslow's Sparrow	.	-7.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	-7.8 ***
Dickcissel	.	-12.5	-3.4	.	-2.5	-9.2	.	.	.	1.2	.	.	.	.	.	.	-1.5 ***
Bobolink	.	-2.2	-9.5	-7.6	.	.	.	.	.	.	.	.	.	.	.	.	-1.2 ***
LeConte's Sparrow	.	.	.	.	.	**11.2**	.	.	.	.	.	.	.	.	.	.	6.1 **
Sedge Wren	**2.7**	.	.	.	.	**10.3**	.	.	.	.	.	.	.	.	.	.	2.6 ***
Eastern Meadowlark	-3.4	-2.3	-2.3	-1.2	.	.	.	-8.6	-2.3	-1.8	.	.	.	-2.3	-2.9	.	-2.8 ***
Western Meadowlark	-6.7	-9.0	.	.	.	.	.	-0.7	.	-1.5	.	.	.	.	.	-1.4	-0.5 **

Data Source: Breeding Bird Surveys (Sauer et al. 2000); designation of grassland birds follows Knopf (1996) with additions of grassland breeding birds from Sauer et al. (2000).

[a] Estimated annual rate of change (%); only those trends with a statistical significance of P<0.10 are listed; positive trends are highlighted and underlined for visual clarity.

[b] US trend estimates are expressed as an annual rate of change for the species throughout the entire US, which may include survey areas other than the states represented here. Statistical sigificance indicated by asterisks; * = P<0.10, ** = P<0.05, *** = P<0.01.

[c] Number of species recorded on more than 14 BBS routes.

Table 1.13 Participants in and expenditures for wildlife-related recreation by participants state of residents for states west of the Mississippi River, 1996

State	Expenditures ($1,000)	Number of participants (in 1,000s)	State	Expenditures ($1,000)	Number of participants (in 1,000s)
Arizona	1,413,052	1,210	Nebraska	559,407	539
Arkansas	1,448,640	890	Nevada	738,453	365
California	8,557,248	7,097	New Mexico	624,156	501
Colorado	2,184,869	1,535	North Dakota	309,954	190
Idaho	711,548	484	Oklahoma	1,392,587	1,199
Iowa	1,018,631	1,032	Oregon	2,052,441	1.260
Kansas	975,514	793	South Dakota	408,299	249
Louisiana	1,962,584	1,271	Texas	6,607,315	4,695
Minnesota	2,729,101	1,663	Utah	607,705	558
Missouri	2,206,154	1,888	Washington	2,008,190	1,908
Montana	432,824	394	Wyoming	349,390	192

Source: U.S. Fish and Wildlife Service

United States Grasslands and Related Resources: An Economic and Biological Trends Assessment

Chapter 2: What is happening to grasslands in the US?

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

The history of loss and degradation of grassland resources in the US can be attributed to several factors. The first, and most obvious of which, is the shear loss of grassland area experienced over the last 150 years. Driven largely by cyclic expansions of agriculture, the US has converted over 330 million acres of grasslands to other land uses. The most productive grassland systems have typically experienced a disproportionate loss, with some grassland types now only being represented in small reserves. Other grassland types remain relatively well represented, but the degraded ecological condition across much of what remains limits the economic and biological benefits these lands can provide. The ecological status of many existing grassland systems are heavily influenced at the local level by combinations of habitat fragmentation, undesirable habitat changes due to fire exclusion, declining range condition due to improper grazing management, and loss of habitat values due to the spread of invasive and non-native plants. Further complications arise from demographic trends related to changes in land ownership.

General grassland trends and ownership characteristics

Grassland area remaining

Accurate estimates of current grassland remaining in the US are difficult and elusive due to major differences in definitions of land cover and land use among the agencies responsible for collecting and reporting such information. The Major Land Use (MLU) data includes both private and federal land, except it also includes derived and/or non-native seeded pastures used primarily for grazing livestock. Thus, for states with relatively large areas in pasture the MLU acres clearly over-estimate the area of remaining native grasslands and under-estimate the proportion of potential grasslands remaining. Conversely, the NRI data includes only non-federal rangelands and for states with significant portions of grasslands under federal ownership would under-estimate the area of remaining native grasslands. Additionally, for all states, the acres currently reported as rangeland by the NRI include significant acreage that was not included in the range category in previous reports. Therefore, it is likely that the NRI rangeland acres represent a slight over-estimate of remaining grasslands, particularly for states with small amounts of federal lands.

Figure 2.1 and Table 2.1 compare the potential grassland acres to the 1997 acres reported for "grassland pasture and range" from the Major Land Use (MLU) reports and the 1997 acres reported for "non-federal rangelands" from the NRI for the 22 western states. Despite the discrepancies among the data, it is clear from Figure 2.1 and Table 2.1 that there are very little remnant native grasslands remaining in the states of Arkansas, Iowa, Louisiana, Minnesota, and Missouri. All of the other western states still have significant acreage of native grasslands remaining, most of which is under private ownership.

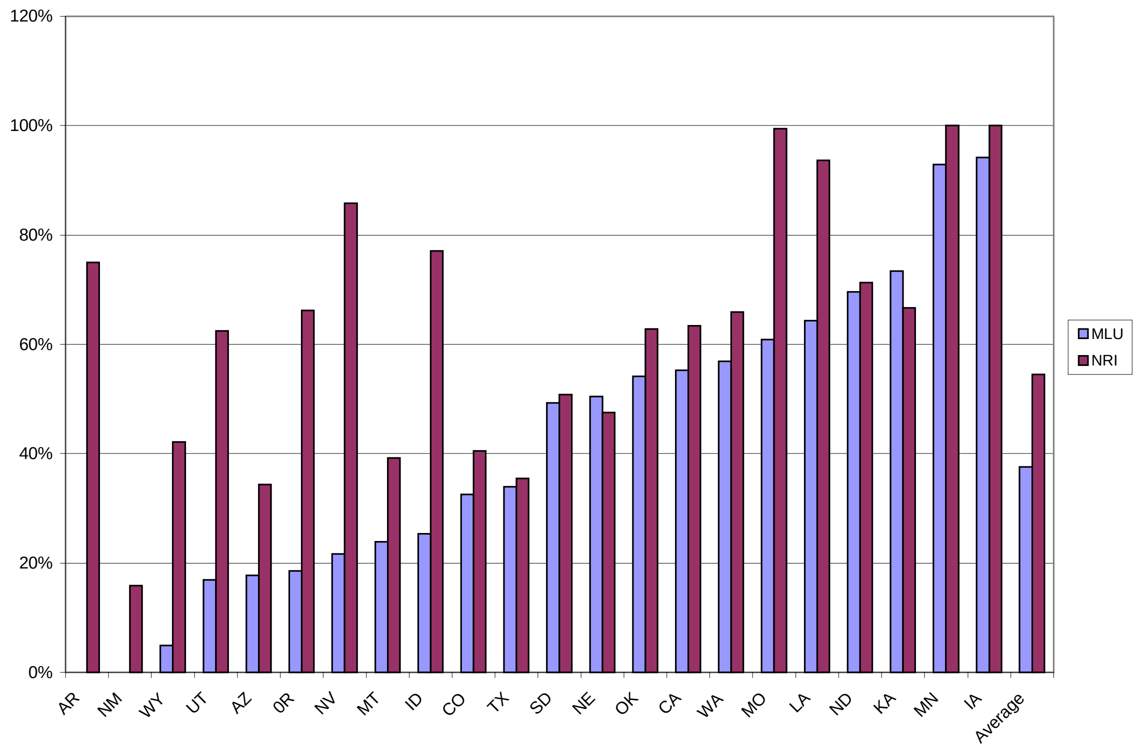

Figure 2. 1. Percent of potential grasslands lost as indicated by 1997 Major Land Use (MLU) report of grassland pasture and range and National Resources Inventory (NRI) report of non-federal rangelands for the 22 western states.

The National Resource Inventory (NRI) reports indicate significant decreases in "pastureland and rangeland" over the 15 years between 1982 and 1997 for the 22 western states. The 1997 MLU reports include 551 million acres of "grassland pasture and range" in the 22 states west of the Mississippi River. This is about 10 percent less than was reported for the same area in 1945.

Similarly, the US Census of Agriculture reports that "other pasture and rangeland" in the states west of the Mississippi River decreased from 415.6 to 380.4 million acres between 1978 and 1997. The Census of Agriculture statistics also excludes public lands, but only include those lands considered to be farms (i.e., greater than $1000 annual revenue).

Characterization of grasslands ownership

*Trends in the number and size of grazing based enterprises***. –** One of the interesting statistics that is available from the Census of Agriculture is the number of farms represented by acreage in other pastureland and rangeland (Table 2.2). For the 22 States examined, 370,068 farms had acreage in other pastureland and rangeland. This is down from the 406,657 farms reporting other pastureland and rangeland in 1978, a percentage change of –9.00. Number of acres in other pastureland and rangeland varied by state, with many of the western states having fewer farms but more acreage per farm. Texas not only had the most acreage in other pastureland and rangeland, but also had the most number of farms represented. Oklahoma, Kansas, Missouri and Nebraska were among the leaders in the number of farms reporting acreage in other pastureland and rangeland, none of which were leaders in the total number of acres reported. A general decline in the number of farms reporting acreage in other pastureland and rangeland occurred between 1978 and 1997.

*Current ownership characterization***-** The 1997 Agricultural Census for the 22 western states indicates that approximately 75% of the pasture and rangeland is in farms (or ranches) with $50,000 or more in annual product sales plus government payments (Figure 2.2) are classified as primarily beef cattle operations (Figure 2.3) and have operators whose primary occupation is farming (ranching) (Figure 2.4).

Approximately 80% of the pasture and rangeland in the 22 western states is in farms (ranches) whose owners are either sole proprietorships, partnerships, or family-held corporations (Figure 2.5) and are operated by persons over 45 years of age (Figure 2.6). Approximately 90% of the pasture and rangeland is in farms (ranches) containing 6,000 or more acres (Figure 2.7) and having operators who own either all or part of the land they operate (Figure 2.8).

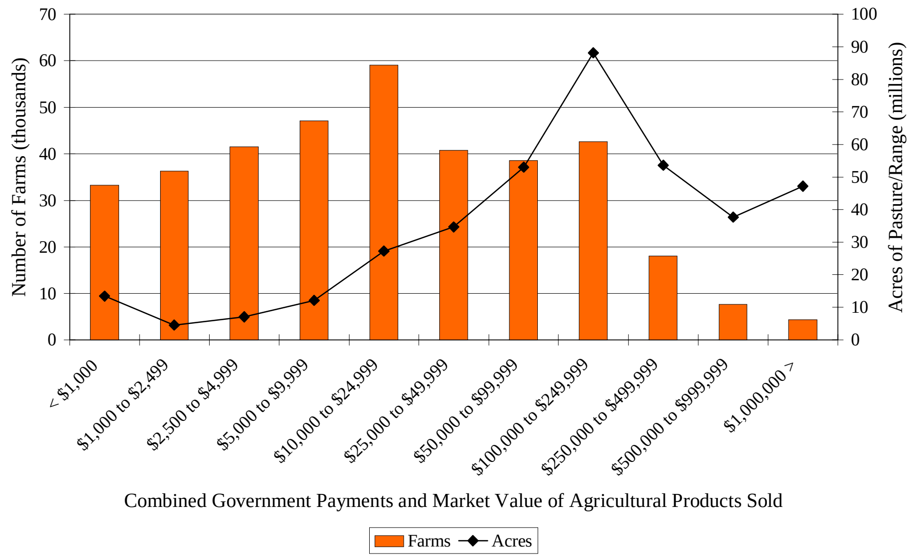

Figure 2. 2. Number of farms and acreage of pasture and range by annual product sales plus government payments category for the 22 states west of the Mississippi. (Source USDA Census of Agriculture, 1997).

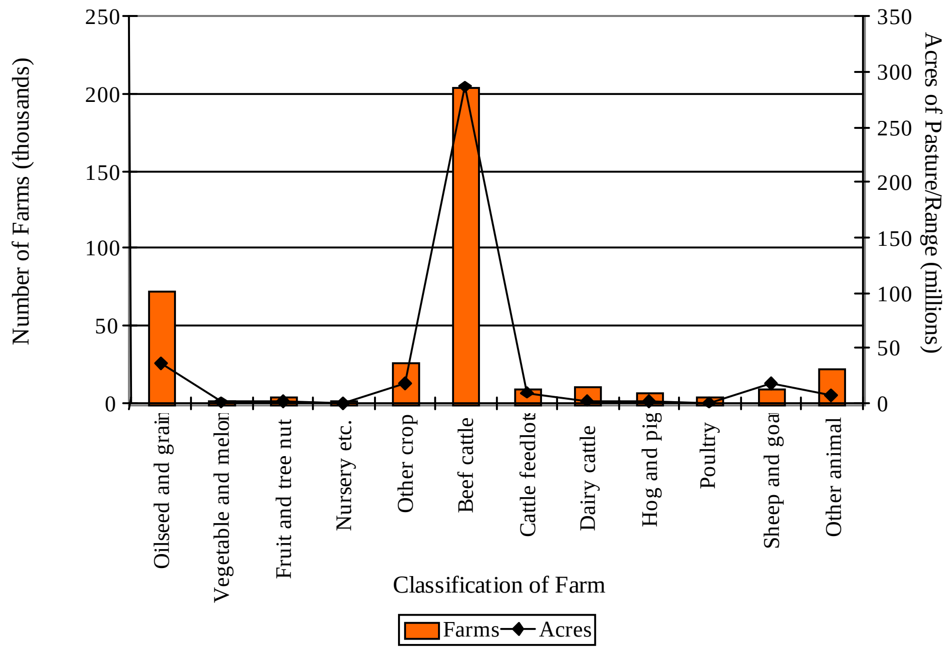

Figure 2. 3. Number of farms and acreage of pasture and range by classification of agricultural operations for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

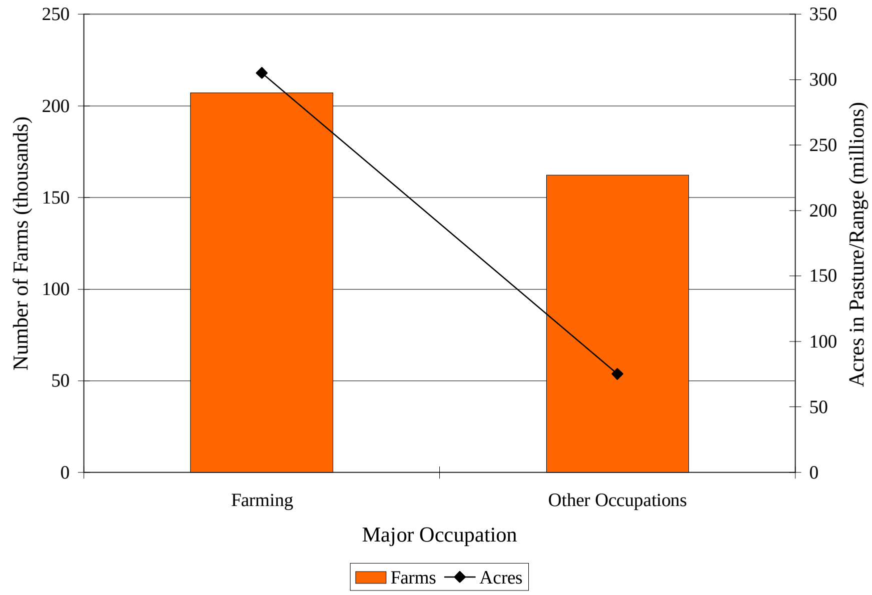

Figure 2. 4. Number of farms and acreage of pasture and range by major occupation category for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

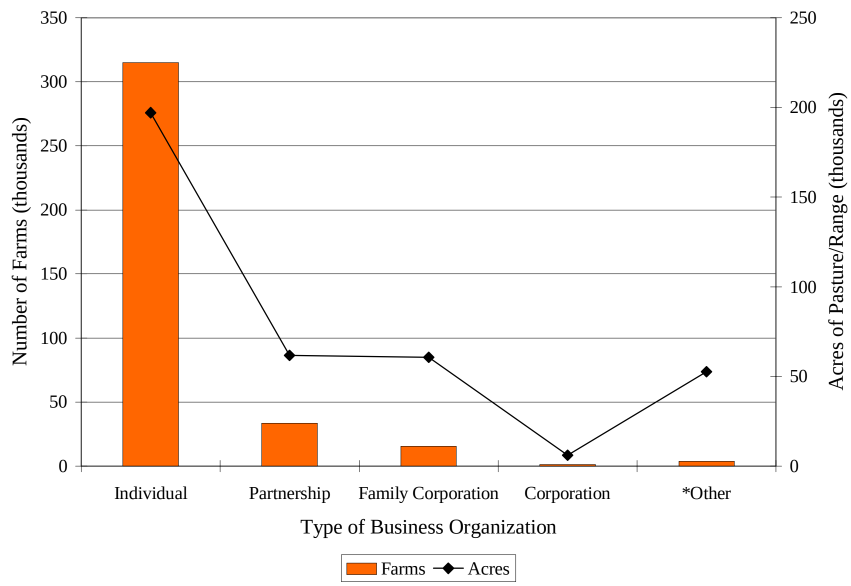

Figure 2. 5. Number of farms and acreage of pasture and range by type of business organization for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

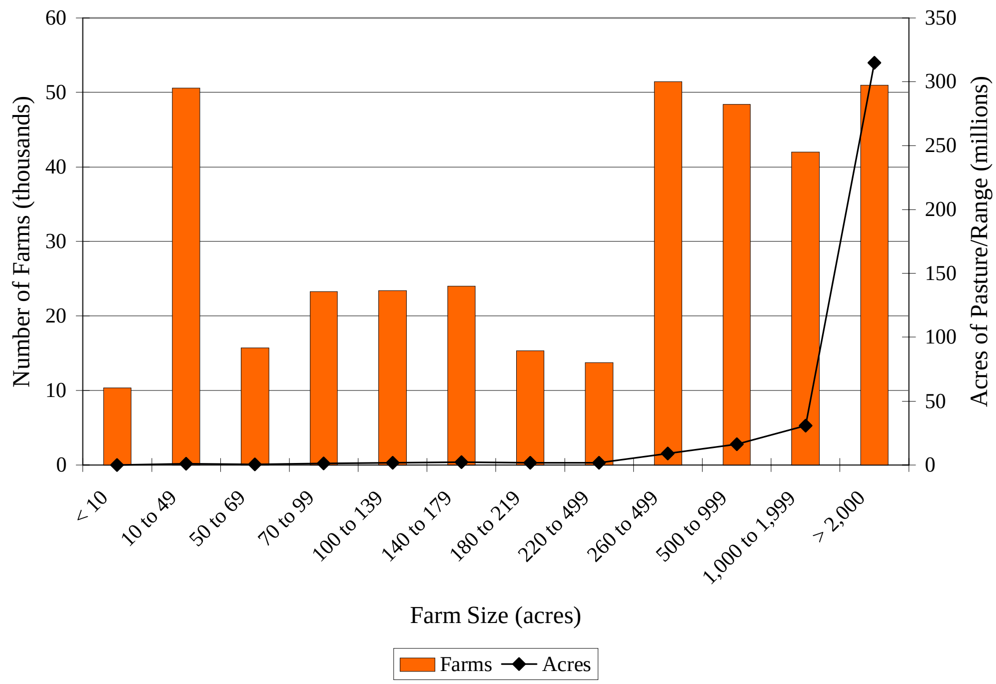

Figure 2. 6. Number of farms and acreage of pasture and range by size of farm for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

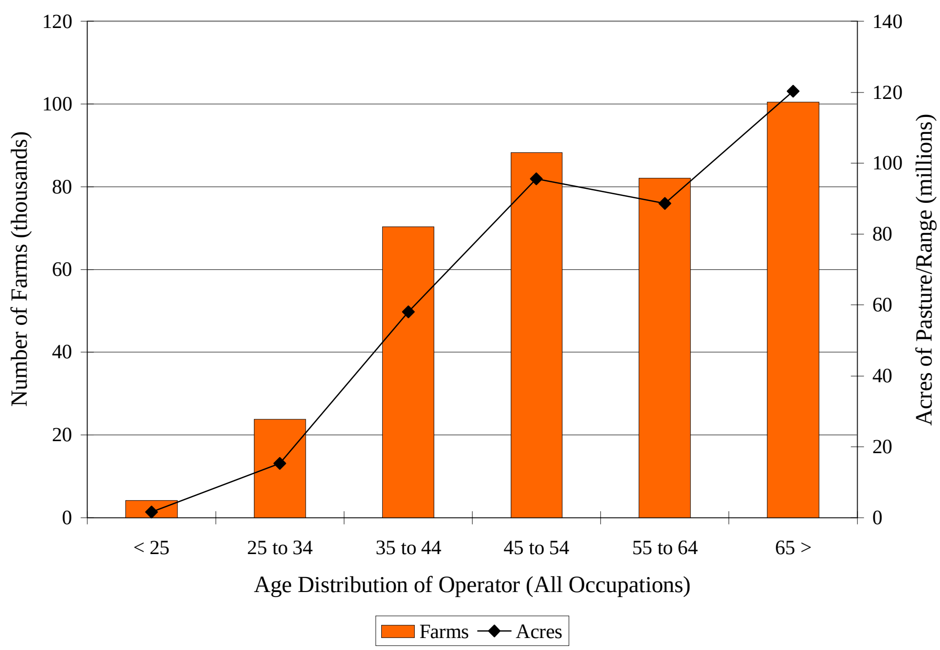

Figure 2. 7. Number of farms and acreage of pasture and range by age distribution of operator for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

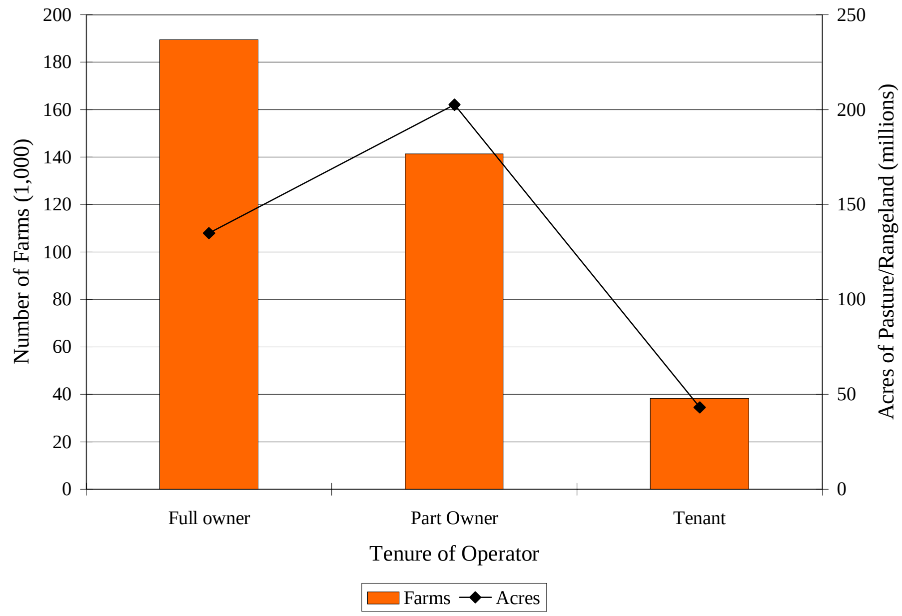

Figure 2. 8. Number of farms and acreage of pasture and range by tenure of operator for the 22 states west of the Mississippi (Source USDA Census of Agriculture, 1997).

Detailed grassland trends for Colorado, Idaho, Montana, North Dakota, South Dakota and Texas

In previous sections, it was established that approximately 50% of pre-settlement grasslands in the US have been converted to other land uses. While almost all parts of the US have experienced some loss of native grasslands, it is those states in the Central Plains that have sustained the largest losses. Within the Central Plains, the degree to which native grasslands have been lost increases from west to east. Some of the more easterly states have lost greater than 90% of their original grasslands (e.g., Minnesota and Iowa). Other States in the Central Plains yet retain a substantial portion of their original grasslands managed as pastureland and rangeland. Private farmers and ranchers manage most of these lands. In this section, we examine some of the economic and ecological trends in six such states: Colorado, Idaho, Montana, North Dakota, South Dakota and Texas. For these states, state-level summaries for farm and ranch ownership are in Table 2.3.

Colorado

Colorado's grasslands extended across approximately 41.34 million acres prior to settlement, about 64% of which was shortgrass prairie (Table 1.3, Figure 1.5). Colorado's native grasslands once accounted for approximately 21% of all shortgrass prairie in the US. Non-federal ownerships occupy about 61% of Colorado's 66.62 million acres of total land surface. Most federal ownerships are in the western half of the state – including most of Colorado's Western Grasslands. Most of the Colorado's remaining Central Plains' grasslands, including substantial acreage of short- and mixed-grass prairie, are in non-federal ownerships in the eastern one-half of the state (Figures 1.2 and 1.6).

Present status

As of 1997, approximately 25.79 million acres of Colorado's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of Colorado's nonfederal grazinglands, about 95% are native rangelands (NRI 2000, Table 2.4). These non-federal rangelands represent about 37% of the state's total land base, and approximately 61% of all non-federal rural land in the state (Figure 2.9). Private farms and ranches account for about 80% of all non-federal rural lands in the state; and the accounting of grazinglands on private farms and ranches represents approximately 77% of that reported for all non-federal grazinglands in the state (Tables 2.3 and 2.4). Grazinglands on farms and ranches account for 19.9 million acres, representing 61% of Colorado's total farm and ranch acreage and roughly 30% of the state's total land area.

Recent land use trends.

In the 15 years prior to 1997, Colorado lost about 1.35 million acres of its non-federal native rangeland (~5%), about 22% of which was transferred to federal ownership (Table 2.4). Of the remaining 1,052,900 acres, roughly 60% was converted to cultivated crops, with an additional 166,600 acres being lost to urban expansion. While urban expansion only accounted for about 10% of rangeland conversion, conversion of rangelands accounted for about 41% of the urban expansion.

About 870,100 acres that were not rangeland in 1982 were reclassified as native rangelands by 1997 – about 12% of which was transferred from federal ownership. Discounting federal lands, roughly 34% of this "new" native rangeland came from cultivated croplands; another 19% came from lands that were formerly classified as non-native pastures, while the remainder came largely from lands formerly classified as forestland. When considering the net change over the 15-year period, the result was a reduction of 479,500 acres of native rangeland in Colorado.

Regional distribution

The 29 Colorado counties east of the eastern edge of the Rockies contain one of the largest single remaining expanses of southern shortgrass prairie. The total grazinglands on farms and ranches in these counties exceeds 14.3 million acres, and represents roughly 70% of total farm and ranch grazinglands in the state (USDA Census of Agriculture). When all non-federal ownerships are considered, the major river drainages in eastern Colorado hold about 17.9 million acres of grazinglands, again representing approximately 70% of the total non-federal grazinglands in the state (Table 2.5 and Figure 2.10a).

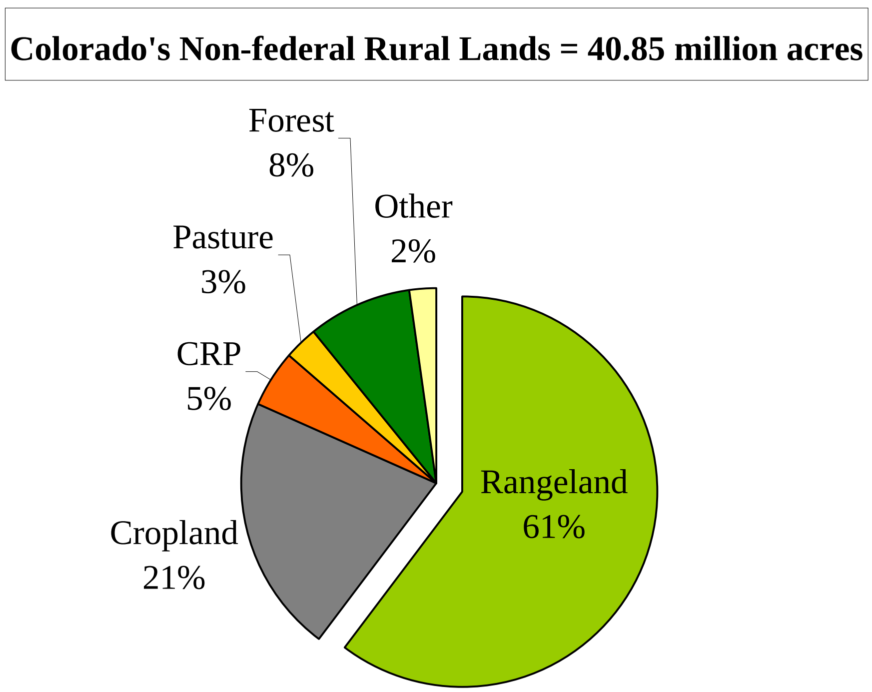

Figure 2. 9. Major land use classes for non-federal rural lands in Colorado, 1997 (Source: NRI, *Revised 2000).*

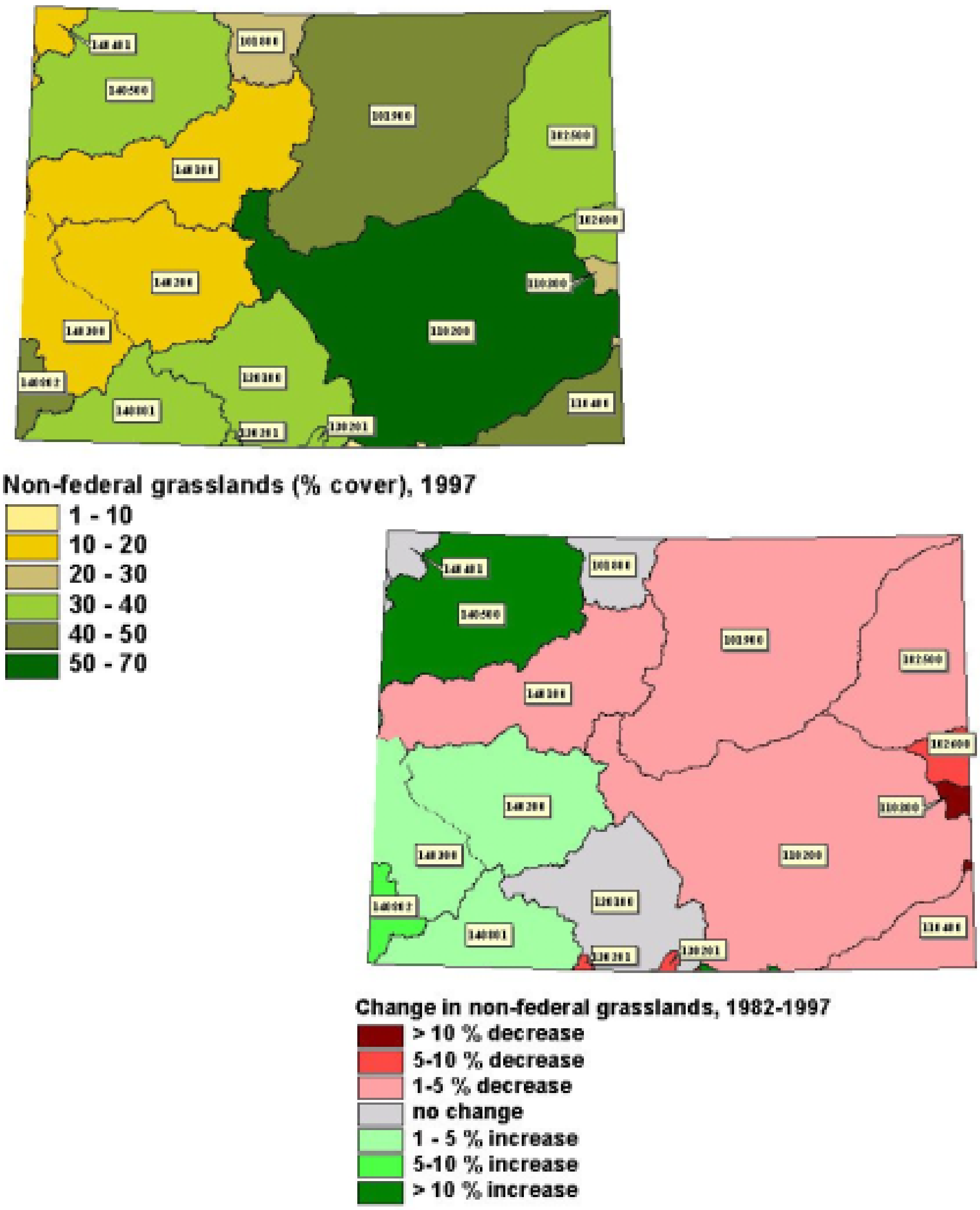

Figure 2. 10. For Colorado, (a) percent Land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. **NOTE:** *Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.3.* (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

From 1982 to 1997, those watersheds draining the short- and mixed-grass prairies of eastern Colorado experienced a cumulative loss of about 713,700 acres of grazinglands, representing a 3.8% net loss (Table 2.3). The greatest losses were in the South Platte and Upper Arkansas River drainages (Figure 2.10b). Meanwhile, those watersheds draining the Western grasslands experienced a cumulative gain of 280,500 acres of grazinglands, representing a 3.7% net gain. At the scale of large watersheds, the only substantial net loss of non-federal grazinglands across Colorado's Western Grasslands appeared in the Colorado Headwaters.

Trends in farm and ranch enterprises

According to the US Census of Agriculture, the total area of grazinglands on farms and ranches in Colorado declined by 5.9% from 1982 to 1997, while the number of grazingland based enterprises increased by about 9% (Table 2.3). The resulting change was a 13.7% decrease in average size of operation. These trends varied across the state according to the differences in the cumulative landowner response to economic pressures, demographics, and agricultural policies (see Chapter 3).

The actual rate at which grasslands were lost, gained, or experience a change in ownership is apparent at different scales of resolution. For example, between 1982 and 1997 the statewide change in non-federal grazinglands in Colorado suggests a net loss of only 1.6% (Table 2.4). When viewed in the perspective of changes across large river basins (Figure 2.10), it is apparent that most losses were generally focused in those basins east of the Continental Divide and in the Colorado Headwater basin (along the Interstate-70). However, when similar data are viewed at the county level, the variability among counties yields a different perspective. For example, in the Arkansas River basin, the adjacent counties of Pueblo and Las Animas experienced somewhat different fates with respect to grasslands. From 1982 to 1997, Pueblo County lost over 160,000 acres of grazinglands, while experiencing a 26% increase in the number of farms and ranches with grazinglands – the result was a 36% loss in average ownership size. In contrast, neighboring Las Animas County increased its grazinglands on farms and ranches by over 54,000 acres while remaining relatively stable in ownership numbers. Statewide and basin-level averages tend to mask these local dynamics[6].

[6] Because the county-level statistics from the USDA Census of Agriculture are somewhat variable in their reporting area, comparisons among years for individual counties are not as reliable as the cumulative statistics for the state or multi-county sub-regions.

Ecological status and trends

The continued loss of shortgrass prairie is among the most pressing ecological issues for native grasslands in Colorado. Based on remote sensing data, about 11.2 million acres of native short- and mixed-grass prairie remains in eastern Colorado; approximately 19% of which occurs on state and federal lands (EDAW 2000). This figure represents about 41% of the pre-settlement coverage by these grassland types. While much of this shortgrass prairie remains, much of what remains is of a different character and productivity than that which has been converted to cropland. Nevertheless, the remaining shortgrass prairie in Colorado continues to support important native plant and animal communities.

Many of the populations of endemic grassland birds that are typical of shortgrass prairies have shown declining trends. According to breeding bird surveys, grassland birds exhibiting the greatest declines in Colorado include Cassin's sparrow and the lark bunting (Table 1.12). Cassin's sparrow, for example, is threatened by continued degradation and loss of grassland habitats with a shrub component (Ruth 2000). In Colorado, Cassin's sparrows appear to have declined by an average of about 5.4% per year from 1966-1999 (Table 1.12). This is a more rapid decline than that documented for any other state in the species range.

As was discussed in previous sections, a substantial component of the loss of plant and animal diversity in short- and mixed-grass prairies may be related to declining prairie dog populations. A 2000 survey of prairie dog colonies in the grasslands of eastern Colorado established a database that included 5001 colonies across 314,114 acres (EDAW 2000). Of these, the 2000 field survey results suggest that about 52% were active, 28% were inactive or absent, and 20% were unknown. Once adjusted for sampling procedures, they estimated a minimum of 3,069 active colonies covered approximately 214,570 acres across the former range of the species in eastern Colorado. Active colony sizes ranged from 0.04 to 4,129 acres; with 92% of the colonies being <200 acres in size. The 214 prairie dog colonies >200 acres accounted for approximately 50% of the total known area in the state. Overall, these figures suggest that known prairie dog colonies in Colorado may occupy <3% of their current potential habitat, and <1% of their pre-settlement habitat. Also of interest was the fact that the rate of habitat occupancy (% of potential habitat with active towns) on private lands was virtually the same as that on public lands.

Idaho

Idaho's native grassland coverage extended across approximately 28.36 million acres prior to settlement, about 90% of which was Great Basin Shrub or Shrub/Steppe (Table 1.3, Figure 1.5). Relatively large areas of Great Basin Shrub and Shrub/Steppe remain intact across southern Idaho, much of this being under control of the BLM, Department of Defense, and other federal agencies. The one grassland type in Idaho that once occurred largely on private and other non-federal lands is the Palouse Prairie (a local subdivision of Great Plains Grasslands). Approximately 2.72 million acres of Palouse Prairie once occupied a landscape in west-central Idaho that has been converted largely to cultivated cropland.

Present status

As of 1997, approximately 7.82 million acres of Idaho's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of Idaho's nonfederal grazinglands, about 83% are native rangelands (Table 2.6). These non-federal rangelands represent about 12% of the state's total land base, and approximately 35% of all non-federal rural land in the state (Figure 2.11). Grazinglands on private farms and ranches account for about 58% of all non-federal grazinglands in the state (NRI 2000, USDA 1997, Tables 2.3 and 2.6). Farm and ranch grazinglands cover about 4.6 million acres, representing 39% of Idaho's total farm and ranch acreage, and roughly 8.6% of the state's total land area.

Recent land use trends

In the 15 years prior to 1997, Idaho lost about 396,200 acres of its non-federal native rangeland (~6 %), about 41% of which was transferred to federal ownership (Table 2.6). Of the remaining 232,400 acres, roughly 32% was placed under cultivation, with an additional 23,200 acres being lost to urban expansion. From 1982 to 1997, Idaho's urban areas increased by 94% (206,400 acres). In all, about 23,200 acres of native rangeland and 40,900 acres of pastureland were lost to urban expansion during this period.

About 271,700 acres that were not classified as non-federal native rangeland in 1982 were reclassified as non-federal native rangelands by 1997; most of which (64%) was native rangeland transferred from federal ownership. Discounting federal lands, roughly 32% of this "new" native rangeland came from cultivated croplands; another 21% came from lands that were formerly classified as non-native pastures, while the remainder came largely from lands formerly classified as forestland (29%). When considering the net change over the 15-year period, the result was a reduction of 124,500 acres of native rangeland on non-federal lands in Idaho. However, considering the fact that, statewide, over 190,000 acres was lost simply by transfer to federal lands (Table 2.4), it is difficult to determine from these figures whether or not the cumulative loss of grazinglands was significant over that period. In fact, the Major Land Use (MLU) classifications, that do include federal lands, suggest a statewide net gain of some 758,000 acres of grazinglands during that same period (Table 1.7). While the statewide total of 21.2 million acres of grazinglands according to MLU does represent a long-term decline of 4.6 million acres from its peak in 1954 (records are from 1945 to 1997), the most recent trends seems to suggest an increase of 3.7% from the 20.4 million acres of grassland pasture and range in 1982 (Table 1.7).

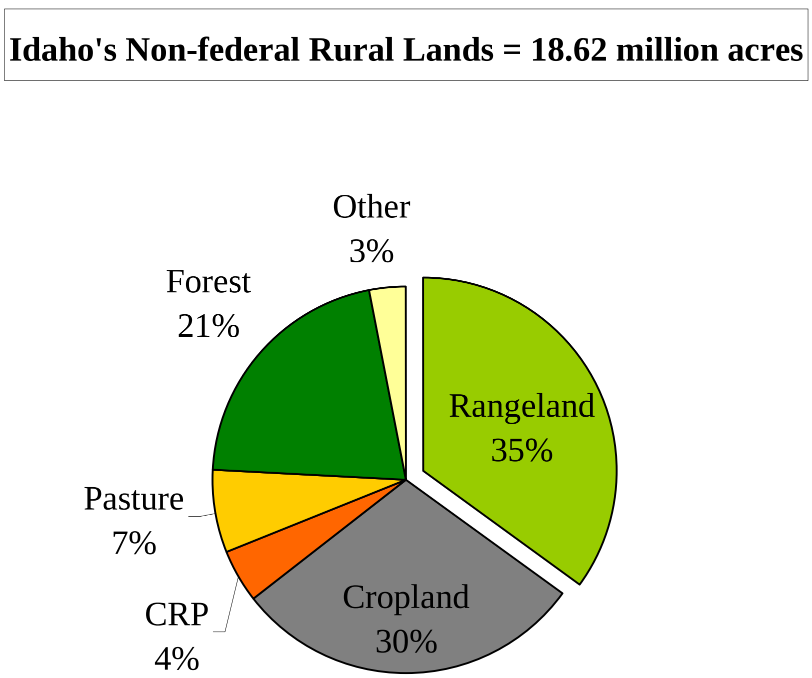

Figure 2. 11. Major land use classes for non-federal rural lands in Idaho, 1997 (Source: NRI, *Revised 2000).*

Regional distribution

The major concentration of Idaho's existing non-federal grazinglands are in the Great Basin Shrub/Steppe grassland types of the southern portion of the state (Figures 1.5 and 2.12a). These concentrations coincide with the Upper Snake and Lower Snake-Boise River drainages that together hold approximately 76% of Idaho's non-federal grazinglands (Table 2.5).

From 1982 to 1997, those watersheds draining Great Basin Shrub/Steppes of southern Idaho experienced a cumulative loss of 129,500 acres of non-federal grazinglands, representing a 1.9% net loss (Table 2.7 and Figure 2.12b). Again, given the overall figures, including federal land transfers, it is difficult to determine whether or not substantial acreages of non-federal grazinglands were actually lost. It is apparent, however, that river basins in the non-federal landscapes of west-central Idaho are now only sparsely covered by grazinglands – these areas once being dominated by the Palouse Prairie ecosystem.

Trends in farm and ranch enterprises

According to USDA Agricultural census data, Idaho's grasslands declined by 24.4% in the 15-year period from 1982 to 1997 (Table 2.1). Meanwhile, the number of grazingland based enterprises decreased by 3.4%, while decreasing in average size by 21.8% (Table 2.1).

Ecological status and trends

Idaho has the least non-federal grasslands of the 6 states highlighted in this report. Almost all of Idaho's Palouse Prairie has been converted to cropland, or is in such a degraded condition that it is not likely to provide much of its former ecological function. The remaining patches of Palouse Prairie are highly fragmented. Much of the grazing lands in the former area of Palouse Prairie have suffered from combinations of fire exclusion and overgrazing, resulting in invasion by cheatgrass (*Bromus tecturum*), a non-native annual grass of little ecological value, and marginal grazing value.

Most existing grasslands in Idaho are in the Great Basin Shrub/Steppe regions in the Snake River drainages. In its native condition, the vegetation of this arid region is often characterized by sagebrush (*Artemesia* spp.) dominated rangelands with varying levels of perennial bunchgrasses such as crested wheatgrass (*Agropyron* spp.) and Idaho fescue (*Festuca Idahoensis*). Elk and mule deer are economically valuable wildlife resources in this area; and these and other species depend upon maintenance of good rangeland conditions for their habitat needs.

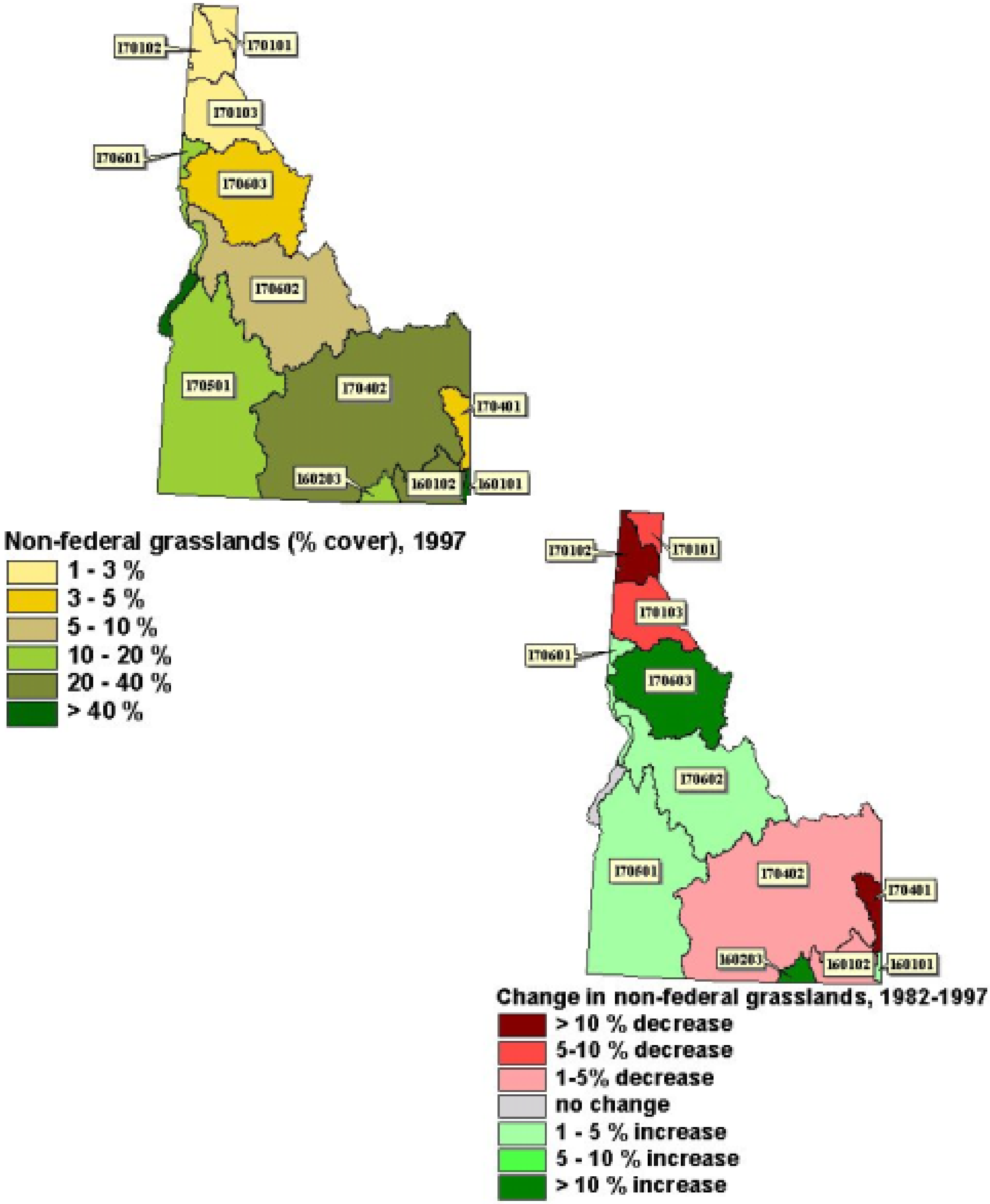

Figure 2. 12. For Idaho, (a) percent land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages**. NOTE:** *Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.5.* (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

Fire suppression and spread of exotic grasses are the major ecological issues on the Shrub Steppe habitats that remain as native grassland. In much of this area, fire exclusion and/or improper fire management, combined with overgrazing, has modified much of the shrub steppe vegetation. On many areas, former land management practices have resulted in reduced cover by native crested wheatgrass and Idaho fescue. As a result, cheatgrass and other invasive grasses tend to increase on these habitats, resulting in further ecological degradation. Other invasive weeds such as yellow starthistle, spotted knapweed, and rush skeletonweed are increasing rapidly on grasslands in southern Idaho. These species are not only detrimental to native wildlife habitats, but they reduce the overall usable plant productivity of these rangelands, and are arguably becoming the most alarming environmental issue in the state's grasslands.

The loss and degradation of sagebrush habitats in southern Idaho has contributed to the decline of sage grouse populations – an endemic to these habitats (Connelly *et al.* 2000). Breeding habitats for sage grouse have declined by at least 17-47% (Connelly and Braun 1997). If the effects of habitat loss, habitat fragmentation, and, habitat alterations cannot be managed, then this species may continue to decline in southern Idaho.

Montana

Montana's native grasslands extended across approximately 60.47 million acres prior to settlement, about 65% of which was shortgrass prairie (Table 1.3, Figure 1.5). Montana's grasslands once accounted for approximately 31% of all shortgrass prairie in the US – the largest concentration of any state. Other major pre-settlement grassland types included northern mixed-grass prairie (6.78 million acres), and Great Basin grasslands (11.16 million acres). About 30% of Montana's 94.11 million acres remain in federal ownership (Table 2.1); this located primarily in the forested regions of the Rocky Mountains and the Great Basin in the western third of the state (Figures 1.2 and 1.6).

Present status

As of 1997, approximately 40.19 million acres of Montana's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of Montana's nonfederal grazinglands, about 91% are native rangelands (Table 2.8). These non-federal rangelands represent about 39% of the state's total land base, and approximately 57% of all non-federal rural land in the state (Figure 2.13). Farming and ranching enterprises account for about 90% of all non-federal rural lands in the state; and the grazinglands on private farms and ranches account for about 94% of all non-federal grazinglands in the state (Tables 2.3 and 2.8). Grazinglands on farms and ranches account for 38 million acres, representing 65% of Montana's total farm and ranch acreage, and roughly 40% of the state's total land area.

Recent land use trends

In the 15 years prior to 1997, Montana lost about 1.55 million acres of its non-federal native rangeland (~4%), only about 2% of which was transferred to federal ownership (Table 2.8). Of the remaining 1,510,600 acres, about 48% was under cultivation by 1997. This figure is likely an underestimate of rangeland loss, given the fact that, another 145,000 acres of land that was classified as rangeland in 1982 was in the CRP in 1997. This suggests that some conversions of rangelands to cultivated cropland after 1982 were soon followed by entry of that land into a CRP contract. This further implies that one out of every 6 acres of rangeland converted to cultivated crops was subsequently judged as marginal cropland, and deferred under the CRP. About 52,900 acres of rangeland was lost to urban expansion.

About 472,500 acres that were not rangeland in 1982 were reclassified as native rangelands by 1997 – about 37% of which was transferred from federal ownership. Discounting federal lands, roughly 25% of this “new” native rangeland came from lands that were formerly classified as non-native pastures, and another 10% came from cultivated croplands. When considering the net change over the 15-year period, the result was a net reduction of 1,077,200 acres of native rangeland on non-federal lands in Montana. Given that, over this same period, there was an overall net loss of 2,356,000 acres of grazinglands when federal lands are also included (4.9% loss according to MLU estimates, Table 1.7), it appears likely that there was a substantial loss of non-federal grazinglands in Montana.

Regional distribution

The major concentration of Montana’s existing non-federal grazinglands is in the shortgrass prairie grassland type in the east-central portion of the state (Figure 2.14a). The non-federal grazinglands in the 8 river basins roughly corresponding to the pre-settlement distribution of shortgrass prairie account for almost 61% of Montana’s non-federal grazinglands (Figure 1.5 compared with Figure 2.14a). All but one of those river basins lost grazinglands from 1982 to 1997 (Figure 2.14b). The cumulative net loss across the shortgrass prairie region was over 500,000 acres during this period. However, the loss of native rangelands during this period was likely higher due to the increase of 368,400 acres of introduced pastureland (Table 2.8). This suggests a substantial loss of remaining shortgrass prairie, most of which appears to be converted to cultivated cropland.

The most substantial losses of non-federal grazinglands were in the Marias River Basin and Milk Watershed adjacent to the northern boundaries of the state. Statewide, only a single major drainage experienced a substantial net increase in non-federal grazinglands – that drainage being the Missouri

Headwaters in the extreme southwestern portion of the state.

Trends in farm and ranch enterprises

The total area of non-federal grazinglands on farms and ranches in Montana declined by 7% from 1982 to 1997, while the number of operations decreased by about 5.3% (Table 2.3). The result was an 11.7% decrease in the average grazingland-based farm and ranch operation.

Ecological status and trends

The majority of Montana continues to support native grasslands, and these grasslands support a varied wildlife resource. Montana continues to support the largest remaining expanses of shortgrass prairie in the US. However, because of recent conversions, the biological resources of shortgrass prairie in Montana may be at risk. Habitat fragmentation and the spread of invasive plants are locally important ecological issues in Montana.

Many of Montana's scenic rural areas are rapidly becoming developed, especially in the Great Basin grasslands of the Bitterroot Valley, Paradise Valley, and Gallatin Valley south of Bozeman. This ex-urban development has resulted in ownership fragmentation and shifts away from traditional land uses. The predictable result is habitat fragmentation, exotic plant introductions, and a related loss of much functional wildlife habitat.

According to US Fish and Wildlife Service estimates, Montana holds approximately 10% of the occupied habitat for black-tailed prairie dogs. The currently occupied 66,420 acres is about 1% of the former occupied habitat for the species (US Fish and Wildlife Service 2000). While this represents a substantial decline, the opportunities for gaining occupied habitat may be greater in Montana than elsewhere in the species range, simply due to the acreage of shortgrass prairie remaining.

Montana's breeding grassland bird fauna is the second richest of any other state (Table 1.12). Endemic grassland birds have not shown significant declines in Montana. In fact, 3 species – the ferruginous hawk, Sprague's pipit, and lark bunting – have shown promising significant increases during the period of 1966-1999 in the Breeding Bird Surveys in Montana (Table 1.12). Of these, the lark bunting has been declining elsewhere in its range.

As in other Western states, habitat degradation due to the spread of invasive plants is of concern across Montana's grasslands. In addition to ecological consequences, unchecked exotic plant invasions on native grasslands can have severe economic effects. For example, after arriving in Montana in 1920, spotted knapweed spread to over 4.7 million acres by 1988 (Invasive Plants Handbook, http://www.denix.osd.mil). The economic loss from spotted knapweed in Montana is now estimated at $42 million annually. Losses to leafy spurge infestations in Montana cost ranchers $2.2 million.

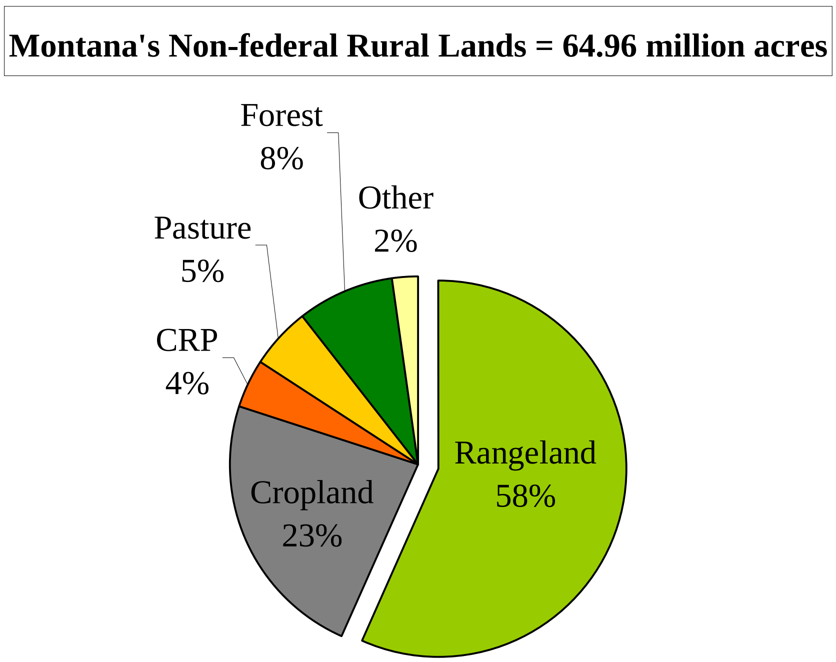

Figure 2. 13. Major land use classes for non-federal rural lands in Montana, 1997 (Source: NRI, *Revised 2000*).

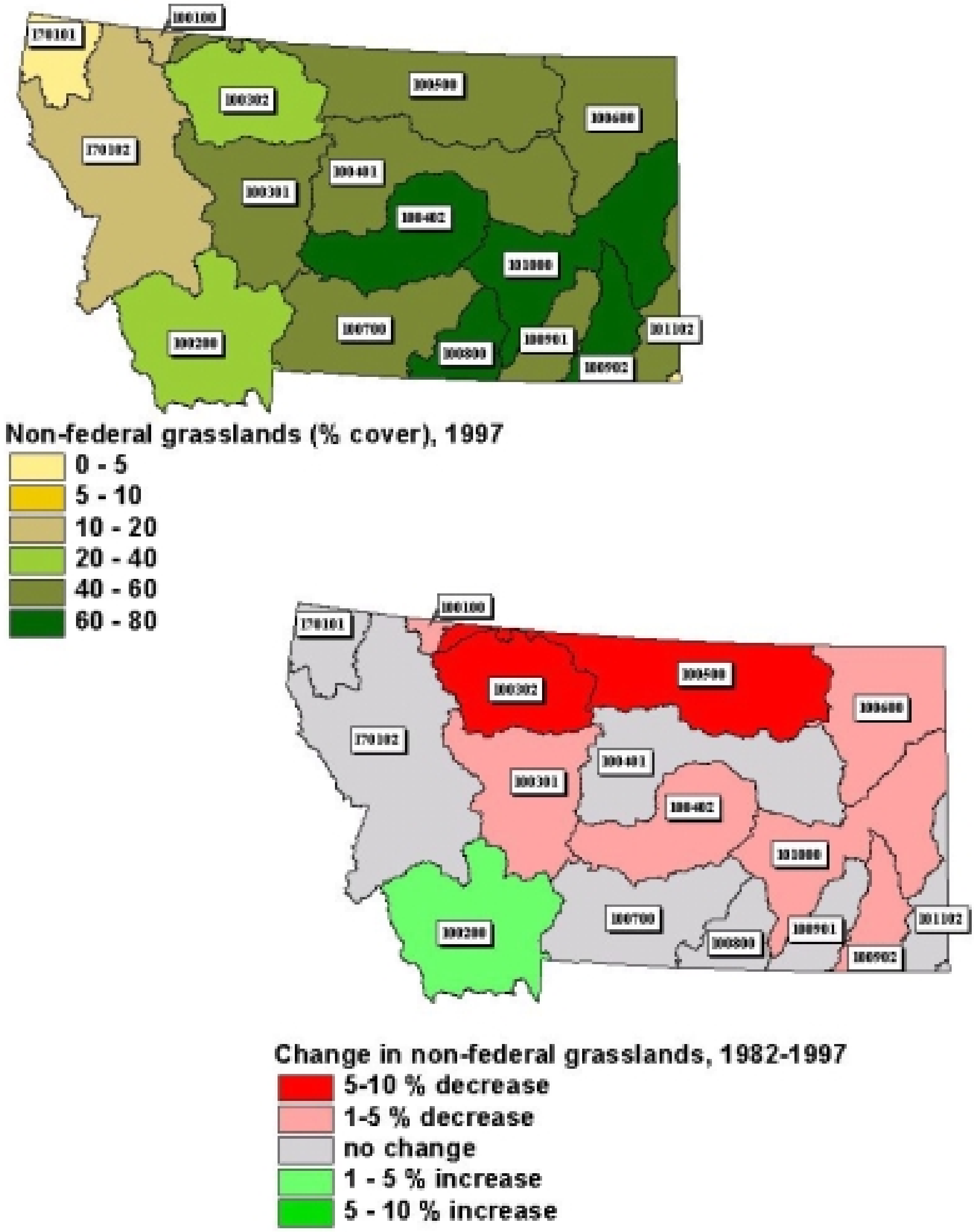

Figure 2. 14. For Montana, (a) percent land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. **NOTE**: *Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.7.* (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

North Dakota

North Dakota's native grasslands extended across approximately 37.31 million acres prior to settlement, about 88% of which was northern mixed-grass prairie (Table 1.3, Figure 1.5). North Dakota's grasslands once accounted for approximately 35% of all northern mixed-grass prairie in the US – second only to South Dakota. Other major pre-settlement grassland types included about 3.3 million acres of tallgrass prairie adjacent to the state's eastern border with Minnesota. Only 3.8% of North Dakota's 45.25 million acres remain in federal ownership, much of which is National Grasslands along the western border with Montana.

Present status

As of 1997, approximately 11.81 million acres of North Dakota's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of North Dakota's non-federal grazinglands, about 90% are native rangelands (Table 2.10). These non-federal rangelands represent about 23% of the state's total land base, and approximately 26% of all non-federal rural land in the state (Figure 2.15). The grazinglands reported for on private farms and ranches account for about 91% of all non-federal grazinglands in the state (Tables 2.3 and 2.10). Grazinglands on farms and ranches account for 10.8 million acres, some 26% of North Dakota's non-federal rural lands.

Recent land use trends

In the 15 years prior to 1997, North Dakota lost about 1.1 million acres of its non-federal native rangeland (~9.5%), only about 2% of which was transferred to federal ownership (Table 2.8, Figure 2.15b). Of that native rangeland loss, about 70% was a conversion to cropland, 46% being under cultivation by 1997. In all, about 1.16 million acres of North Dakota's non-federal grazinglands (including pastureland) were converted to cropland between 1982 and 1997. In the mean time, about 2.8 million acres were deferred from crop production under the CRP. This implies that about 41% of the acreage that was deferred from cropping under CRP in North Dakota may have simply been replaced by breaking-out grazinglands, the majority of which (64%) were native rangelands. This dynamic begs the question of to whether or not conversions of native grasslands to croplands were indirectly accelerated by the deferments of the CRP.

Urban expansion in North Dakota increased urban lands by only 19%, being relatively stagnant in comparison to other states. A little more than 16,000 acres of North Dakota's grazinglands were converted to urban use from 1982 to 1997.

About 293,400 acres that were not rangeland in 1982 were reclassified as native rangelands by 1997 –

only about 3% of which was transferred from federal ownership. Roughly 50% of this "new" native rangeland came from lands that were formerly classified as cropland. Another 31% came from non-native pastures. When considering the change over the 15-year period, the result was a net reduction of 791,800 acres of native rangeland on non-federal lands in North Dakota.

Regional distribution

North Dakota's existing non-federal grazinglands increase along the transition from the northeast to the southwest (Figure 2.16a). The former tallgrass prairies along the eastern portion of the state have experienced the greatest losses – the non-federal grazinglands in those areas now covering less than 10% of the land. The largest concentrations of nonfederal grazinglands are in the southwestern portion of the state where substantial acreage of northern mixed-grass prairie remains.

From 1982 to 1997, all 12 major watersheds (hydrologic units) in North Dakota experienced a net loss in grazinglands (Figure 2.16b). On a percentage basis, the loss of grazinglands uniformly followed the same gradient of grazingland cover. In other words, those drainages with the least to lose lost the most. In the 2 Red River drainages in the easternmost part of the state, for example, the total acreage of grazingland represents less than 5% of North Dakota's total; but, the Red River basin coincides with most of the area formerly dominated by tallgrass prairie. Over 102,000 acres in the Red River basin was recently converted from grazinglands to other land use, primarily cropland. This represents a loss of almost 20% of the grazinglands of the tallgrass prairie in North Dakota. One of the largest concentrated losses of grazinglands was in the Lake Oahe drainage in the south-central portion of the state where over 185,000 acres of grazingands were recently converted to croplands.

Trends in farm and ranch enterprises

The total area of grazinglands on farms and ranches recorded by the USDA Census of Agriculture actually increased by 6% from 1982 to 1997. However, when compared with the 1978 census, the area of grazinglands appears to have decreased by 4%. The number of farms and ranches with grazinglands declined by about 7%. The result was a 14% increase in the average area of grazinglands on farms and ranches.

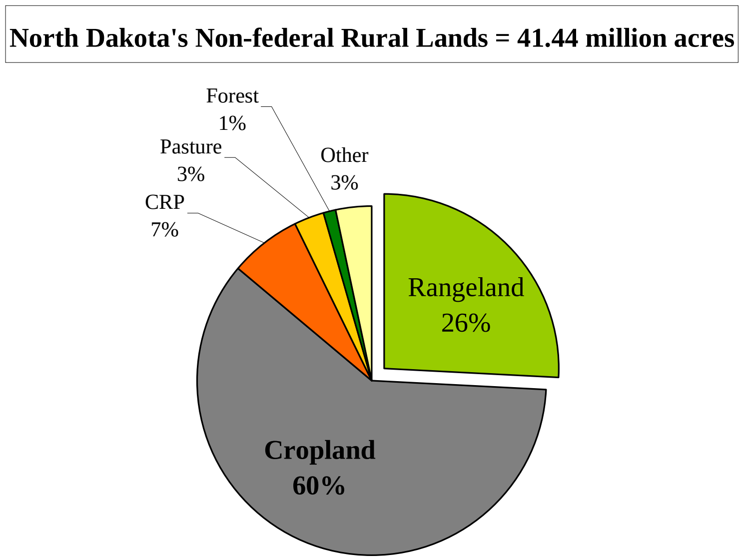

Figure 2. 15a. Major land use classes for non-federal rural lands in North Dakota, 1997 (Source: NRI, *Revised 2000*).

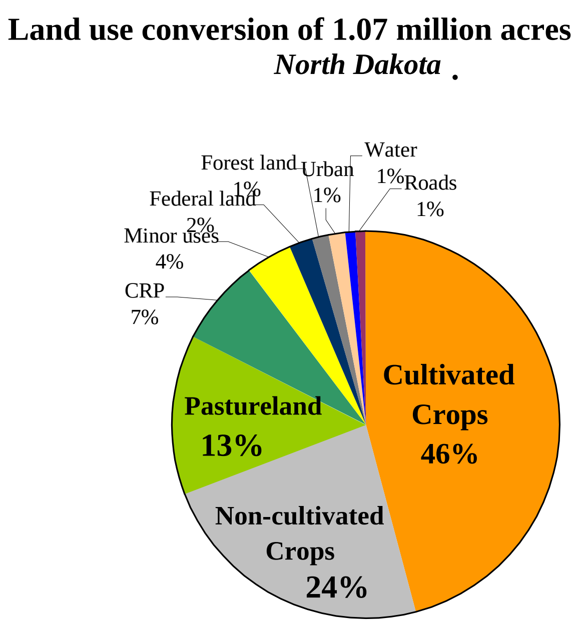

Figure 2. 15b. Land use conversion of non-federal native rangelands in North Dakota, 1982-1997

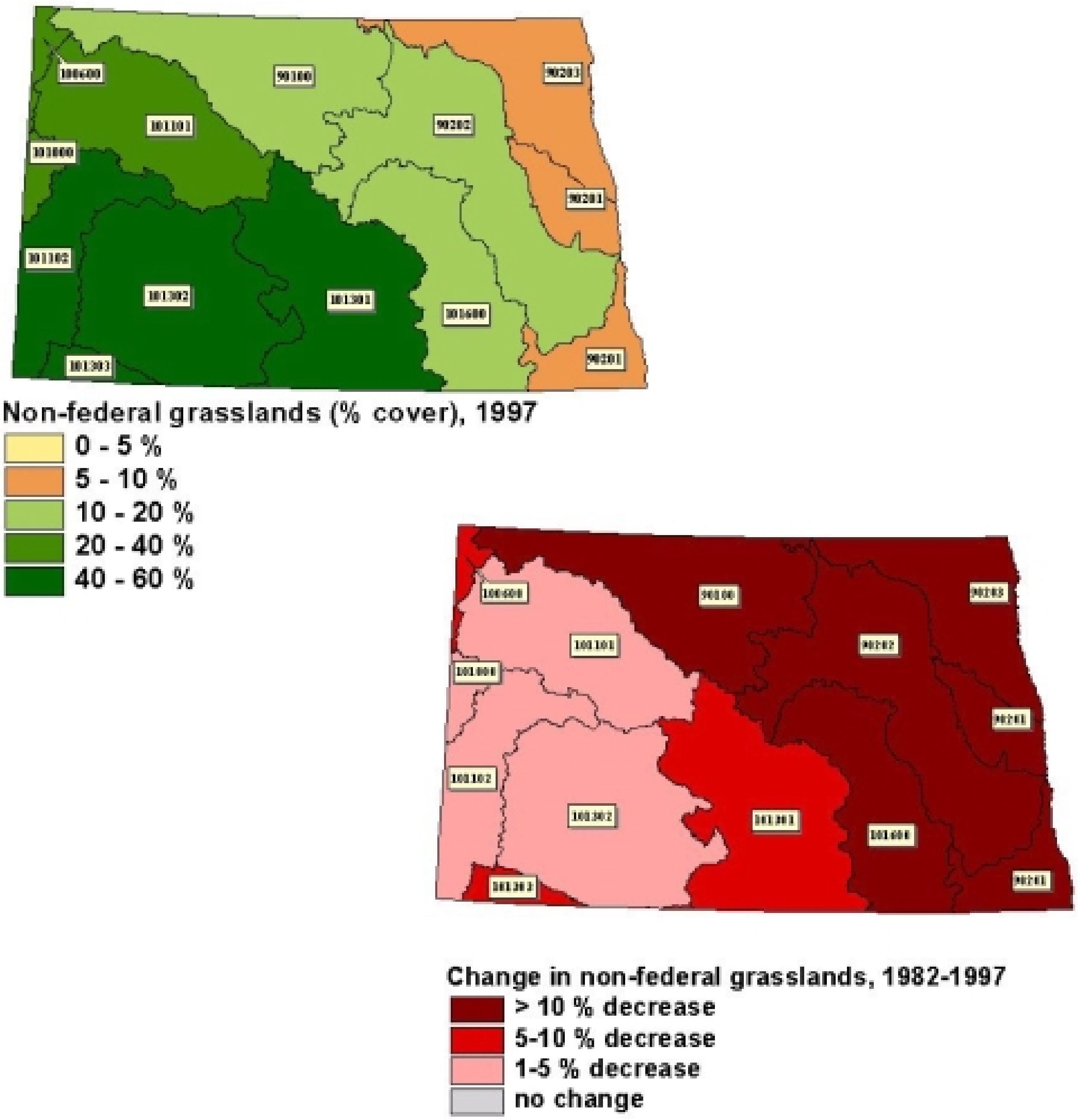

Figure 2. 16. For North Dakota, (a) percent land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. **NOTE:** ***Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.9***. (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

Ecological status and trends

As North Dakota has recently continued to lose grasslands throughout the state, many grassland-associated species will likely continue a trend downward. In general, the most recent grassland losses have been concentrated in the eastern and northeastern half of the state (Figure 2.16). These losses are concentrated in the prairie pothole region, an area of extreme importance for the waterfowl resource of North America. As such, one of the most pressing grassland issues in North Dakota is the continued loss and degradation of these complex grassland and wetland landscapes. Within the US, North Dakota has the largest area of this prairie pothole region.

The prairie pothole region produces about 50-80% of North America's supply of major species of ducks; and is the primary production area for ducks in the Central and Mississippi flyways (Batt *et al.* 1989, Smith 1995). During the 10 years between 1986 and 1995, the prairie pothole region supported an annual average of approximately 15 million breeding ducks – although subject to some annual variability due to drought conditions, these numbers were about 16% lower than the 40 year average from 1955-1995 (Smith 1995). Nesting success in the prairie potholes of North and South Dakota is often too low to maintain stable populations for several species; including mallards, northern pintails, gadwalls, northern shovelers and blue-wing teal (Shaffer and Newton 1995). The cause of these declines is complex, but is ultimately associated with the conversion of grasslands to cultivated croplands and the other land use changes associated with intensively managed agricultural landscapes.

Predation is the major factor leading to waterfowl nesting failures in the prairie potholes (Sovada *et al.* 2001). This predation appears to be a direct result of land use conversions of grassland to cultivated cropland. Predation on waterfowl increases as the proportion of grassland in a prairie landscape decreases, such that waterfowl nesting success in the prairie pothole region is correlated with the amount of grassland remaining in the landscape (Greenwood *et al.* 1995). Because of this, the protection and restoration of grasslands in this part of North Dakota, and in other portions of the prairie pothole region, is probably the highest priority action needed for stabilizing waterfowl production in North America (Sovada *et al.* 2001). While the trend data for species other than waterfowl are not as readily available, it is safe to assume that many of the other species that depend on the grassland—wetland complex of the prairie potholes of North Dakota are impacted similar to waterfowl.

The grasslands of North Dakota are also important areas for breeding populations of several endemic grassland birds. One species in particular, Baird's sparrow has the peak of its breeding distribution in

North Dakota (Dechant *et al.* 2001). Native prairie is optimal breeding habitat for Baird's sparrow. During the period from 1966 to 1999, Breeding Bird Survey records indicate that Baird's sparrow experienced one of the most drastic declines of any endemic grassland bird in the US; decreasing at an average rate of 3.4% per year (Table 1.11). This species seems to depend upon large expanses of native prairie with minimal shrub cover (Dechant *et al.* 2001). This species also suffers from the vegetative conditions resulting from a lack of periodic fire (Madden *et al.* 1999). Using Baird's sparrow as an indicator species, it appears that the condition of North Dakota's native grasslands may not only be suffering from an overall loss in grassland area, but also from increased fragmentation and habitat changes resulting from fire exclusion.

The spread of non-native invasive plants has reduced the habitat capability of much of North Dakota's remaining grasslands. For example, leafy spurge (*Euphorbia esula*), an aggressive rangeland invader, now occupies several million acres in North Dakota and elsewhere in the northern Great Plains. When a grassland area becomes infested with leafy spurge it has reduced wildlife habitat values and loses native plant diversity. In addition, livestock forage consumption is negatively impacted. When grasslands are fragmented by other land uses and subjected to unmanaged grazing, they are more likely to become infested by leafy spurge, or one or more of several other invasive plants. In addition to the ecological damage caused by invasive plants, the economic damage can be substantial. For leafy spurge alone, the cost in terms of production losses, control expenses, and other impacts to the economy exceeds $144 million per year in the Dakotas, Montana and Wyoming (USDA/APHIS 2000). Well-managed, and un-fragmented, grassland systems are less likely to incur these costs.

South Dakota

South Dakota's native grasslands extended across approximately 44.51 million acres prior to settlement, about 82% of which was northern mixed-grass prairie (Table 1.3, Figure 1.5). South Dakota's grasslands once accounted for approximately 38% of all northern mixed-grass prairie in the US – the largest concentration of any state. Other major pre-settlement grassland types included about 7.39 million acres of tallgrass prairie adjacent to the state's eastern border with Minnesota and Iowa. Only 6.3% of South Dakota's 49.36 million acres are under federal ownership, much of which is National Grasslands in the western portion of the state.

Present status

As of 1997, approximately 23.98 million acres of South Dakota's non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of South Dakota's non-federal grazinglands, about 91% are native rangelands (Table 2.12). These non-federal rangelands represent about 44% of the state's total land base, and approximately 49% of all non-federal rural land in the state (Figure 2.17). The grazinglands reported on private farms and ranches account for about 98% of all non-federal grazinglands in the state (Tables 2.3 and 2.12). Grazinglands on farms and ranches account for 23.59 million acres, representing 57% of South Dakota's non-federal rural lands. According to preliminary results from a remote sensing analysis, South Dakota's native grasslands currently occupy approximately 18.9 million acres, representing about 38% of the state (Smith *et al.* Unpublished data from South Dakota GAP Analysis Project).

Recent land use trends

In the 15 years prior to 1997, South Dakota lost about 1.23 million acres of its non-federal native rangeland (~5.3%), only about 3% of which was transferred to federal ownership (Table 2.10). Of that native rangeland loss, about 68% was a conversion to cropland, 46% (632.2 acres) being under cultivation by 1997. This pattern was almost identical in scale to the overall loss and conversion of native rangelands in North Dakota. In all, about 1.82 million acres of South Dakota's non-federal grazinglands (including pastureland) were converted to cropland (including non-cultivated cropland) between 1982 and 1997. In the mean time, about 1.69 million acres were deferred from crop production under the CRP. The conversion of grazinglands to cultivated croplands offset about 74% of the acreage that was deferred under CRP during this period – over half of those grazinglands were in native rangeland in 1982. As was the case with North Dakota, this suggests that some of the conservation benefits derived from CRP deferments may have been offset by sod-busting of range and pastureland.

South Dakota experienced only a 4.4% net decline in cultivated cropland over the period of 1982 to 1997; this being somewhat different than the national average of 13.2% (NRI 2000). In fact, in the 5 years from 1982 to 1987, South Dakota was the only state in the nation to have a substantial increase in cultivated cropland (494,000 acre increase). In comparison, Montana – a state with a similar acreage of cultivated cropland in 1982 – reduced cultivated croplands by about 777,000 acres between 1982-87. . Urban lands in South Dakota increased moderately (105,300 acre increase) representing a 44% expansion from 1982.

About 142,700 acres of South Dakota that was not rangeland in 1982 was reclassified as native rangeland by 1997 – only about 6% of which was transferred from federal ownership. About 26% of this "new" native rangeland came from cropland, and 37% came from lands formerly in non-native pasture. When considering change from 1982 to 1997, the net result was a reduction of 1,089,000 acres of native rangeland on non-federal lands in South Dakota.

Regional distribution

South Dakota's existing non-federal grazinglands increase along the transition from the eastern to western portion of the state (Figure 2.18a). The previous tallgrass prairies along the eastern portion of the state have experienced the greatest losses – the non-federal grazinglands in those areas now covering less than 20% of the land. The largest concentrations of nonfederal grazinglands are in the western portion of the state where substantial acreage of northern mixed-grass prairie remains.

From 1982 to 1997, all 14 major watersheds (hydrologic units) in South Dakota experienced a net loss in grazinglands (Figure 2.18b). The watersheds draining the extreme eastern border of the state had the least cover by grazinglands and experienced the most dramatic recent losses on percentage basis. This is of importance as this area along the western extreme of the tallgrass prairies, very few of which remain. In the 4 basins roughly coinciding with the former range of tallgrass prairie, experienced a loss of grazinglands of about 271,500 acres in the period from 1982 to 1997. This represents a loss of 16.7% of the grazinglands of the tallgrass prairie in South Dakota. One of the largest concentrated losses of grazinglands in South Dakota was in the James River Basin of the east-central portion of the state. Over 500,000 acres of grazinglands were converted to other uses in the James River Basin – this represents a 14.5% loss of grazinglands and accounts for over 30% of the entire loss of grazinglands for the state.

Trends in farm and ranch enterprises

In South Dakota, the total area of grazinglands on farms and ranches recorded by the USDA Census of Agriculture remained relatively stable from 1982 to 1997 (Table 2.1). However, when compared with the 1978 census, the area of grazinglands appears to have decreased by 2.5%. The number of South Dakota's grazingland-based farms and ranches declined by about 8.7% during 1982-1997. The overall result was a 10.5% increase in the average area of grazinglands on farms and ranches.

Ecological status and trends

While South Dakota has experienced recent losses in grassland area across the state, it is the tallgrass prairies and mixed-grass prairies in the eastern portion of the state that received the most concentrated conversions of grasslands. The shortgrass prairies in the western portion of the state remain relatively intact. While comparing figure 2.15a to figure 2.18a, it is apparent that grasslands remaining in South Dakota are somewhat greater than those in North Dakota, both states have experienced very similar patterns of recent land use conversions (Figures 2.15b and 2.18b).

Much of the recent losses in South Dakota's grasslands correspond regionally to the southern tip of the prairie pothole region of the eastern one-third of the state. The conversion of this grassland—wetland complex to cultivated croplands has the same negative impacts on waterfowl and associated biological resources as have been experienced in North Dakota (see previous section on North Dakota).

The black-tailed prairie dog historically occupied the western three-fourths of South Dakota (Hall and Kelson 1959:364-366), accounting for about 8% of the species range in the US. South Dakota currently holds approximately 147,000 acres of occupied habitat, accounting for about 22% of the currently occupied habitat in the US (US Fish and Wildlife Service 2000). Although the occupied habitat in South Dakota has declined by as much as 92% from historic levels, the state's current grassland area occupied by prairie dogs represents a significant proportion of the remaining prairie dog population in the US. From this perspective, the conservation of South Dakota's remaining prairie habitats is of national interest.

The chestnut-collared longspur is an endemic grassland bird with much of its breeding habitat in the short- and mixed-grass prairies of central South Dakota. Optimal breeding habitat for this species includes level to rolling mixed-grass and shortgrass uplands with sparse shrubby cover; and in drier habitats, they prefer moist lowlands (Dechant *et al.* 2000). In general, their habitats are enhanced by periodic fire. According to Breeding Bird Surveys, the populations of chestnut collared longspurs in South Dakota declined by about 7.1% per year in the period from 1966 to 1999 (Table 1.12). Range wide, most of the specie's decline appears to have occurred during the 20 year period from 1980 to 1999. These declines likely reflect the results of an overall decrease in its prairie habitat combined with degradation in the condition of existing habitat.

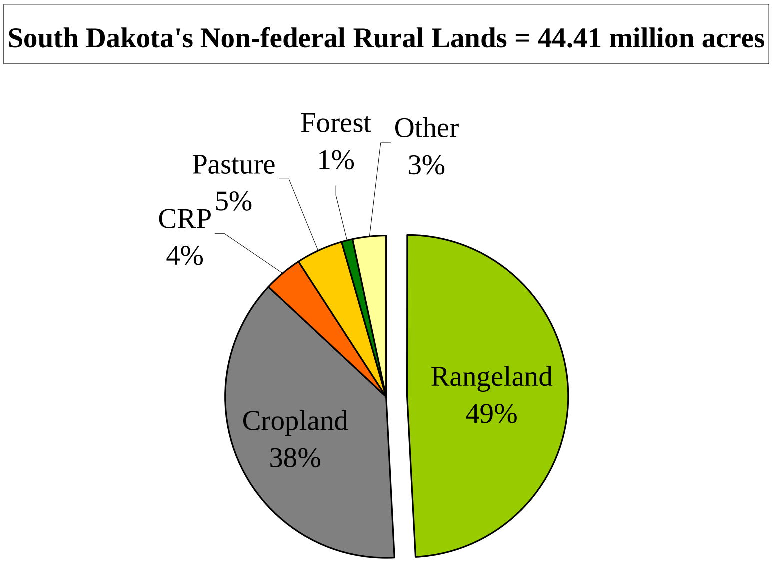

Figure 2. 17a. Major land use classes for non-federal rural lands in South Dakota, 1997 (Source: NRI, Revised 2000).

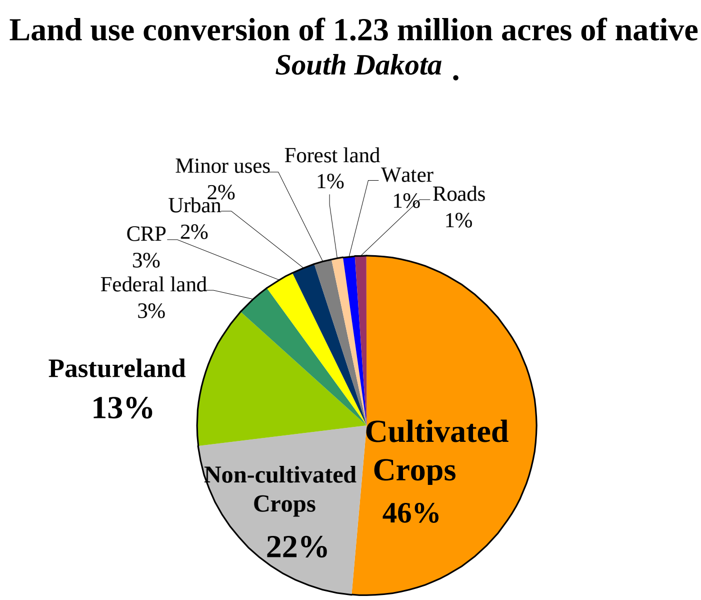

Figure 2. 17b. Major land use classes for non-federal rural lands in South Dakota, 1997 (Source: NRI, Revised 2000).

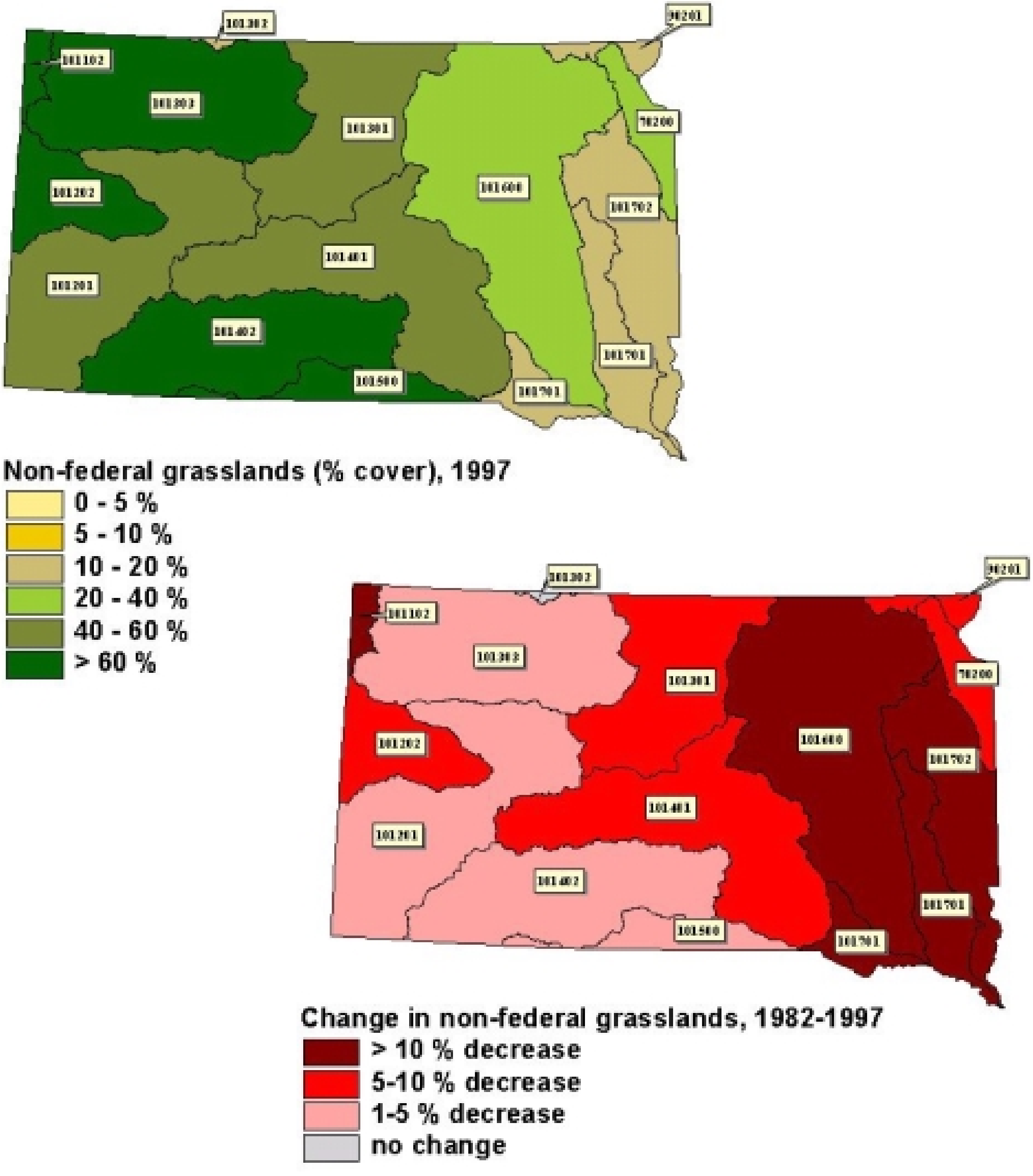

Figure 2. 18. For South Dakota, (a) percent land cover by non-federal rangeland and pasture, and (b) change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. NOTE: *Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.9.* (Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

Texas

Texas' native grasslands extended across approximately 148.3 million acres prior to settlement (Table 1.3 and Figure 1.5). Texas' grasslands once accounted for almost 17% of the entire US pre-settlement grassland coverage. Texas' pre-settlement grasslands represented 11 different grassland types, representing the majority of the nation's post oak savanna, coastal prairie, and desert savanna grassland types (Figure 1.5). Central Plains grassland types once accounted for approximately 84.52 million acres in Texas; and Western Grassland types covered approximately 63.81 million acres of the state. All grassland types of the Central Plains are represented in Texas, as well as 5 of the 9 Western Grassland types (Figure 1.5).

Federal lands in Texas account for roughly 4% of the total land area, and are concentrated in the forested regions in the eastern part of the state. Federal landholdings in grassland regions include Fort Hood in Central Texas, Big Bend National Park in West Texas and scattered parcels of National grasslands in north-central Texas and the Panhandle.

Present status

As of 1997, approximately 111.66 million acres of Texas' non-federal lands were in native rangeland or introduced pasture grasses (grazinglands). Of Texas' nonfederal grazinglands, about 86% are native rangelands (Table 2.14). These non-federal rangelands represent about 56% of the state's total land base, and approximately 62% of all non-federal rural land in the state (Figure 2.19). The grazinglands on private farms and ranches account for about 77% of all non-federal grazinglands in the state (Tables 2.3 and 2.14). According to the USDA Census of Agriculture, grazinglands on commercial farm and ranch enterprises account for 86 million acres, and roughly 50% of the state's total land area.

Recent land use trends

In the 15 years prior to 1997, Texas lost about 3.6 million acres of its non-federal native rangeland (~4%), about 99,600 acres of which were transferred to federal ownership (Table 2.14). Of that native rangeland loss, about 27% was converted to cultivated cropland; about 26% was converted to non-native pasture; and about 23% was lost to urban expansion (Table 2.14). In all, about 1.59 million acres of Texas' grazinglands (including pastureland) were converted to cultivated cropland between 1982 and 1997. In the mean time, about 3.91 million acres were deferred from crop production under the CRP. The conversion of grazinglands to cultivated croplands offset about 41% of the acreage that was deferred under CRP during this period – about 62% of those grazinglands were in native rangeland in 1982.

About 3.01 million acres that were not rangeland in 1982 were reclassified as native rangelands by 1997 – about 37% of which was transferred from federal ownership. Roughly 45% of this "new" native rangeland came from lands that were under cultivation in 1982; and about 46% was previously classified as non-native pastures. When considering the net change over the 15-year period, the result was a net reduction of only 598,200 acres of native rangeland. During this same period there was a 19% decrease in cultivated croplands in Texas.

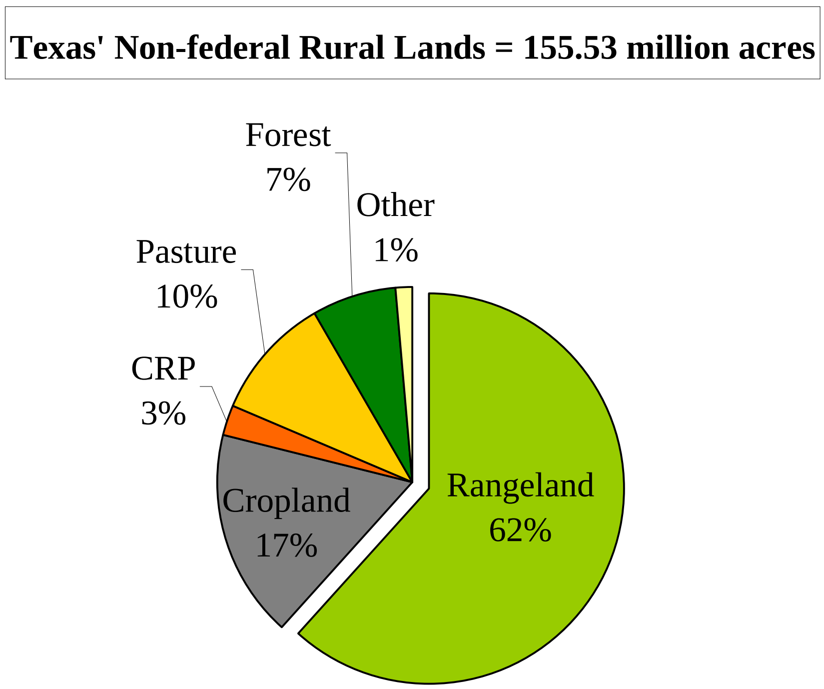

Figure 2. 19. Major land use classes for non-federal rural lands in Texas, 1997 (Source: NRI, *Revised 2000*).

Regional distribution

The major concentration of Texas' existing non-federal grazinglands are in West Texas and along the Rio Grande Valley in South Texas (Figure 2.20a). Other substantial concentrations are in the shortgrass prairies of the southern plains (upper panhandle), and in the savannas of central and south-central Texas.

Overall, the coverage by grazinglands in Texas is shifting from the more populated eastern portions of the state to the less populated areas to the west and north (Figure 2.20a). From 1982 to 1997, the regions experiencing the greatest declines in grazinglands were in the eastern portion of the state, including the Blackland Prairies and Post Oak Savanna grassland types (Figure 2.20b). Other areas that experienced declining grazingland acreage in Texas included the extreme southern portions of the state, the grasslands of central Texas and the shortgrass prairie region in the panhandle. The only areas experiencing a substantial increase in grazinglands were the Red-Pease, Brazos Headwaters, and Red-Lake Texoma Basins in north Texas; and the San Bernard Coastal, Lavaca River, and Guadalupe River Basins along the central Texas coast (Figure 2.20b, Table 2.15).

Trends in farm and ranch enterprises

The total area of non-federal grazinglands on farms and ranches in Texas remained relatively stable when considering the 1982 versus the 1997 Census of Agriculture (Table 2.1). The number of grazingland-based farm and ranch enterprises increased by 8.2% during this period. The result was a 7.6% decrease in the average grazingland-based farm and ranch operation. However, the most dramatic changes in farm and ranch enterprises seem to have occurred more recently. When comparing the size class distributions of Texas' farm and ranches in the 5-year period from 1992 to 1997, it is apparent that most counties in Texas experienced dramatic increases in the smaller operations (i.e., those <500 acres). About 55% of Texas counties experience losses in mid-sized ownerships (500-2000 acres), and 48% of the counties gained numbers of larger ownerships (those >2000 acres). The net effect over that 5-year period was a decline in average ownership size in 74% of Texas' counties; as well as a polarization of ownership sizes (Wilkins *et al.* 2000). In other words, Texas is losing mid-sized (500-2000 acre) farm and ranch enterprises while gaining in both smaller and larger ownerships.

Ecological status and trends

The grasslands of Texas cover the most area, and are the most ecologically diverse of any state in the nation. Thus, the ecological status of grasslands in Texas is highly variable depending upon the region of the state. Those areas of the state having received the greatest recent losses in grassland area correspond with the Blackland Prairies, Post Oak Savannas and the Savannas of the Edwards plateau (Figure 2.20b).

These are the same areas that have received the most recent ownership fragmentation pressures (Wilkins *et al.* 2000).

In addition to cropland conversions, native grasslands in Texas have been adversely impacted by urban expansion, ownership and habitat fragmentation, conversions to introduced pasture grasses, and the long-term changes in habitats that result from fire exclusion and improper grazing management. As a result, much of the state's existing native grasslands have been invaded by woody vegetation – both native and non-native. In fact, in many areas of the state, the invasion and increase in woody vegetation is likely reducing surface and underground water yields (Bednarz *et al.* 2000). The management of woody vegetation for wildlife needs, livestock production, and water yield is an issue of major ecological importance in Texas.

In Texas, as in other states, the trends of endemic grassland species have tended to reflect the overall loss and/or degradation of native grassland habitats. One of the most evident species in this regard is the federally endangered Attwater's prairie chicken, endemic to the Coastal Prairie. Approximately 6 million acres of Coastal Prairie once supported a healthy population of prairie chickens (Campbell 1995). Since 1930, conversion to rice cultivation, urban sprawl, introduction of improved pasture grasses, and declining range conditions associated with continuous grazing has reduced the suitable habitat for this species to about 200,000 acres – approximately 3% of its former range (Campbell 1995). On those grasslands remaining in the Coastal Prairie, the invasion of native woody species such as mesquite (*Prosopis glandulosa*) and huisache (*Acacia farnesiana*); and introduced invaders such as Chinese tallowtree (*Sapium sebiferum*) and Macartney rose (*Rosa bracteata*), have changed the structure and function of the habitat such that it no longer supports many of the wildlife species endemic to the area, including the Attwater's prairie chicken.

The same general trends have led to the demise of other grassland endemics elsewhere in the state. For example, in the savanna grasslands of the Edwards Plateau of central Texas, fire exclusion, overgrazing, and broad-scale brush control efforts have contributed to the development of habitats that no longer support populations of the Endangered black-capped vireo (Campbell 1995). Worsening this situation is the increase of nest parasitism from brown-headed cowbirds associated with grain fields and concentrated livestock operations. For this, and other species, managers have determined that selective control of juniper, combined with prescribed fire, and rotational grazing management, harvest management of white-tailed deer, and cowbird trapping can result in local recovery (Armstrong 2000).

Elsewhere in Texas, the trends are similar to those examples given above. The species involved tend to vary from one grassland type to another; but the overall dynamics related to combinations of ownership fragmentation, land use changes, heavy continuous grazing, fire exclusion, and the introduction of non-native species (including Brazilian fire ants) has resulted in habitat modifications across vast areas of former grasslands. At times the reaction to these habitat changes have taken the form of large-scale brush eradication projects followed by the establishment of non-native grasses. In many cases, these actions have actually worsened the habitat conditions for many native species. Owing to the fact that most of Texas is privately owned and much of the state remains in native rangelands (about 62%, Figure 2.18), the future of much of the state's biological resources will depend upon how native grasslands are managed from this point forward. The most successful management actions seem to be those that mimic natural processes, and focus on restoring native habitats.

Summary

Chapter 1 provided arguments supporting the contention that grasslands were historically and are currently of great ecological and economic importance to the United States. Chapter 2 focused on the ecological status and land use trends of grasslands in the United States. Information regarding the historical extent and distribution of grasslands relative to their current status were explored and grassland ownership patterns were discussed at the national level. These features of US grasslands were then explored for 6 important and distinct grassland states: Colorado, Idaho, Montana, North Dakota, South Dakota and Texas. Chapter 3 will further explore the similarities and distinctions between the drivers of grassland use and change in the United States, in the 6 focus states, and in 17 case studies of particular counties within these focus states.

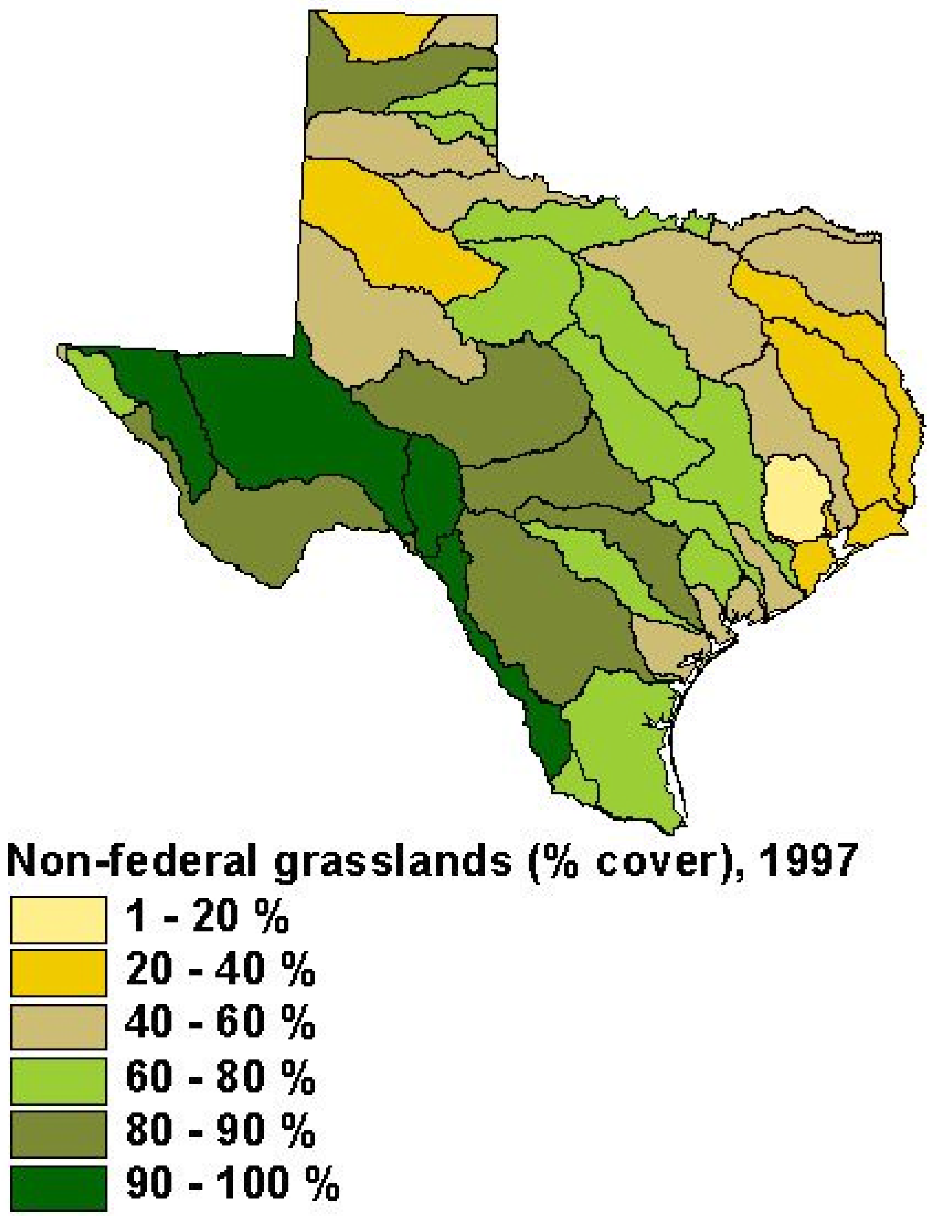

Figure 2. 20a. For Texas, percent Land cover by non-federal rangeland and pasture. Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

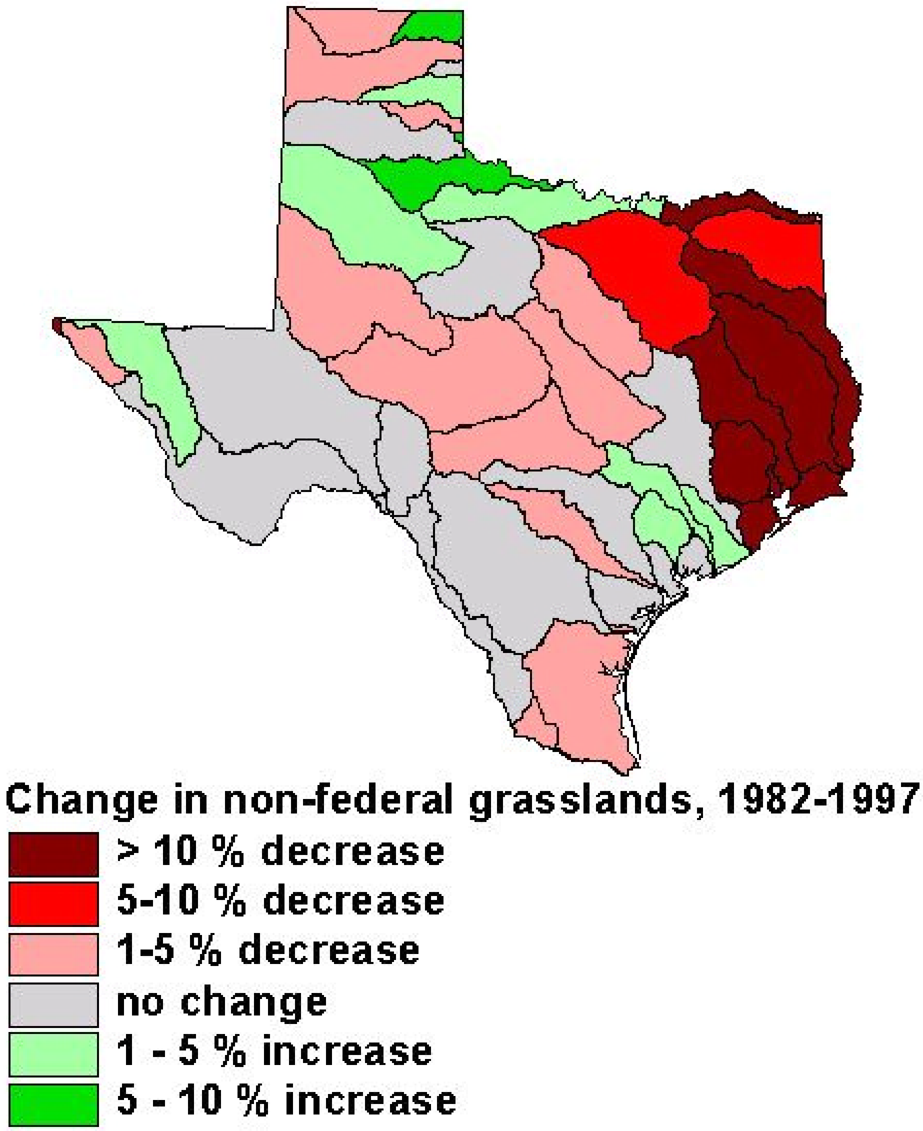

Figure 2. 20b. For Texas, change in cover of non-federal rangeland and pasture from 1982 to 1997, by major river drainages. Source: USDA /NRCS Natural Resources Inventory, unpublished data from NRI state coordinator).

Figure 2. 20c. River basin boundaries and Six-digit labels for each drainage correspond to the hydrologic unit codes in Table 2.13.

Table 2.1. Acres of potential grasslands compared to 1997 estimates of grassland pasture and range from MLU and non-federal rangeland from NRI for the 22 western states.

State	AZ	AR	CA	CO	ID	IA	KA	LA	MN	MO	MT	NE	NV	NM
						………1,000,000 acres………								
Potential Grasslands (Table 1.3)	49.26	0.16	49.96	41.34	28.36	25.45	47.18	4.43	21.86	15.36	60.47	44.05	59.07	47.55
Grassland Pasture and Range (MLU-1997)	40.51	2.01	22.34	27.87	21.17	1.48	12.56	1.58	1.54	6.01	46.04	21.83	46.28	52.19
Non-Federal Rangeland (NRI-1997)	32.32	0.04	18.27	24.57	6.50	0.00	15.73	0.28	0.00	0.09	36.75	23.09	8.37	39.99
Potential acres lost (less GPR - MLU)	8.75	0.00	27.62	13.47	7.19	23.97	34.62	2.85	20.32	9.35	14.43	22.22	12.79	0.00
% of Potential lost (GPR - MLU)	18%	0%	55%	33%	25%	94%	73%	64%	93%	61%	24%	50%	22%	0%
Potential acres lost (less NFR - NRI)	16.94	0.12	31.69	16.77	21.86	25.45	31.45	4.15	21.86	15.27	23.72	20.96	50.70	7.56
% of Potential lost (NFR - NRI)	34%	75%	63%	41%	77%	100%	67%	94%	100%	99%	39%	48%	86%	16%

Table 2.1 (Continued). Acres of potential grasslands compared to 1997 estimates of grassland pasture and range from MLU and non-federal rangeland from NRI for the 22 western states.

State	ND	OK	0R	SD	TX	UT	WA	WY	Total
					………1,000,000 acres………				
Potential Grasslands (Table 1.3)	37.31	37.76	27.51	44.51	148.53	28.59	17.18	47.21	833.10
Grassland Pasture and Range (MLU-1997)	11.33	17.31	22.40	22.59	98.06	23.74	7.41	44.87	551.12
Non-Federal Rangeland (NRI-1997)	10.69	14.03	9.29	21.88	95.74	10.73	5.86	27.30	401.52
Potential acres lost (less GPR - MLU)	25.98	20.45	5.11	21.92	50.47	4.85	9.77	2.34	331.98
% of Potential lost (GPR - MLU)	70%	54%	19%	49%	34%	17%	57%	5%	38%
Potential acres lost (less NFR - NRI)	26.62	23.73	18.22	22.63	52.79	17.86	11.32	19.91	481.58
% of Potential lost (NFR - NRI)	71%	63%	66%	51%	36%	62%	66%	42%	55%

Table 2.2. Number of farms reporting acreage in other pastureland and rangeland[1], by State, according to the US Census of Agriculture, 1978 to 1997.

	1978	1982	1987	1992	1997
Arizona	2,338	2,163	2,399	2,385	2,203
Arkansas	13,390	11,827	12,936	10,642	12,288
California	12,056	13,463	14,211	11,949	12,952
Colorado	12,685	11,872	11,875	11,949	12,952
Idaho	7,689	6,744	6,923	6,247	6,517
Iowa	25,868	24,254	22,415	20,629	18,756
Kansas	38,748	34,510	32,362	29,949	29,854
Louisiana	6,141	5,996	6,419	5,656	6,380
Minnesota	20,134	19,794	18,166	15,969	15,503
Missouri	29,480	30,729	32,093	28,224	28,740
Montana	14,230	13,237	13,675	13,129	13,941
Nebraska	28,279	24,997	24,299	21,554	22,460
Nevada	962	1,010	1,034	1,024	1,027
New Mexico	6,789	6,424	6,803	6,767	6,570
North Dakota	19,285	15,644	16,025	14,565	14,541
Oklahoma	41,903	36,590	36,122	33,391	36,763
Oregon	9,215	8,546	9,178	8,621	9,415
South Dakota	20,392	18,474	17,957	17,326	16,858
Texas	79,178	78,443	83,251	78,805	84,875
Utah	4,576	4,096	4,502	4,391	4,619
Washington	8,257	7,600	7,994	6,934	6,886
Wyoming	5,062	5,381	5,467	5,453	5,968
Total	406,657	381,794	386,106	355,559	370,068

[1] Excludes pastureland that is classified in cropland and woodland pasture.

Table 2.3. State-level summaries of farms and ranches holding grazinglands (i.e., pastureland/rangeland) according to Census of Agriculture, 1978-1997.

State	1997	1992	1987	1982	1978	% change 1978-97	% change 1982-97
Colorado							
Total Area (ac)	19,943,701	21,314,825	21,173,673	21,194,052	22,725,732	-12.2	-5.9
No. Operations	12,952	11,949	11,875	11,872	12,685	2.1	9.1
Avg Size (ac)	1540	1784	1783	1785	1792	-14.1	-13.7
Idaho							
Total Area (ac)	4,589,326	5,811,794	5,528,460	6,074,020	6,748,908	-32.0	-24.4
No. Operations	6,517	6,247	6,923	6,744	7,076	-7.9	-3.4
Avg Size (ac)	704	930	799	901	954	-26.2	-21.8
Montana							
Total Area (ac)	37,974,463	39,294,203	39,459,291	40,811,816	42,357,296	-10.3	-7.0
No. Operations	13,941	13,129	13,675	13,237	14,230	-2.0	5.3
Avg Size (ac)	2724	2993	2886	3083	2977	-8.5	-11.7
North Dakota							
Total Area (ac)	10,375,089	10,284,485	10,206,220	9,783,849	10,808,961	-4.0	6.0
No. Operations	14,541	14,565	16,025	15,644	19,285	-24.6	-7.1
Avg Size (ac)	714	706	637	625	560	27.3	14.1
South Dakota							
Total Area (ac)	23,588,662	23,946,525	23,069,181	23,392,939	24,183,243	-2.5	0.8
No. Operations	16,858	17,326	17,957	18,474	20,392	-17.3	-8.7
Avg Size (ac)	1399	1382	1285	1266	1186	18.0	10.5
Texas							
Total Area (ac)	86,073,441	87,798,825	86,802,117	86,068,315	87,337,112	-1.4	0.0
No. Operations	84,875	78,805	83,251	78,443	78,178	8.6	8.2
Avg Size (ac)	1014	1114	1043	1097	1117	-9.2	-7.6

Table 2.4. Changes in land cover/use between 1982 and 1997, Colorado.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated cropland	6,619.8	342	206.6	262.7	0.0	43.8	89.6	5.3	1.5	0.6	11.6	1,831.5	9,415.0
Non-cultivated Cropland	229.7	705.4	128.6	53.6	1.0	15.4	21.3	0.9	2.2	0.3	25.0	5.1	1,188.5
Pastureland	45.0	85.7	819.1	147.3	3.8	10.9	34.8	0.8	1.0	0.0	7.3	9.0	1,164.7
Rangeland	632.1	38.2	33.4	23,704.0	42.8	73.6	166.6	12.6	5.5	3.8	296.7	44.3	25,053.6
Forest land	0.7	1.4	4.3	252.5	3,358.1	17.8	79.9	2.0	0.5	1.0	38.8	0.0	3,757.0
Minor land use	15.4	4.8	2.3	34.9	0.6	790.3	12.9	0.8	0.6	0.0	13.4	0.0	876.0
Urban build-up	0.0	0.0	0.0	0.0	0.0	0.0	772.7	0.0	0.0	0.0	0.0	0.0	772.7
Rural transportation	3.5	0.4	0.0	6.7	1.1	0.6	2.1	449.4	0.0	0.0	0.0	0.0	463.8
Small water	0.7	1.0	0.1	2.3	0.2	0.0	0.0	0.0	136.2	0.0	0.0	0.0	140.5
Census water	1.2	0.5	0.0	8.6	0.0	0.0	0.0	0.0	0.0	175.6	0.0	0.0	185.9
Federal land	19.3	22.7	16.6	101.5	34.1	11.6	0.0	0.0	0.0	0.0	23,401.0	0.0	23,606.8
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	7,567.4	1,202.1	1,211.0	24,574.1	3,441.7	964.0	1,179.9	471.8	147.5	181.3	23,793.8	1,889.9	66,624.5

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Source: USDA, NRCS.

This table contains both the 1982 and the 1997 land cove/use and the change in acreage that occurred between the two. For example, the 1982 total for rangeland acreage (1,000 acres) was 25,053.6 and the 1997 total was 24,574.1, with 23,704 acres that did not change classification during the time period. Reading along the rangeland row gives the number of acres that were removed from rangeland between 1982 and 1997. Reading along the rangeland column gives the number of acres that were converted to rangeland between 1982 and 1997.

Table 2.5. NRI pastureland and rangeland in Colorado (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit	1982	1987	1992	1997	1982-97
		(1,000 acres)			(% change)
101800 North Platte	372	369	369	369	-0.8
101900 South Platte	5303	5133	5058	5058	-4.6
102500 Republican	2062	2017	2010	1992	-3.4
102600 Smoky Hill	223	218	205	211	-5.3
110200 Upper Arkansas	10125	9791	9745	9786	-3.4
110300 Middle Arkansas	87	71	71	71	-18.6
110400 Upper Cimarron	833	806	785	801	-3.8
110800 Upper Canadian	2	2	2	2	11.8
130100 Rio Grande Headwaters	1629	1618	1612	1618	-0.7
130201 Upper Rio Grande	53	49	49	49	-7.6
140100 Colorado Headwaters	1053	1095	1041	1038	-1.4
140200 Gunnison	895	895	909	920	2.8
140300 Upper Colorado-Dolores	484	461	487	504	4.3
140401 The Green River Basin	67	67	67	67	0.0
140500 White-Yampa	1803	1853	2002	2022	12.2
140600 Lower Green	8	8	8	8	0.0
140801 Upper San Juan	920	933	942	945	2.7
140802 Lower San Juan	302	305	304	326	8.0
Total	26,218	25,689	25,664	25,785	-1.7

Table 2.6. Changes in land cover/use between 1982 and 1997, Idaho.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	3,889.0	406.3	162.9	30.9	1.5	34.1	77.2	3.2	0.2	0.0	90.9	705.4	5,401.6
Non-cultivated Cropland	344.4	450.3	89.5	8.1	7.1	9.2	17.1	1.1	0.6	0.0	24.7	36.5	988.6
Pastureland	146.9	58.6	955.9	20.7	0.0	14.2	40.9	1.6	1.3	0.0	26.8	11.9	1,278.8
Rangeland	74.3	24.6	40.5	6,228.8	24.8	12.3	23.2	3.7	1.7	0.0	163.8	27.3	6,625.0
Forest land	1.1	3.7	13.2	28.0	3,740.1	12.9	38.6	2.7	3.2	2.3	148.9	0.4	3,995.1
Minor land use	14.6	1.3	4.6	6.8	7.7	454.4	7.6	0.0	0.0	0.0	1.5	3.1	501.6
Urban build-up	0.1	0.0	0.0	0.0	0.0	0.0	218.8	0.0	0.0	0.0	0.0	0.0	218.9
Rural transportation	3.2	0.3	1.9	2.1	4.4	0.2	1.8	317.4	0.0	0.0	0.0	0.0	331.3
Small water	0.8	1.0	0.8	0.1	0.1	0.0	0.0	0.0	72.9	0.0	0.0	0.0	75.7
Census water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	469.4	0.0	0.0	469.4
Federal land	66.9	29.9	45.5	175.0	162.1	15.2	0.0	0.0	0.0	0.0	33,106.7	0.0	33,601.5
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	4,541.3	976.0	1,314.8	6,500.5	3,947.8	552.5	425.2	329.7	79.9	471.7	33,563.3	784.8	53,487.5

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Source: USDA, NRCS.

This table contains both the 1982 and the 1997 land cove/use and the change in acreage that occurred between the two. For example, the 1982 total for rangeland acreage (1,000 acres) was 6,625.0 and the 1997 total was 6,500.5, with 6,228.8 acres that did not change classification during the time period. Reading along the rangeland row gives the number of acres that were removed from rangeland between 1982 and 1997. Reading along the rangeland column gives the number of acres that were converted to rangeland between 1982 and 1997.

Table 2.7. NRI pastureland and rangeland in Idaho (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit	1982	1987	1992	1997	1982-97
		(1,000 acres)			(% change)
160101 Upper Bear	60	61	63	63	4.3
160102 Lower Bear	476	470	464	466	-2.2
160203 Great Salt Lake Basin	49	49	49	58	18.1
170101 Kootenai River Basin	14	11	15	13	-5.2
170102 Pend Oreille River Basin	32	38	33	27	-13.9
170103 Spokane River Basin	88	80	73	82	-6.8
170401 Snake Headwaters	47	38	37	37	-21.7
170402 Upper Snake	3749	3619	3578	3575	-4.6
170501 Middle Snake - Boise	2325	2400	2401	2379	2.3
170502 Middle Snake - Powder	178	178	178	178	0.2
170601 Lower Snake	108	103	103	110	1.2
170602 Salmon River Basin	535	538	542	559	4.5
170603 Clearwater River Basin	243	246	281	269	10.9
Total	7,904	7,830	7,816	7,815	-1.1

Table 2.8. Changes in land cover/use between 1982 and 1997, Montana.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	10,974.3	686.2	379.2	28.1	0.0	76.8	17.8	5.9	1.8	0.7	1.6	2,429.3	14,601.7
Non-cultivated Cropland	501.3	1,589.0	324.9	42.8	0.0	18.9	12.9	1.6	0.7	0.0	1.1	101.9	2,595.1
Pastureland	284.3	181.0	2,424.5	73.8	16.1	24.2	24.4	2.2	1.3	0.0	3.5	38.8	3,074.1
Rangeland	721.3	160.4	283.3	36,278.4	91.5	35.1	52.9	13.8	7.3	0.0	38.2	145.0	37,827.2
Forest land	0.0	0.4	4.8	86	5,260.6	1.9	28.1	3.9	0.7	0.0	41.2	0.0	5,427.6
Minor land use	4.8	3.0	6.4	39.5	27.7	1,275.5	8.8	0.0	0.0	0.0	5.4	5.6	1,376.7
Urban build-up	0.0	0.0	0.0	0.0	0.0	0.0	217.6	0.0	0.0	0.0	0.0	0.0	217.6
Rural Transportation	3.6	2.1	2.5	7.9	0.9	1.5	0.8	641.6	0.0	0.0	0.0	0.1	661.0
Small water	6.1	3.2	1.6	19.5	1.8	0.2	0.0	0.0	262.0	0.0	0.0	0.0	294.4
Census water	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	755.1	0.0	0.0	761.1
Federal land	31.0	18.5	15.3	174.9	32.2	2.9	0.0	0.0	0.0	0.0	26,998.7	0.0	27,273.5
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	12,526.7	2,643.8	3,442.5	36,750.9	5,430.8	1,443.0	363.3	669.0	273.8	755.8	27,089.7	2,720.7	94,110.0

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Source: USDA, NRCS.

This table contains both the 1982 and the 1997 land cove/use and the change in acreage that occurred between the two. For example, the 1982 total for rangeland acreage (1,000 acres) was 37,827.2 and the 1997 total was 36,750.9, with 36,278.4 acres that did not change classification during the time period. Reading along the rangeland row gives the number of acres that were removed from rangeland between 1982 and 1997. Reading along the rangeland column gives the number of acres that were converted to rangeland between 1982 and 1997.

Table 2.9. NRI pastureland and rangeland in Montana (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit	1982	1987 (1,000 acres)	1992	1997	1982-97 (% change)
100100 Saskatchewan	66	64	64	64	-2.9
100200 Missouri Headwaters	2987	2981	3050	3065	2.6
100301 Upper Missouri	3209	3202	3179	3154	-1.7
100302 The Marias River Basin	2071	1986	1946	1914	-7.6
100401 Fort Peck Lake	3699	3593	3617	3679	-0.5
100402 The Musselshell River Basin	4185	4179	4138	4090	-2.3
100500 Milk	4228	4060	4006	3985	-5.7
100600 Missouri-Poplar	2709	2686	2670	2618	-3.3
100700 Upper Yellowstone	3667	3702	3714	3646	-0.6
100800 Big Horn	1728	1732	1735	1740	0.7
100901 The Tongue River Basin	1382	1361	1373	1377	-0.3
100902 The Powder River Basin	1773	1726	1774	1744	-1.6
101000 Lower Yellowstone	5902	5872	5880	5842	-1.0
101102 The Little Missouri River Basin	1246	1219	1230	1237	-0.7
101202 The Belle Fourche River Basin	0	0	0	0	0.0
170402 Upper Snake	0	0	0	0	0.0
170101 The Kootenai River Basin	95	98	90	94	-0.9
170102 The Pend Oreille River Basin	1956	1972	1923	1944	-0.6
Total	40,901	40,432	40,389	40,193	-1.7

Table 2.10 Changes in land cover/use between 1982 and 1997, North Dakota.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	21,157.2	977.5	122.7	49.4	0.0	97.8	19.4	14.2	5.7	26.8	45.4	2,566.4	25,082.5
Non-cultivated Cropland	805.8	799.2	108.5	97.2	0.0	16.7	3.2	0.3	3.0	0.0	2.5	119.6	1,956.0
Pastureland	285.2	130.2	740.9	92.0	0.0	10.0	2.7	2.6	3.1	0.0	0.5	22.5	1,289.7
Rangeland	491.6	253.0	141.4	10,396.0	15.1	39.6	14.0	8.8	10.2	10.7	21.5	79.3	11,481.2
Forest land	7.8	0.0	5.0	7.2	436.3	1.5	1.7	0.8	0.2	0.0	0.7	0.0	461.2
Minor land use	57.1	22.9	8.5	25.9	2.2	1,197.7	1.4	0.0	0.0	16.0	0.5	13.9	1,346.1
Urban build-up	0.3	0.0	0.0	0.0	0.0	0.0	219.1	0.0	0.0	0.0	0.0	0.0	219.4
Rural Transportation	5.9	0.1	0.6	4.3	0.3	0.0	0.1	703.5	0.0	0.0	0.0	0.0	714.8
Small water	6.4	0.1	1.2	7.6	0.3	0.0	0.0	0.0	179.9	0.0	0.2	0.0	195.7
Census water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	776.4	0.0	0.0	776.4
Federal land	3.4	0.2	0.0	9.8	0.0	0.0	0.0	0.0	0.0	0.0	1,713.7	0.6	1,727.7
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	22,820.7	2,183.2	1,128.8	10,689.4	454.2	1,363.3	261.6	730.2	202.1	829.9	1,785.0	2,802.3	45,250.7

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Table 2.11. NRI pastureland and rangeland in North Dakota (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit	1982	1987	1992	1997	1982-97
		(1,000 acres)			(% change)
090100 Souris	1227	1154	1133	1059	-13.7
090201 Upper Red	285	229	230	215	-24.6
090202 Devils Lake-Sheyenne	951	897	882	839	-11.8
090203 Lower Red	244	223	214	212	-13.1
100600 Missouri-Poplar	115	109	109	106	-7.6
101000 Lower Yellowstone	104	104	102	102	-2.2
101101 Lake Sakakawea	1650	1618	1610	1569	-4.9
101102 The Little Missouri River Basin	1290	1261	1260	1263	-2.1
101301 Lake Oahe	2844	2701	2700	2658	-6.5
101302 The Cannonball - Heart - and Knife River Basins	2935	2825	2836	2790	-4.9
101303 The Grand and Moreau River Basins	278	269	264	262	-5.7
101600 James	849	787	772	745	-12.2
Total	12,771	12,175	12,111	11,818	-7.5

Table 2.12. Changes in land cover/use between 1982 and 1997, South Dakota.

	Land cover/use in 1997												
	- - - 1,000 acres - - -												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	12,065.40	1,091.20	237.9	18.9	0	50.4	48.3	9.3	2.6	4.4	29.3	1,439.40	14,997.10
Non-cultivated Cropland	970.5	724.4	94.8	18	0	9.4	5.6	1.8	0.6	1.6	10.9	112.9	1,950.50
Pastureland	618	306.3	1,597.50	53.1	1.5	12	12.7	2.4	0.5	0.2	10.3	96.4	2,710.90
Rangeland	632.2	266.7	170	21,733.70	13.8	22.3	25.6	13.3	13.2	0.6	40.1	34.2	22,965.70
Forest land	1.2	1.4	0	16.6	491.5	3.1	10.3	0.8	0	0	1.8	0	526.7
Minor land use	45.9	4.7	7.4	16.4	3.7	1,385.80	2	0.6	0	0	5.9	3	1,475.40
Urban build-up	0	0	0	0	0	0	242	0	0	0	0	0	242
Rural Transportation	3.1	0.8	0.3	5.4	0.7	0.1	1.1	583.9	0	0	0	0	595.4
Small water	2.1	1.4	0.3	5.1	0.2	0	0	0	190.6	0	0	0	199.7
Census water	0.2	0	0	0	0	0	0	0	0	664.9	0	0	665.1
Federal land	1.4	1.5	0	9.2	6.9	0.9	0	0	0	0	3,009.60	0	3,029.50
CRP	0	0	0	0	0	0	0	0	0	0	0	0	0
1997 total	14,340.00	2,398.40	2,108.20	21,876.40	518.3	1,484.00	347.6	612.1	207.5	671.7	3,107.90	1,685.90	49,358.00

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Table 2.13. NRI pastureland and rangeland in South Dakota (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit	1982	1987	1992	1997	1982-97
		(1,000 acres)			(% change)
070200 Minnesota	340	324	317	310	-8.8
090201 Upper Red	84	76	73	76	-9.9
101102 The Little Missouri River Basin	337	338	326	301	-10.8
101201 The Cheyenne River Basin	3805	3731	3691	3693	-2.9
101202 The Belle Fourche River Basin	1392	1384	1338	1321	-5.1
101301 Lake Oahe	2322	2204	2168	2163	-6.9
101302 The Cannonball - Heart - and Knife River Basins	10	10	10	10	0.0
101303 The Grand and Moreau River Basins	4636	4558	4531	4464	-3.7
101401 Fort Randall Reservoir	3503	3365	3301	3238	-7.6
101402 The White River Basin	3655	3623	3583	3593	-1.7
101500 Niobrara	803	789	788	777	-3.2
101600 James	3587	3241	3131	3067	-14.5
101701 Lewis and Clark Lake	544	478	466	451	-17.1
101702 The Big Sioux River Basin	660	579	556	519	-21.3
Total	25,677	24,699	24,279	23,985	-6.6

Table 2.14. Changes in land cover/use between 1982 and 1997, Texas.

	Land cover/use in 1997												
	1,000 acres												
Land cover/use in 1982	Cultivated cropland	Non-cultivated cropland	Pastureland	Rangeland	Forest land	Minor land uses[a]	Urban build-up	Rural transportation	Small water[b]	Census water[c]	Federal land	CRP[d]	1982 total
Cultivated Cropland	24,445.3	233.0	2,009.9	1,356.8	68.9	135.0	479.1	11.9	31.7	25.2	36.7	3,674.3	32,507.8
Non-cultivated Cropland	236.3	271.8	159.6	52.1	11.9	10.0	35.5	0.8	2.2	0.9	3.3	30.4	814.8
Pastureland	608.6	60.2	12,469.4	1,389.9	1,644.5	157.6	556.3	25.4	60.5	69.4	12.5	53.1	17,107.4
Rangeland	984.3	41.2	924.4	92,729.7	36.6	319.5	838.6	44.5	76.8	107.4	99.6	140.3	96,342.9
Forest land	3.2	0.0	294.2	6.5	8,978.8	53.5	253.0	13.5	26.8	3.4	5.1	0.0	9,638.0
Minor land use	42.0	1.4	38.7	158.9	48.8	1,534.4	58.3	0.8	0.7	0.1	4.7	7.4	1,896.2
Urban build-up	0.2	0.0	0.0	0.0	0.0	0.0	4,615.1	0.0	0.0	0.0	0.0	0.0	4,615.3
Rural Transportation	6.5	0.1	5.4	24.6	0.4	0.1	12.5	1,621.6	0.0	0.0	0.0	0.0	1,671.2
Small water	3.5	0.2	9.0	19.5	6.3	0.0	0.1	0.0	701.3	0.0	0.1	0.0	740.0
Census water	0.1	0.0	2.8	6.2	0.0	1.0	0.0	0.0	0.0	2939.0	0.0	0.0	2,949.1
Federal land	0.0	0.0	1.0	0.5	19.8	0.0	0.0	0.0	0.0	0.0	2,747.9	0.0	2,769.2
CRP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1997 total	26,330.0	607.9	15,914.4	95,744.7	10,816.0	2,211.1	6,848.5	1,718.5	900.0	3,145.4	2,909.9	3,905.5	171,051.9

[a] Minor land uses includes farmsteads and other farm structures, field windbreaks, barren land, and marshland.
[b] Small water consists of streams < 660 feet wide and water bodies < 40 acres.
[c] Census water consists of steams >= 600 feet wide and water bodies >= 40 acres.
[d] CRP = Conservation Reserve Program

Table 2.15. NRI pastureland and rangeland in Texas (6-digit hydrologic units) and percentage change from 1982 to 1997.

Hydrologic unit		1982	1987	1992	1997	1982-97
		(1,000 acres)				(% change)
110901	Middle Canadian	3940	3898	3879	3866	-1.9
110902	Lower Canadian	34	34	34	34	0.0
111001	The Beaver River Basin	719	697	695	706	-1.8
111002	Lower Beaver	565	565	566	600	6.1
111201	The Prairie Dog Town Fork Red River Basin	2069	2056	2050	2086	0.8
111202	The Salt Fork Red River Basin	602	597	581	591	-1.8
111203	The North Fork Red River Basin	880	852	859	892	1.3
111301	Red-Pease	1650	1643	1664	1742	5.6
111302	Red-Lake Texoma	2962	2922	2908	2999	1.3
111303	The Washita River Basin	216	215	215	218	0.6
111401	Red-Little	764	715	692	636	-16.7
111402	Red-Saline	0	0	0	3	0.0
111403	Big Cypress-Sulphur	1864	1802	1765	1727	-7.4
120100	Sabine	1793	1722	1603	1492	-16.8
120200	Neches	1678	1522	1482	1313	-21.7
120301	Upper Trinity	4549	4490	4346	4315	-5.2
120302	Lower Trinity	2082	2046	2008	1854	-11.0
120401	The San Jacinto River Basin	524	485	444	405	-22.7
120402	Galveston Bay-Sabine Lake	642	606	622	570	-11.2
120500	Brazos Headwaters	2559	2542	2550	2609	2.0
120601	Middle Brazos-Clear Fork	3183	3198	3191	3210	0.9
120602	Middle Brazos-Bosque	3472	3438	3414	3434	-1.1
120701	Lower Brazos	3639	3678	3676	3668	0.8
120702	The Little River Basin	3114	3069	3094	3068	-1.5
120800	Upper Colorado	4687	4662	4645	4632	-1.2
120901	Middle Colorado-Concho	8056	7998	7979	7955	-1.3

Table 2.15 (continued). NRI pastureland and rangeland in Texas (6-digit hydrologic units) and percentage change from 1982 to 1997.

120902	Middle Colorado-Llano	4766	4721	4701	4666	-2.1
120903	Lower Colorado	1305	1300	1277	1319	1.1
120904	San Bernard Coastal	592	624	633	602	1.6
121001	The Lavaca River Basin	925	952	964	971	4.9
121002	The Guadalupe River Basin	3165	3155	3166	3183	0.5
121003	The San Antonio River Basin	1775	1736	1707	1705	-3.9
121004	Central Texas Coastal	1776	1778	1775	1768	-0.4
121101	The Nueces River Basin	9369	9344	9335	9439	0.7
121102	Southwestern Texas Coastal	4354	4353	4263	4277	-1.8
130301	Rio Grande-Caballo	37	33	31	30	-18.9
130401	Rio Grande-Fort Quitman	879	873	862	856	-2.6
130402	Rio Grande-Amistad	7161	7161	7110	7111	-0.7
130403	The Devils River Basin	2631	2631	2631	2631	0.0
130500	Rio Grande Closed Basins	3420	3444	3488	3486	1.9
130700	Lower Pecos	11442	11411	11375	11408	-0.3
130800	Rio Grande-Falcon	3054	3055	3055	3043	-0.4
130900	Lower Rio Grande	561	549	549	543	-3.1
Total		11,3450	11,2567	11,1884	11,1659	-1.6

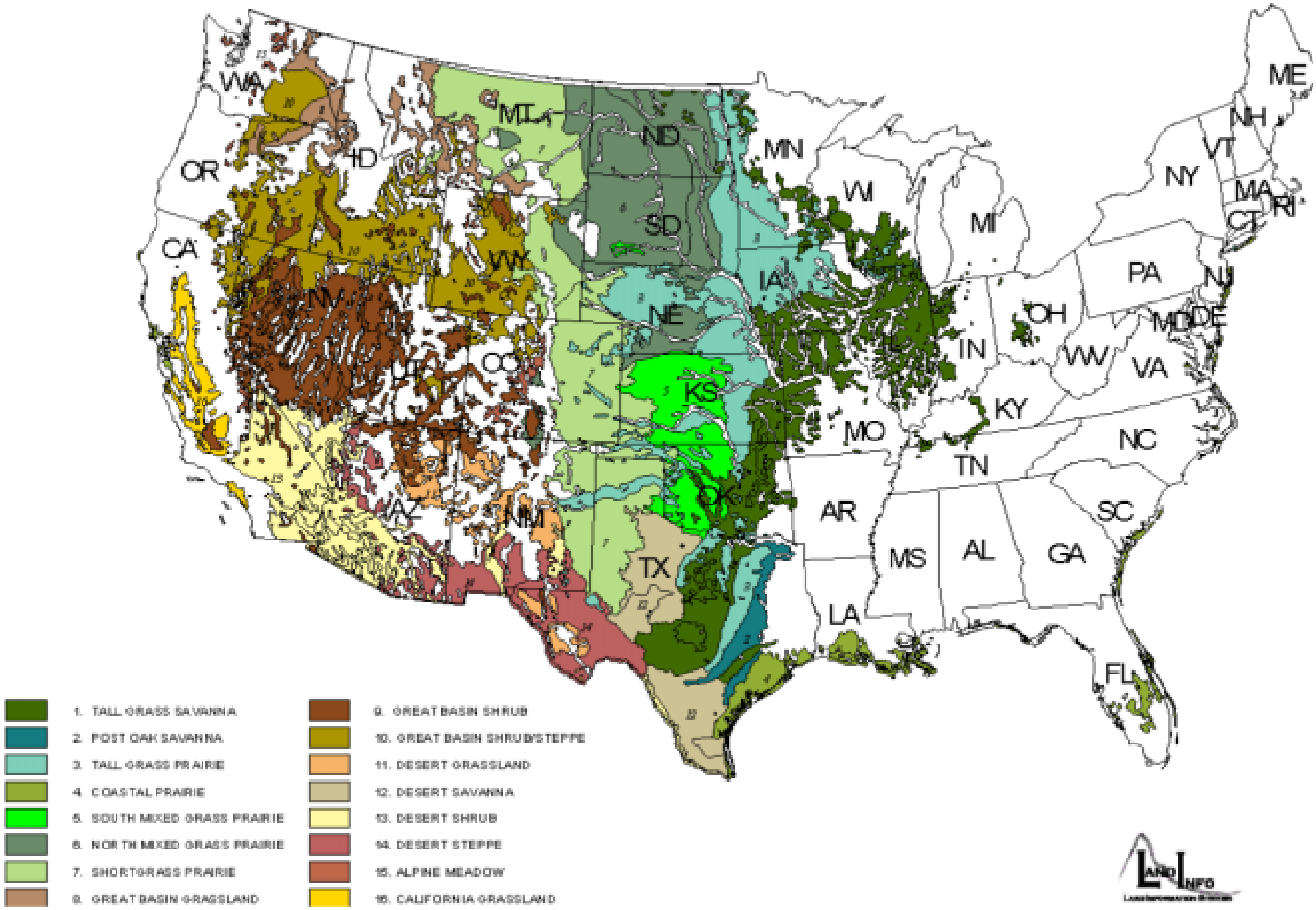

Figure 1.5. Coverage by pre-settlement grassland in the contiguous US. ***Included from Chapter 1 as a reference.***

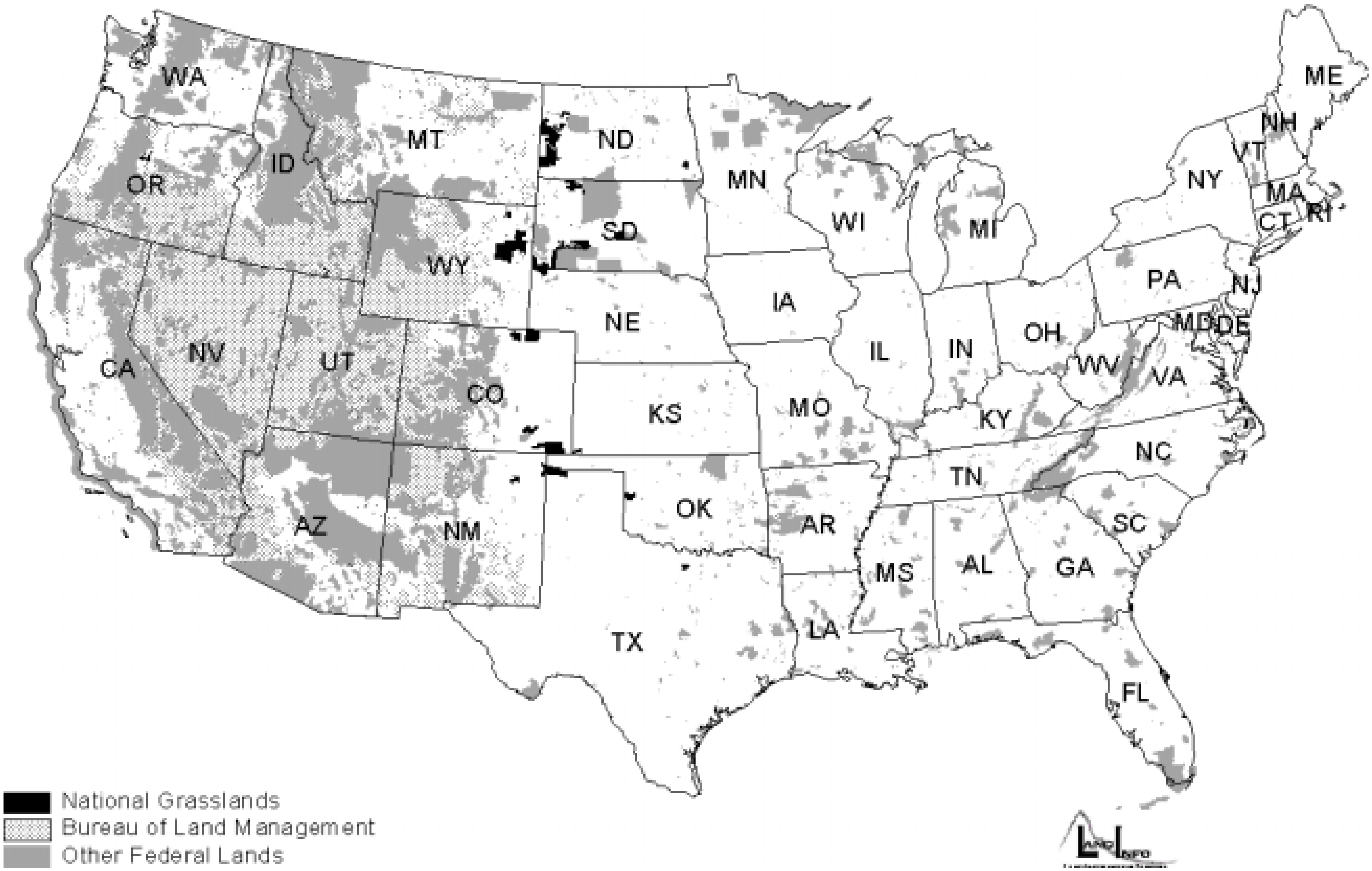

Figure 1.6. Federal ownership of lands in the contiguous US. ***Included from Chapter 1 as a reference.***

United States Grasslands and Related Resources: An Economic and Biological Trends Assessment

Chapter 3: What is driving the changes in grassland use in the US?

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

Factors broadly influencing grassland use

Human population

Pressure from growth in human population and the resulting demand for housing, businesses, roads, schools, utilities, etc. is an ever-increasing threat to traditional use of grasslands. During the past decade, 9 of the 12 fastest growing states in the US were in the West with growth rates of more than 20% (Table 3.1). Overall, the 22 states west of the Mississippi River gained more than 16.5 million people between 1990 and 2000; a 17.3% increase. This overall growth was achieved in spite of the fact that 9 Great Plains states grew by less than 10% including North Dakota, which grew by less than 1%.

Personal income

One factor that can be an important contributor to population growth pressure is economic opportunity. One measure of relative economic well being is per capita personal income. In 1999 per capita personal income in the US averaged $28,542 and has been increasing at about 5% per year since 1995. Only 5 of the 22 states west of the Mississippi River had per capita incomes higher than the US average in 1999, but 12 of the states had average growth rates of 5% or greater during the 1995 –1999 period (Table 3.2).

The current and continued economic prosperity enjoyed by most sectors of the US economy allow people to consider the purchase of second homes and vacation homes in desirable rural areas. These people enter the market for farm and ranch land because of the lifestyle it provides, not for the potential profits from ranching. As a result, land prices are bid higher than returns to ranching would imply, creating a sell out opportunity for ranchers and a more difficult situation in which to continue to ranch. In addition, prosperity is driving an increase in the average size of houses and of lots. Not only are high amenity areas under population growth pressure, but the land and resource demands of each individual are also increasing.

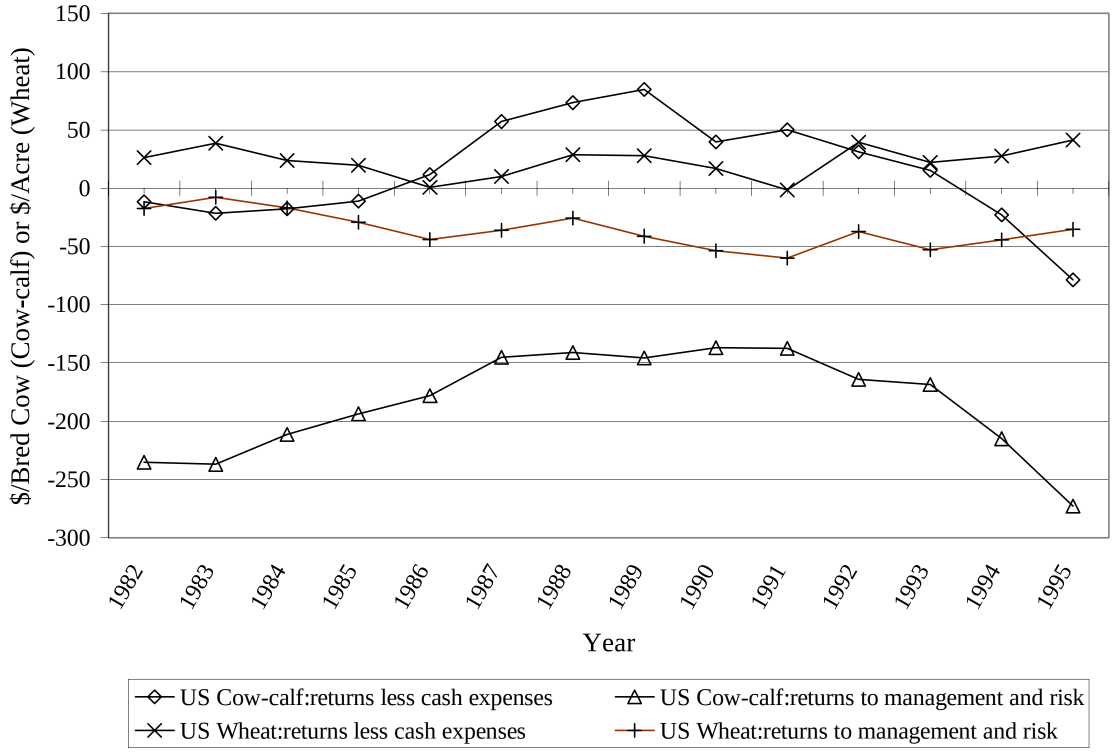

Figure 3. 1. Returns to management and risk and returns less cash expenses for cow-calf ($/bred cow) and wheat ($/acre) enterprises without including direct government commodity payments, United States.

Economics of ranching vs. cropping

While several commodities compete with range livestock for resources, wheat farming is probably one of the more common competitors in the west because of the marginal quality land that typically passes between the two enterprises. Though cyclical in nature, cow-calf enterprise returns-less-cash-expenses were below wheat returns-less-cash-expenses in 8 out of the 14 years from 1982 to 1995 (Figure 3.1), not accounting for government commodity payments that may have been received (ERS/USDA). When overhead costs were accounted for, returns to management and risk for cow-calf operators were considerably below the same returns for wheat producers (Figure 3.1). Hired labor, the opportunity cost of unpaid labor, capital recovery cost of machinery and equipment, taxes and insurance were all higher costs for cow-calf producers compared to wheat producers. Conversely, the opportunity cost of land was higher for wheat producers.

Government policy

In general, the policy of the federal government has been to support production agriculture in the US, through either protection from competition or subsidization of production. The protection policies have generally involved the use of tariffs, import taxes and quotas to shield US agricultural production from foreign competition. Subsidization takes many forms including: product price and producer income support, disaster (drought / flood) relief grants and/or low interest loans, and subsidized input costs like crop insurance, utilities, transportation and soil and water conservation practices. In many cases, a result (albeit unintended) of these agricultural support policies has been, and is, to provide incentives for private landowners to convert grasslands to crop production and/or to thwart, or at least delay, the re-conversion of croplands back to grass. These incentives are provided anytime policies or programs are the cause of a piece of land being more profitable to the landowner if used as cropland in lieu of grazing land.

For example, in the Northern Great Plains the 1999 ERS/USDA soybean cost and returns data estimate average annual operating costs of $66.52/acre; overhead costs of $135.04/acre, which includes opportunity costs for owner labor and land; and an average yield of 40 bu/acre. With an estimated average sale price of approximately $4.00/bu (Aurora Co. South Dakota FSA/USDA office), the soybean enterprise would average a loss of $41.56/acre. With a USDA Commodity Credit Corporation loan rate of $4.92/bu, however, the average producer could expect to collect an additional $0.92/bu as a Loan Deficiency Payment, which would result in the average soybean enterprise producing a loss of only $4.76/acre over all costs and a net return of $130.28/acre over operating costs. For the same year, ERS/USDA indicates that the average Northern Great Plains cow-calf enterprise would have returned a loss of $46.67/acre (assuming an average stocking rate of 9 acres/bred cow), when considering all costs and a net return of only $6.76/acre over operating costs.

In addition to qualifying for Loan Deficiency Payments, cropland is eligible for subsidized crop insurance and/or disaster payments that are significantly more effective in reducing negative financial impacts due to crop production losses compared to livestock production losses. Thus, due to the government support programs, keeping, or converting, land in crops can be both more profitable and less risky than producing livestock on grassland.

Federal estate tax

The Federal Estate Tax, also known as "inheritance tax" or "death tax," is an excise tax levied at death upon the estate of all US resident decedents. The rate of the Federal Estate Tax is computed on a graduated scale, beginning at 37%. In 2001, a credit, called the Unified Credit, is permitted against every estate equal to the estate tax on an estate valued at $675,000. The Unified Credit is scheduled to increase to $1 million through 2006 ($700,000 in 2002 and 2003, $850,000 in 2004, $950,000 in 2005 and $1 million in 2006). If a couple engages in estate planning and creates a "Bypass Trust" or "Credit Shelter Trust" as a part of their wills, they can effectively shelter one Unified Credit each, or $1.35 million in 2001, from the Federal Estate Tax to be levied against their decedents.

A bill to rescind the inheritance tax is currently pending in Congress. Although agriculturists appear to be largely in favor of such a change in policy, it would have an uncertain effect on pastureland and grassland conversion. Currently, producers of sufficient size that are subject to the inheritance tax can avoid a large proportion of it by ensuring their lands will remain in agriculture through a perpetual agricultural conservation easement. If concerned parties retain the right to convert the land in question to higher "value" uses, they will remain subject to the tax. The current tax structure may tie the decision to preserve pasturelands and grasslands or convert them to the current generation. However, the tax can only be considered at fault for land conversion when estate planning is inadequate. Pasturelands and grasslands passed on to heirs in the absence of an inheritance tax are as likely to be converted as any other land with its development rights intact.

As more and more farmers and ranchers approach traditional retirement age, the choice to sell the ranch to the highest bidder or maintain the land in agriculture forever (often at a significant economic cost) is often forced due to our inheritance tax structure. If landowners do not plan to keep the land in agriculture through appropriate estate planning, the tax bill heirs will bear on the land assessed at the "highest and best" use can often provide the impetus for converting the land to residential or commercial uses.

Non-agricultural demand for land

Per acre sale prices of agricultural lands in the western US increased by 66% between 1990 and 2000 (USDA-NASS), indicating a significant increase in the demand for land. Sale prices for pasture and cropland for 1997 and 2000 for the states west of the Mississippi River are shown in Table 3.3. For this period, prices for both pasture and cropland increased by approximately 10%. However, for the same period cropland rental rates increased only 7% and pastureland rental rates increased by less than 5%. Since rental rates are considered the more accurate indicator of "value in use," these data indicate that forces outside production agriculture are fueling the increased demand for agricultural land, especially pastureland.

Further evidence of the non-agriculture demand for land in the western states can be seen in a comparison of rental rates to selling prices for 2000 (Table 3.4). Cropland annual rental rates averaged $79.38 per acre across the 18 western states reported and the rental rate averaged 5.77% of the sale price. Assuming an 8% capitalization rate, the $79.38 rental rate would indicate that agriculturists (crop producers) could justify a sale (purchase) price of only $992 compared to the $1,480 actual average (Table 3.4). This indicates that the value of cropland for crop production accounts for only 67% of its average sales price in 2000.

A similar comparison for pastureland shows an average annual rental rate of $12.14 per acre across the 12 states reported with the rental rate representing only 3.3% of the sale price. With the 8% capitalization rate livestock, producers could justify a purchase price of only $152 instead of the $481 average (Table 3.4). This indicates that the average value of pastureland for livestock production accounts for only 32% of its average sales price in 2000.

Another indicator that non-agricultural interests are driving the market for agricultural land can be seen in the comparisons of crop and pastureland sales price ratios to crop and pastureland rental rate ratios. On average, pastureland rental rates were only 27% of cropland rates (Table 3.4). However, pastureland sale prices averaged 43% of cropland sale prices. In other words, this data indicates that the average acre of cropland rented had a "value in use" of almost 4 times the "value in use" of the average acre of pastureland rented. However, in the market for agricultural land, cropland was valued just over 2 times greater than pastureland. Again, these differences in ratios indicate that the majority of the demand for pastureland sales is not stemming from livestock producers desiring to purchase more grazing lands.

It is likely that these lands are facing increasing demand for x-urban, rural residential uses. Currently, there are more Americans in their late 30s and early 40s than any other age. This group will remain the modal age category as they move into their 50s, 60s and 70s. They will live longer, retire younger, be wealthier and be more active than previous generations. This group of people is likely to increase the demand for second homes and ranchettes in high amenity rural areas.

Telecommunications. – Recent innovations in telecommunications has effectively separated job location from the decision of where to live. As a result, people can increasingly have their cake and eat it too; have a high paying city job, but live in an aesthetically desirable, high amenity rural area. Internet broadband, video conferencing, e-commerce, and cellular technology are facilitating a new type of rural resident, not unlike rural electrification did in the early to mid 20th century.

Factors influencing grassland use in Colorado, Idaho, Montana, North Dakota, South Dakota and Texas

Colorado

Human population

Population growth and income are principal correlates with pastureland and grassland loss in Colorado. Reaching 4.3 million residents in the most recent census, Colorado was the third fastest growing state (30.6%) in the US and one of eight states growing by more than 1 million residents between 1990 and 2000. Population growth is driven by three factors in Colorado: 1) a highly educated workforce has resulted in growth in the communications, manufacturing, business services, air transportation, and regional services fields; 2) the rise of second homes in resort communities; 3) the arrival of greater numbers of retirees. All three of the factors are expected to spur continued growth in Colorado in the foreseeable future.

Population and growth in Colorado is not evenly distributed across the state. Eleven of Colorado's 63 counties had populations greater than 100,000 residents in 1998. These eleven counties experienced an average growth rate of 28.7% from 1990-98. All are located in the "Front Range" within view of the Rocky Mountains to the west. The remaining 52 counties in Colorado had populations of fewer than 45,000 people and their average annual growth rate for the period was 21.8%. In Colorado there are 16 rural counties (population <5,000) and they had an average growth rate of 14.8%.

Personal income

Colorado is the fifth wealthiest and second most educated state in the US. More than 1 in 3 Coloradoans holds a university degree and the state's average wage in 1999 was $31,546 (US $28,542). However, the distribution of Colorado's wealth and education is highly unequal. For example, Pitkin County (where Aspen is located) is traditionally among the wealthiest counties in the US ($59,000 average personal income, 1998). The San Luis Valley region of the state has maintained an average income of roughly ¼ that of Pitkin County for at least a half century (13,000-20,000 average personal income, 1998). Front Range incomes are higher on average than the rest of the state, comprising about 82% of total income and about 75% of total population.

The number and proportion of Coloradoans employed in agriculture is slowly declining. In the agriculturally dependent and grassland dominated Eastern Plains, incomes are lower on average (approximately $22,000 average personal income, 1998) than the rest of the state. Average incomes in the agricultural sector are second lowest (to retail) in the state. The interface between the urban Front Range and the rural Eastern Plains increasingly creates scenarios where the "best and highest use" of pasturelands and grazinglands is in x-urban residential development. In some, formerly rural, markets, average housing prices have outstripped increases in average personal income by as much as 150% in recent years, indicating that urbanites are purchasing land and building homes in formerly rural areas.

Non-agricultural demand for land

Colorado agricultural lands are being converted to urban uses, 35-acre ranchettes, other low-density uses and public open lands purchases. Precise estimates of land converted to low-density x-urban development are not readily available. However, the increase in the number of farm and ranch operations and the decrease in the average size of these operations provide evidence of this conversion of working agricultural operations to "lifestyle" farms. The amount of Colorado land in urban uses is increasing at a rate of 28,000 acres per year (Obermann *et al.*, 2000).

State and local efforts at agricultural land preservation

In part due to the state's current affluence, Coloradoans have invested hundreds of millions of dollars toward land preservation over the past decade. Coloradoans created the statewide Great Outdoors Colorado Land Trust (GOCO) and the residents of more than 25 counties and municipalities have taxed themselves to preserve public attributes of undeveloped or agricultural lands, often in partnership with land trusts. Through the donation or purchase of conservation easements or outright purchase, approximately 660,000 acres of Colorado private lands have been permanently preserved from residential or commercial development in cooperation with some 37 local, state, regional and national land trusts (CCLT in State of Colorado, 2000). Some of these trust lands were historically and will remain in some type of agriculture. Others were not suitable for agriculture or may be converted from agriculture to some low intensity use, including grassland (e.g., parks, wildlife refuges, open space buffers). In addition, more stringent growth management and planning at the state level appears likely in the near future and a prairie dog protection easement program is anticipated.

Colorado case study 1: Weld County

Weld County can be considered illustrative of the many forces of change present in rural Colorado communities that are resulting in the conversion of pasturelands and grasslands into more intensive uses. The issues present in Weld County are quite similar to the forces of change in Pueblo and Adams Counties. These latter two counties together experienced a loss of more than 225 thousand acres (about 15% of total state losses) in pasturelands and grasslands since 1982.

Weld County is located in the South Platte River Basin in the northeastern section of the I-25 corridor and provides the northern border of the Denver Metropolitan region. Weld County is 2.5 million acres in total area, with more than 2 million acres of private land and about one half of the remainder is Pawnee National Grasslands. Data indicate that Weld County experienced a moderate drop in its substantial grassland acreage since 1982, from approximately 973 thousand to 952 thousand acres.

In terms of agribusiness income ($390 million, 1997) and sales (2.9 billion, 1997), Weld County is the most important agricultural county in Colorado and among the most important in the US. The county has deep roots in animal agriculture, having significant beef, sheep, dairy and hog industries within its borders. Typical of agriculturally oriented economies, per capita income in Weld is well below the state average and increased from $18,500 in 1994 to just under $22,000 in 1998.

Weld County experienced a 37% growth in population over the past decade. This growth is concentrated along its western and southern borders, providing housing for Ft. Collins, Boulder and Denver commuters. Weld County land in farms declined to 1.9 million acres in 1997 compared to 2.1 million acres in 1992 and 1987. The number of farms and ranches has stayed relatively constant at about 2,950, but the median operation size (153 acres) was substantially below the county mean (647 acres). More than one third of Weld county operations had agricultural sales in excess of $50 thousand in 1997, while more than one third had sales of less than $10 thousand. These data potentially imply that working operations are being combined into fewer, even larger operations and/or other farms and ranches are subdividing into rural residential properties.

Colorado case study 2: Routt County

Routt County is illustrative of the forces of change in communities with high levels of natural amenities and a high proportion of public lands within their boundaries. These counties are broadly in transition from ranching communities to outdoor recreation based economies driven by tourism, second homes buyers and retirees. Park and Custer Counties, which combined for a loss of 180 thousand acres of pastureland and grassland since 1982, are facing broadly similar issues to Routt County.

Routt County is located in the Yampa River Basin in northwest Colorado and is home to the city of Steamboat Springs and the famous ski area of the same name. Routt County and the surrounding region have long traditions in the sheep and beef cattle industries. Agriculture constitutes a relatively small proportion of total economic activity (3.7% of employment, 0.8% of total income), although agricultural sales were a nontrivial $30 million in 1997. Increasingly, farm and ranch lands in Routt County contribute directly and indirectly to the local economy through consumptive (e.g., elk and deer hunting and trout fishing) and nonconsumptive use (e.g, hiking, backpacking, mountain biking, river rafting) outdoor recreation.

Routt County's average personal income was $31,795, or about 5% above Colorado state average and about 1/3 higher than a more typical agriculture-based community in 1998. Routt County's population grew by almost 40% to 19,690 over the past decade, not atypical of mountain and other high amenity communities in Colorado and the West.

Routt County's 1.5 million acres are approximately equal parts public and private lands. Not withstanding the significant efforts of private land trusts, almost 90 thousand acres of pastureland and grassland were lost in the county since 1982. In 1997, Routt County had 438 farms and ranches on 576 thousand acres; 76 more farms and ranches on 23 thousand fewer acres since 1982. The average size agricultural property decreased by 367 acres to 1,316 over the period. However, the number of properties of greater than 500 acres remained constant and constituted approximately 40% of all agricultural operations in the county in 1997. The number of operations of between 10 and 500 acres increased over the period. Interestingly, approximately 40% of all operations report sales of less than $10 thousand in 1997, implying that many Routt County farms and ranches are "lifestyle" or "hobby" farms.

As farm size decreases, wildlife habitat, open space, water catchment, and biodiversity benefits of pasturelands and grasslands can be expected to diminish as well. Whether the likely increase in lifestyle farms increases or decreases the amount and quality of grassland recovered from pastureland and cropland depends upon the quality of land stewardship practiced by lifestyle farmers relative to the former owners. Unmanaged land is likely to result in problems with invasive weeds and incomplete recovery of native grasslands. Leased land is likely to take on the characteristics of the lessee's management practices. Proper management of lifestyle farms could improve the stock of grassland notwithstanding the unambiguously negative impact of diminished parcel size.

Idaho

Human population

One of the issues driving changes in land use in Idaho is population growth. The population of Idaho in 2000 was close to 1.3 million people. Since 1990, only 2 of 44 counties lost population. Boise County had a 90.1% increase in population and Teton county witnessed a 74.4% increase. Nineteen counties had over a 20% population increase. Much of the population increase has occurred in counties that have easy access to one of the three interstates that run through the state. Per capita income in metropolitan areas outgrew per capita income in non-metropolitan areas by almost 10% from 1982 to 1998.

Land use and land in farms

Approximately 40% of Idaho's land base is considered rangeland. Most of this land is under federal management, with 35% of Idaho's federal lands under Bureau of Land Management jurisdiction and the 61% managed by the US Forest Service (Idaho State Profile). According to NRI statistics, 7.8 million acres of grasslands are in private ownership. The majority of these acres lie in the southern portion of the state.

From 1982 to 1997, farm numbers in Idaho declined 9.71%, from 24,714 to 22,314 farms, according to the Census of Agriculture. Average farm size during this period declined slightly from 563 acres to 530 acres.

The number of farms reporting pasture and rangeland declined from 6,923 in 1982 to 6,517 in 1997 (Figure 3.2), while the number of acres in pasture and rangeland declined 27% (6.07 million acres to 4.59 million acres) between 1982 and 1997 according to the US Census of Agriculture. From 1982 to 1997, 34 of the 44 counties in Idaho declined in pasture and rangeland. The NRI places 1997 rangeland acreage in Idaho at 6.50 million acres, considerably more than the Census of Agriculture estimate, but down 1.88% than the 1982 NRI estimate of 6.62 million acres. The difference between the Census and NRI estimates can be attributed to definitional differences as well as sampling and survey techniques.

An analysis of 1997 Agricultural Census data for all counties in Idaho shows an inverse correlation between the number of acres in pasture and rangeland and the level of government farm payments, but no relationship with net farm income. The dispersion of rangelands, both federal and private, among areas suited for farming throughout much of the state has probably resulted in these correlations not being as significant as in the other states examined.

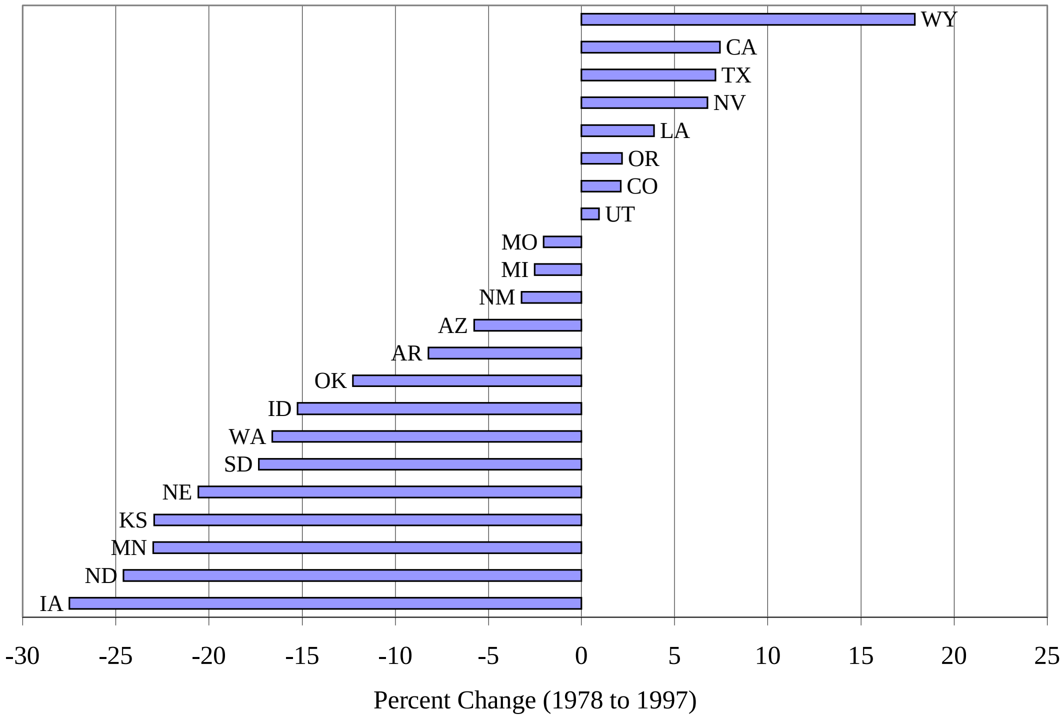

Figure 3. 2. Percent change in the number of farms reporting acreage in other pastureland and rangeland for each of the 22 contiguous states west of the Mississippi River as determined by US Census of Agriculture inventory estimates, 1978 to 1997. Sources: USDC/BC various years, USDA/NASS 1997**.**

According to the NRI data, the most significant rangeland areas are in the Lower Bear (#160102), the Upper Snake (#170402) and the Middle Snake-Boise (#170501) (see Figure 2.11). One county from each area was used for closer analysis. On a hydrologic unit basis, NRI statistics must be interpreted cautiously because of the increased measurement error. Trends are, therefore, more reliable than the actual acreage estimates.

Idaho case study 1: Lower Bear Watershed and Bear Lake County

The Lower Bear Watershed extends into Northeastern Utah, but has 383,700 acres of rangeland and 82,000 acres of pastureland in Idaho. According to the NRI, the 383,700 acres of rangeland in 1997 was down 6.6% from the 409,200 acres that were classified as rangeland in 1982. More than 13,000 of the lost rangeland acres are now non-cultivated cropland, 7,300 acres are classified under CRP land, and 500 acres went into urban development during this 15 year period. While the size of the individual parcels involved in these interchanges is uncertain, the decrease in biodiversity from fragmenting and changing the structure of these rangelands is assuredly diminished.

Bear Lake County is located in the southeastern portion of Idaho and borders Utah and Wyoming. The extreme western edge of the county is located in the Upper Bear hydrologic unit. Just over 50% of the land in the county is under private ownership and 46.5% is under federal management, mainly US Forest Service. The population of Bear Lake County grew 5.4% between 1990 and 2000, when it reached a population of 6,411. The majority (76%) of employed residents work in Bear Lake County. The average farm size in 1997 was 541 acres, down 17% from 1982. The median farm size in 1997 was 239. The decline in farm size has also been accompanied by a decline in the percentage of rangeland relative to cropland—from an average of 55% in rangeland to 41% in rangeland. The recreational amenities this area affords, and the close proximity to a large population center (Salt Lake City, Utah), will continue to place pressure on ranchers to transfer rangelands to uses with a higher economic return (i.e., development and recreation).

Idaho case study 2: Upper Snake Watershed and Twin Falls County

The Upper Snake Watershed extends slightly into Wyoming, Utah and Nevada, but is mainly located in southeastern and south central Idaho. According to the NRI, this watershed contains more rangeland and pastureland acreage than any other watershed in Idaho, with almost 3 million acres of rangeland and 575,400 acres of pastureland. From 1982 to 1997, rangeland declined 4.5% (3.14 to 3.00 million acres), while pastureland increased 3.7% (608,200 to 575,400 acres). From 1982 to 1997, 61,100 acres of rangeland and 92,100 acres of pastureland went into cultivated cropland. Almost 3,700 acres of rangeland and 12,800 acres of pastureland went into urban development, while 160,500 acres of rangeland and pastureland reverted to federal control. During this time, 44,600 acres of cropland and pastureland were converted to rangeland.

Twin Falls County is located on the western edge of the Upper Snake Basin. The county is comprised of just over 1.2 million acres. More than one half (52%) of the county is under federal management, principally the Bureau of Land Management. The population of Twin Falls County grew 20% from 1990 to 2000 to the current population of 64,284, constituting the fourth largest county population in Idaho. The majority of residents work within the county. Zoning laws have limited urban development throughout the countryside by restricting home lots to a minimum of 40 or 160 acres, depending upon the distance from the urban area. While these zoning regulations have helped preserve the aesthetic value of the land, the impact on rangeland health and biodiversity is uncertain at best.

During the 1970s and into the early 1990s, rangeland acreage was converted to cultivated land (sugar beets, potatoes, alfalfa and small grains) on the west and south ends of Twin Falls County. Deep wells were used to irrigate the land. Little of this conversion is occurring today. This county is typical of many in Southern Idaho where large amounts of rangeland acreage have been brought into crop production by legislation that has allowed farmers to drill wells for irrigation purposes. While this has been a benefit to the economy of Idaho, the impact on rangeland biodiversity, especially on private lands, have been detrimental and has lead to conflicts between threatened wildlife species (e.g., sage grouse) and farming interests.

Idaho case study 3: Middle Snake-Boise Watershed and Boise County

The Middle Snake-Boise Watershed is located in the southwestern portion of Idaho. More than 2.1 million acres of private rangeland and 264,000 acres of pastureland are located in this watershed, according to the NRI. Rangeland and pastureland acreage actually increased by 2% and 5%, respectively, from 1982 to 1997. The increase in rangeland occurred mainly from conversion of federal land to private ownership. Increases in pastureland resulted from cropland conversion. Had it not been for the conversion of federal lands, rangeland would have decreased over the period, since 18,400 acres went into urban development and 13,300 acres went into cropland. Urban land in this area increased from 76,700 acres in 1982 to 168,700 acres in 1997.

Boise County is located in the Middle Snake-Boise hydrologic unit in the west-central portion of the state. Boise County borders Ada County, which contains Boise City, the largest metropolitan area in Idaho. Boise County has just over 1.2 million acres. Just over 75% of the county is under federal management. Approximately 200,000 acres (16.4%) are privately owned. The county population was 6,670 people in 2000, which was an increase of 90.1% from 1990. Over 38% of the work force commutes outside the county, primarily to Ada County. According to the Census of Agriculture, the average farm size decreased from 1,089 acres in 1982 to 583 acres in 1997. The median farm size in 1997 was 175 acres. Although the average farm size has decreased substantially in the past two decades, the number of farmers has increased from 73 to 78 and the number of farms reporting pasture and rangeland acreage has increased from 30 to 40. Boise County is typical of the impact population growth, accompanied by increases in per capita income, have upon the surrounding rangeland areas. Boise County is truly becoming a bedroom community of Ada County and the surrounding area. The decline in average farm size not only fragments rangelands but the management of the remaining countryside is often not as conducive to rangeland health and biodiversity.

Montana

Human population

The 2000 Census places Montana's population at 902,195 people, with a population density of 6.2 people per square mile. Montana experienced a 12.9% growth in population from 1990 to 2000, with 33 of 56 counties experiencing a population increase during this time. Most of the growth in population occurred in the western portion of the state, while the decline in population mainly occurred in the eastern and north central portion of the state. For example, Ravalli County in the southwestern part of the state experienced a 44% increase in population, while Garfield County in east-central Montana experienced a 20% decline. Non-metropolitan per capita income grew from 10,203 in 1982 to 19,902 in 1998. The gap between metropolitan and non-metropolitan per capita income grew 11% from 1982 to 1998.

Land use and land in farms

The number of farms in Montana grew from 23,570 in 1982 to 24,279 in 1997, while the average farm size decreased slightly from 2,568 to 2,414 acres. According to the Census of Agriculture, 57% of the farms had pasture and rangeland acreage, up 1% from 1982 (Figure 3.2).

According to the Census of Agriculture, Montana experienced a 3.72% decline in pasture and rangeland acreage from 1982 to 1997 (40.8 million to 39.3 million acres), with 36 of 56 counties experiencing a decrease. Some of the largest decreases occurred in the western portion of the state. NRI statistics place 1997 rangeland acreage at 36.8 million acres, down 2.85% from the 37.8 million acres in 1982.

All but one of Montana's hydrologic watersheds experienced declines in rangeland acreage from 1982 to 1997, while the majority experienced increases in pastureland units. All major watersheds also witnessed decreases in cropland acreage, largely due to an increase in acreage enrolled in the CRP. Three watershed units, Lower Yellowstone (#101000), Milk (#100500) and the Missouri Headwaters (#100200) will be more closely scrutinized in this report. On a hydrologic unit basis, NRI statistics must be interpreted cautiously because of the increased measurement error. Trends are, therefore, more reliable than the actual acreage estimates.

Montana case study 1: Lower Yellowstone Watershed and Rosebud County

The Lower Yellowstone Watershed covers an 8.5 million acre area that flows from south-central Montana northeast to the North Dakota border (Figure 2.13). This watershed contains the greatest amount of rangeland acreage (5.6 million acres) in Montana. From 1982 to 1997, the watershed experienced less than a 1% decline in rangeland and a 6.8% decline in pastureland. While the total acreage in rangeland was basically constant, the acreage comprising the rangeland base did change somewhat. Some 18,400 rangeland acres went into cultivated cropland, 33,200 acres into uncultivated cropland, 9,800 acres into pastureland, and 10,700 rangeland acres ended up being classified under the CRP. During this time period, 9,500 acres of cultivated cropland and 10,000 acres of pastureland were converted back into rangeland. Additional acreage from various land uses, including federal land and small waterways, were also reclassified as rangeland. Cultivated cropland decreased 19% from 1982 to 1997, with most of this acreage going to the CRP, uncultivated cropland, and pastureland. Urban area increased 78%, from 8,200 to 14,600 acres, with 2,600 of those acres coming from rangeland.

Rosebud County is located in the southern portion of the Lower Yellowstone Watershed. Rosebud is the fourth largest county in Montana with over 3.2 million acres. The county population decreased to 9,383 in 2000 from 10,505 in 1990. Most of the farmland acreage is in winter wheat, other spring wheat, or barley. Some acreage is planted in corn, sugar beets and dry beans. Rosebud ranks fifth in Montana in hay production with over 85,000 acres harvested in 1999. The January 1, 2000 cattle inventory was 85,000 head; the fifth largest in Montana. The average farm size decreased 13.5% to 7,406 acres from 1982 to 1997. The median farm size was 1,788 acres in 1997. The number of farms in Rosebud County increased almost 3% from 1982 to 1997, to 362 farms, while the number of farms reporting pasture and rangeland acreage increased 10%. Census of Agriculture estimates placed pasture and rangeland acreage at 2.2 million acres in 1997, or 86% of total farmland acreage. The Agricultural Census reported a 15% decrease in pasture and rangeland acreage from 1982 to 1997, though county personnel (along with NRI statistics) had difficulty justifying this large of decline. County personnel indicate that several ranches along the Yellowstone River were purchased by out-of-state interests, and are still being operated as working ranches and farms, but are being valued for their wildlife and other amenities. This county typifies many areas where population growth is declining or stagnant, most acreage considered valuable for cropland has already been plowed, and acreage is being purchased by outside interests for a piece of rural life. This type of area may be a prime candidate for conservation easements to maintain the vast rangelands in existence before demands from outside interests put pressure on converting rangelands to other uses.

Montana case study 2: Milk Watershed and Hill County

The Milk Watershed is located in the north-central portion of Montana. Just over 3.70 million acres of rangeland are located in this watershed. Rangeland acreage dropped 6.6% (down from 3.97 million acres) between 1982 and 1997; the most precipitous decline in Montana. The majority of lost acreage (235,800 acres) was converted to cultivated cropland, pastureland (52,700 acres) and CRP acreage (32,700 acres). An additional 24,800 acres of uncultivated cropland, 4,900 acres of pastureland and 35,500 acres of federal land was reclassified as rangeland during this period. Cultivated crop acreage declined 10.7% from 1982 to 1997, and acreage devoted to urban development increased 54%, from 10,500 acres to 16,200 acres.

Hill County is located in the northern center of the state and borders Canada. The county population was 16,673 in 2000, down 5.6% from 1992. Most of the farm acreage in Hill County is planted to some type of wheat or barley. The county ranks first in Montana in other spring wheat with 11.5 million acres planted in 1999. Over 25,000 acres of hay was harvested in 1999, mainly to support a cattle inventory of 28,700 head. The number of farms in Hill County increased from 675 to 692 from 1982 to 1997, while the number of farms reporting pasture and grazing land declined from 323 to 297. The average farm size declined 7.6% to 2,374 acres, with a median farm size of 1,519 acres. According to the Census of Agriculture, Hill County experienced a 13% decrease in pasture and rangeland acres between 1982 ando 1997. This, again, is higher than the decline in rangeland that can be justified by the NRI data, but still substantiates a decline in rangeland acreage. This area is typical of many counties that are agricultural based and has rangeland acreage that can be converted to marginal cropland. When the agricultural economy is depressed and government programs, such as the CRP, provide incentives to convert rangeland to farmland, it is only natural that some farmers will take advantage of these programs to supplement their farm income. While less than 10% of rangeland acreage in the Milk Watershed was converted to other agricultural uses, the increased fragmentation and loss of biodiversity can be significant.

Montana case study 3: Missouri Headwaters Watershed and Beaverhead County

The Missouri Headwaters Watershed is located in the southwestern portion of Montana. Just less than 2.6 million acres of rangeland and 468,000 acres of pastureland are located within this watershed. While rangeland acreage was essentially the same in 1982 and 1997, acreage actually increased by almost 15% from 1982 to 1992 before decreasing again between 1992 and 1997. From 1982 to 1997, 48,000 acres were diverted from rangeland to pastureland, 30,100 acres became forested lands, and 16,300 acres of rangeland went into urban development. Almost 17,000 pastureland acres were reclassified to rangeland during these 15 years and 96,000 acres previously under federal ownership were reclassified as private rangelands. Urban development increased 153% during this period, going from 13,300 to 33,600 acres, most of it coming out of rangeland.

Beaverhead County is located in the far southwest corner of Montana and covers over 3.5 million acres. County population increased 9% from 1990 to its population of 9,202 in 2000. Beaverhead ranks first in Montana for beef cattle production and hay acres harvested, and ranks fifth for sheep production. Some small grains and potatoes are also grown. The number of farms increased from 342 to 360 and the number of farms reporting pasture and rangeland increased from 238 to 248 between 1982 and 1997. However, average farm size decreased from 4,522 to 3,200 acres during this same time period, with the median farm size of 863 acres in 1997. According to the Census of Agriculture, there were just over 1 million acres of pasture and rangeland reported in 1997; a 17% decrease from what was reported in 1982. This decrease could not be substantiated by county personnel nor by the NRI statistics for the watershed that Beaverhead County is a part of. This area, though, is representative of many mountain valleys that were traditionally cattle/rangeland based economies but are beginning to see pressure from outside interests for development because of the natural amenities of the area. Fragmentation and destruction of the natural biodiversity can quickly follow.

North Dakota

Human population

According to Census 2000 data, North Dakota is the second least populated (Wyoming has the lowest population) and grew the least (0.5%) over the past decade among the 22 western states (Table 3.1). An examination of county Census data indicate that only 6 of North Dakota's 53 counties actually gained population during the 1990 to 2000 period and 15 counties lost more than 15% of their population over the decade.

Land use and land in farms

NRI statewide data for North Dakota indicate that range and pastureland declined by almost 1 million acres (8%) between 1982 and 1997 (Table 2.15). This change was accompanied by a decline in cropland of about 2 million acres and an increase of 2.8 million acres in CRP land. The implication in these statistics is that over 775,000 acres of range and pastureland were converted to cropland during this period.

A correlation analysis of 1997 Census of Agriculture data for all counties in North Dakota shows that counties with the largest portions of their agricultural land in the “pasture” and/or “range” category are significantly more likely to receive lower total government payments, have lower net cash returns from agricultural product sales and lower per capita personal income than counties with less pasture and rangeland. Conversely, the counties with large proportions of pasture and rangeland are significantly more likely to have larger numbers of beef cattle and larger land holdings than counties with less pasture and rangeland.

North Dakota case study 1: Dickey County

Dickey County is located in the southeastern part of North Dakota in the James Hydrologic Unit (#101600, Table 2.9 and Figure 2.15). About one-half of the county can be characterized as “Prairie Pothole”. The county lost 5.7% of its population between 1990 and 2000. The county’s economy is based primarily on agriculture and the average per capita personal income in the county in 1998 was about 9% below the state average and about 24% below the US average.

The county reported 15% fewer farms in the 1997 Census of Agriculture than in 1982, including a 6% reduction in the number of farms reporting pasture and/or rangeland acreage. As a result of the reduction in farm numbers, size of the average farm increased by 11% during the 15- year period. During this period range and pastureland acreage remained at about 17% of total land in farms; approximately 100,000 acres. According to reports from county Farm Service Association (FSA) personnel (Dickey Co. ND, FSA/USDA) this trend is continuing. However, wetter than normal conditions have caused many of the potholes to remain filled with water and create discontinuities in much of the cropland. As a result, increases in CRP acres of about 3.5% of the county's 1997 cropland acres have been observed since the early 1990s (from approximately 42,000 acres in 1997 to about 76,000 in 2000).

North Dakota case study 2: Stutsman County

Stutsman County is also located in the James Hydrologic unit, about 50 miles north of Dickey County. Most of the county can be characterized as "Prairie Pothole". The county's economy is largely agricultural based and the average per capita personal income in the county in 1998 was about 4% above the state average and about 13% below the US average. The county lost 1.5% of its population between 1990 and 2000.

The county reported 14% fewer farms in 1997 than in 1982. However, the average size farm increased by more than 10% and 9.6% fewer farms reported pasture and/or rangeland acreage by 1997. During this period range and pastureland acreage remained at about 17% of total land in farms; approximately 215,000 acres. According to reports from county FSA personnel (Stutsman Co. ND, FSA/USDA) this trend has continued since 1997, except that more than 2,800 acres of formerly unplowed grassland was broken into cropland in 2000. However, the county FSA also reported that, like Dickey County, due to wetter than normal conditions, there has been a significant increase in CRP acres since the early 1990s (from approximately 139,000 in 1997 to about 189,000 in 2000).

North Dakota case study 3: Mountrail County

Mountrail County is in northwest North Dakota in the Lake Sakakawea Hydrologic Unit (#101101, Table 2.9 and Figure 2.15). Like the other North Dakota counties highlighted in this report Mountrail is largely characterized as "Prairie Pothole" country. The county's economy is largely agricultural based and the average per capita personal income in the county in 1998 was about 8% below the state average and about 23% below the US average. The county lost 5.6% of its population between 1990 and 2000.

The county reported 14% fewer and 15% larger average size farms in the 1997 Census of Agriculture than in 1982. The number of farms reporting pasture and/or rangeland acreage diminished by 6% by 1997. During this period, range and pastureland acreage increased from about 25% to about 30% of total land in farms; approximately 301,000 acres in 1997. According to reports from county FSA (Mountrail Co. ND, FSA/USDA) and Agricultural Extension

(Mountrail Co. ND, Cooperative Extension Service) personnel, this trend is continuing with small increases in the acreage devoted to grazing land an/or forage production. Since 1997, CRP acreage has been reduced by about one-third due to expiring contracts and the landowners inability to obtain renewal contracts. County officials estimate that about one-third of the acreage coming out of CRP since 1997 has reverted to cropland and about two-thirds to grazing land. Rapidly increasing demand for access rights to land for hunting is beginning to influence owners to maintain and/or create more wildlife habitat on their land.

South Dakota

Human population

South Dakota is the third least populated among the 22 western states. Due to significant population growth on its eastern and western sides the state managed an overall 8.5% increase from 1990 to 2000. However, the population of the state's rural interior continued to erode. Poor economic performance in agricultural production plus a lack of employment alternatives led to population declines in 30 of South Dakota's 66 counties and 9 lost more than 10%.

Land use and land in farms

NRI State-wide data for South Dakota indicate that range and pastureland declined by about 1.7 million acres (7%) between 1982 and 1997 (Table 2.10). This change was accompanied by a decline of only 0.2 million acres in cropland and an increase of 1.7 million acres in CRP land. The implication is that about 1.5 million acres of range and pastureland were converted to cropland during this period.

A correlation analysis of 1997 Census of Agriculture data for all counties in South Dakota shows that counties with the largest portions of their agricultural land in the "pasture" and/or "range" category are significantly more likely to receive lower total government payments, have lower net cash returns from agricultural product sales and lower per capita personal income than counties with less pasture and rangeland. Conversely, the counties with large proportions of pasture and rangeland are significantly more likely to have larger numbers of beef cattle and larger land holdings than counties with less pasture and rangeland.

South Dakota case study 1: Aurora County

Aurora County is located in southeastern South Dakota and includes land in both the James and Fort Randall Reservoir Hydrologic Units (#101600 and #101401, Table 2.9 and Figure 2.17). The economy is largely agriculturally based. Average per capita personal income in the county in 1998 was about 19% below the state average and about 29% below the US average. The county lost 2.5% of its population in the decade between 1990 and 2000.

Aurora County reported 12% fewer farms in the 1997 Census of Agriculture than in 1982. During this period cropland acreage (including CRP land) remained at about 66% (approximately 226,000 acres) of total land in farms. However, according to county FSA records (Aurora Co. SD, FSA/USDA), cropland increased by about 3% (more than 6,600 acres) from 1996 through 2000, due to plowing up previously uncultivated grasslands. County officials also noted that non-resident ownership of rural land is increasing in the county. Most of the agricultural land, however, is being incorporated into other local farms through rent or lease arrangements. County officials also note an increased interest in management practices that maintain or improve the wildlife habitat and hunting potential of the land.

South Dakota case study 2: Hyde County

Hyde County is about 50 miles northeast of Aurora County and lies primarily in the Fort Randall Reservoir Hydrologic Unit. The county's economy is also primarily dependent on agriculture. County average per capita personal income was about 6.6% below the state average and about 18% below the US average in 1998. The county lost 1.5% of its population between 1990 and 2000.

While total farm numbers declined by only 3% between 1982 and 1997, according the Census of Agricultural, farms with range and/or pastureland declined by 13%. During this period the proportion of total farmland made up of range and pastureland declined from 65% to 58% (a loss of approximately 9,000 acres).

According to county FSA records (Hyde Co. SD, FSA/USDA), this trend is continuing as cropland in the county increased by more than 5% (several thousand acres) between 1997 and 2000 due to breaking out previously unplowed rangeland. According to county officials, the continued conversion of grassland to cropland is largely due to federal government program incentives. Landowners find it more profitable to convert the land to cropping primarily since it is then eligible for government support including loan deficiency payments and subsidized crop insurance.

South Dakota case study 3: Jones County

Jones County is in central South Dakota and is primarily situated in the Fort Randall Reservoir Hydrologic Unit. The county's economy is also primarily agriculturally based and county average per capita personal income was about 1% above the state average and about 11% below the US average in 1998. The county lost 9.9% of its population between 1990 and 2000.

The county reported 8.6% fewer, but 19% larger average size farms in the 1997 Census of Agricultural than in 1982. During this period range and pastureland acreage remained at about 60% of total land in farms (approximately 356,000 acres).

According to reports from County FSA Office personnel (Jones Co. SD, FSA/USDA) this trend is continuing with little or no breaking of grassland sod into cropland during the last several years. Farm size is continuing to increase with land consolidation via leasing. One factor contributing to the maintenance of grazing lands in the county is the significant increase in use of the land for hunting and the consequent interest in maintaining wildlife habitat.

Texas

Human population

Texas' population is the second largest in the US; second only to California. Texas grew a whopping 22.8% during the decade between 1990 and 2000. However, 66 of its counties (26%) experienced no or negative growth. Most of the population decreases were in counties in the northwestern portion of the state and consisted primarily of counties with economies based largely on agriculture.

Land use and land in farms

A correlation analysis of 1997 Census of Agricultural data for all counties in Texas shows that counties with the largest portions of their agricultural land in the "pasture" and/or "range" category are significantly more likely to receive lower total government payments, have lower net cash returns from agricultural product sales and lower per capita personal income than counties with less pasture and rangeland. Conversely, the counties with large proportions of pasture and rangeland are significantly more likely to have larger land holdings than counties with less pasture and rangeland.

During the years 1995 –1999 the statewide average per acre median price for rural land in Texas was $677 and the average annual increase was 7.8% (Real Estate Center). Most of this demand originated from non-agricultural interests as prices notably exceeded the productive value of the land. For example, in many parts of Texas, wildlife based enterprises, primarily lease-hunting, are generating more net income per acre of rangeland than livestock production. Fortunately, ranchers in these areas have learned to manage both their livestock and wildlife enterprises so that they are largely complementary. This kind of complementary land use activity may offer one of the best hopes for providing the economic viability necessary to sustain the ranching industry in many other parts of the US in the future.

Texas case study 1: Cottle County

Cottle County is located in the Rolling Plains Land Resource Region and is in the Red-Pease Hydrologic Unit (#111301 Table 2.13 and Figures 2.19c). It is representative of one of the few areas in Texas that experienced an increase in grassland area of more than 5% between 1982 and 1997. The county is also representative of a region of the state where the economy is primarily dependent on agriculture and, consequently, suffers from low incomes and declining employment opportunities because of prolonged poor performance in the agriculture sector. County average per capita income was 26% below the state average and 29% below the US average in 1998. The county lost 15.3% of its population between 1990 and 2000.

From 1995 through 1999 the median per acre price for rural land in Cottle and surrounding counties averaged $243 and exhibited an average annual increase of only 2% (Real Estate Center). The relatively depressed land market was a reflection of both the depressed agricultural economy and the lack of demand for other uses of land in this area.

The county reported 4% fewer, but 8% larger, farms in the 1997 Census of Agricultural than in 1982. By 1997, the number of farms reporting range and/or pastureland increased by almost 16%. During this period, the proportion of total farmland made up of range and pastureland increased from 63% to 73% (approximately 60,000 acres increase). Cotton acreage is reportedly declining significantly. According to reports from county FSA (Cottle Co. TX, FSA/USDA) personnel, the trend in farm consolidation has continued during the past 4 years along with prolonged drought conditions and low commodity prices.

Texas case study 2: McCulloch County

McCulloch County encompasses the geographic center of the state and is a transition area containing typical Edwards Plateau rangelands in its southern half and Rolling Plains mixed range and cropland in its northern half. It lies in the Middle Colorado – Llano Hydrologic Unit (#120902, Table 2.13 and Figure 2.19c). It is representative of one of several areas in Texas that experienced a decrease of less than 5% in grassland area between 1982 and 1997.

The county's economy is primarily agriculturally based, although it is more diversified than the economy of Cottle County. Wildlife based enterprises, especially lease-hunting , are an important and growing land use alternative for McCulloch County. The county average per capita personal income was 29% below the state average in 1998 and 33% below the US average. The county lost 6.5% of its population between 1990 and 2000.

From 1995 through 1999 the median per acre price for rural land in McCulloch and surrounding counties averaged $709 and exhibited an average annual increase of 9.8% (Real Estate Center). Since climatic and economic conditions for production agriculture were poor over the period, above average land prices must be reflective of demand from non-agricultural interests, primarily wildlife-based recreation.

The county reported 5% more farms in the 1997 Agricultural Census than in 1982 and the number of farms reporting range and/or pastureland increased by almost 20%. During this period, the proportion of total farmland made up of range and pastureland dropped from 76% to 73% (an approximate 50,000 acre loss).

According to reports from county Agricultural Extension (McCulloch Co. TX, Agricultural Extension Service) personnel, the trend toward more but smaller rural land holdings has continued during the past 4 years. This trend has been fuelled primarily by land purchases by people living outside the county with interests in wildlife-based recreation. In addition, some of the land is being taken completely out of agricultural production in cases where wildlife breeding and other land use goals may preclude agricultural enterprises. Such uses are, however, generally compatible with maintaining good rangeland habitat. County Agricultural Extension personnel also report that more cropland would have been taken out of production during the past 3 to 5 years had it not been for the financial support of government programs, particularly the subsidized crop insurance.

Texas case study 3: Wise County

Wise County is located in North Central Texas in the Upper Trinity Hydrologic Unit (#120301, Table 2.13 and Figures 2.19c). It is representative of one of several areas in Texas that experienced a decrease of more than 5% in grassland area between 1982 and 1997. It is also representative of several areas in Texas that are within convenient commuting distance of a major growth center along the rapidly developing I-35 corridor. Average per capita personal income in the county in 1998 was about 17% below the state average and about 21% below the US average. The population of Wise County grew by 47% between 1990 and 2000.

From 1995 through 1999 the median per acre price for rural land in Wise and surrounding counties averaged $ 1,830 and exhibited an average annual increase of 15.8% (Real Estate Center). The median tract size sold in Wise County during this period (57 acres) was less than half of the statewide average.

The county reported 33% more farms in the 1997 Census of Agriculture than in 1982 and the number of farms reporting range and/or pastureland increased by 14%. Average farm size in the county declined from 260 acres in 1982 to 198 acres in 1997. Despite these large increases in the number and decreases in size of farms, range and pastureland decreased by only about 10,000 acres during this period according to the 1997 Census of Agriculture. This is clearly a case of where the primary damage to grasslands from population growth is fragmentation into smaller and smaller units.

According to reports from county Agricultural Extension (Wise Co. TX, Agricultural Extension Service) personnel, the trend toward more but smaller rural land holdings has continued during the past 4 years. The trend is fuelled primarily by land purchases by persons seeking x-urban homesites and “ranchettes” (homesites with 3 to 30 acres and facilities for keeping a horse(s) and/or a few livestock or a small orchard).

Summary

Chapter 3 explored a number of the potential drivers of land use change in the United States with special focus on grasslands. Six broad anthropogenic influences on the extent of grasslands were delineated:

1. Population growth;
2. Affluence and increases in personal income;
3. Relatively low economic returns to agricultural compared to alternative land uses;
4. Incentives favoring cropping over livestock grazing created by federal policies;
5. Non-agricultural demand for rural lands; and
6. Advances in rural telecommunications and its implications for employment opportunity.

The observed influences of these drivers of land use change were illustrated using a variety of case studies from across the 22 state focus region. These 17 brief case studies from Colorado, Idaho, Montana, North Dakota, South Dakota and Texas brought forward the diversity of local situations with regard to rangeland and grassland loss, highlighting the potentially distinct implications of federal grassland protection policies at the local level.

Table 3.1. Resident population in 1990 and 2000, numerical and percent change in resident population 1990 to 2000 of the 22 states west of the Mississippi River ranked by percent change.

US Rank	State	Population		Changes in Population	
		1990	2000	Number	Percent
1	Nevada	1,201,833	1,998,257	796,424	66.27
2	Arizona	3,665,228	5,130,632	1,465,404	39.98
3	Colorado	3,294,394	4,301,261	1,006,867	30.56
4	Utah	1,722,850	2,233,169	510,319	29.62
5	Idaho	1,006,749	1,293,953	287,204	28.53
8	Texas	16,986,510	20,851,820	3,865,310	22.76
10	Washington	4,866,692	5,894,121	1,027,429	21.11
11	Oregon	2,842,321	3,421,399	579,078	20.37
12	New Mexico	1,515,069	1,819,046	303,977	20.06
18	California	29,760,021	33,871,648	4,111,627	13.82
19	Arkansas	2,350,725	2,673,400	322,675	13.73
20	Montana	799,065	902,195	103,130	12.91
21	Minnesota	4,375,099	4,919,479	544,380	12.44
26	Oklahoma	3,145,585	3,450,654	305,069	9.7
30	Missouri	5,117,073	5,595,211	478,138	9.34
32	Wyoming	453,588	493,782	40,194	8.86
35	Kansas	2,477,574	2,688,418	210,844	8.51
36	South Dakota	696,004	754,844	58,840	8.45
37	Nebraska	1,578,385	1,711,263	132,878	8.42
40	Louisiana	4,219,973	4,468,976	249,003	5.9
43	Iowa	2,776,755	2,926,324	149,569	5.39
50	North Dakota	638,800	642,200	3,400	0.53

Source: US Department of Commerce Bureau of the Census, Census 2000.

Table 3.2. Per capita personal income, for states west of the Mississippi River, 1995–99

State	-Dollars-					% Change			
	1995	1996	1997	1998	1999	95-96	96-97	97-98	98-99
Colorado	24,865	26,231	27,950	29,860	31,546	5.5	6.6	6.8	5.6
Nevada	25,808	27,142	28,201	29,806	31,022	5.2	3.9	5.7	4.1
Minnesota	24,583	26,267	27,548	29,503	30,793	6.9	4.9	7.1	4.4
Washington	23,878	25,287	26,817	28,632	30,392	5.9	6.1	6.8	6.1
California	24,496	25,563	26,759	28,280	29,910	4.4	4.7	5.7	5.8
Nebraska	22,196	24,045	24,590	25,861	27,049	8.3	2.3	5.2	4.6
Oregon	22,668	23,649	24,845	25,958	27,023	4.3	5.1	4.5	4.1
Texas	21,526	22,557	24,242	25,803	26,858	4.8	7.5	6.4	4.1
Kansas	21,899	23,121	24,355	25,687	26,824	5.6	5.3	5.5	4.4
Wyoming	21,514	22,098	23,820	24,927	26,396	2.7	7.8	4.6	5.9
Missouri	22,094	23,099	24,252	25,403	26,376	4.5	5.0	4.7	3.8
Iowa	21,181	22,713	23,798	24,844	25,617	7.2	4.8	4.4	3.1
Arizona	20,634	21,611	22,781	24,133	25,189	4.7	5.4	5.9	4.4
South Dakota	19,848	21,736	22,275	23,797	25,045	9.5	2.5	6.8	5.2
North Dakota	19,084	21,166	20,798	22,767	23,313	11.0	-1.7	9.5	2.4
Utah	18,858	19,955	21,156	22,294	23,288	5.8	6.0	5.4	4.5
Oklahoma	19,394	20,151	21,106	22,199	22,953	3.9	4.7	5.2	3.4
Louisiana	19,541	20,254	21,209	22,352	22,847	3.6	4.7	5.4	2.2
Idaho	19,630	20,353	20,830	21,923	22,835	3.7	2.3	5.2	4.2
Arkansas	18,546	19,442	20,229	21,260	22,244	4.8	4.0	5.1	4.6
Montana	18,764	19,383	20,167	21,324	22,019	3.3	4.0	5.7	3.3
New Mexico	18,852	19,478	20,233	21,178	21,853	3.3	3.9	4.7	3.2

Source: USDC – Bureau of Economic Analysis

Table 3.3. Average cropland and pastureland sale prices and percent change in sale prices, 1997 and 2000, for states west of the Mississippi River.

State	Cropland Price 1997 ($/acre)	Cropland Price 2000 ($/acre)	% Change in Cropland Price 1997 – 2000	Pastureland Price 1997 ($/acre)	Pastureland Price 2000 ($/acre)	% Change in Pastureland Price 1997 – 2000
AZ	3,700	4,300	16.22	300	360	20.00
AR	968	1,080	11.57	890	1,000	12.36
CA	5,080	5,960	17.32	1,100	1,000	(9.09)
CO	772	852	10.36	320	345	7.81
ID	900	1,170	30.00	640	850	32.81
IA	1,700	1,890	11.18	615	650	5.69
KS	649	666	2.62	365	375	2.74
LA	1,080	1,110	2.78	1,210	1,150	(4.96)
MN	1,090	1,270	16.51	360	410	13.89
MO	1,040	1,250	20.19	660	790	19.70
MT	458	458	0.00	190	205	7.89
NE	1,020	1,110	8.82	200	230	15.00
NV	1,700	1,900	11.76	220	270	22.73
NM	1,330	1,370	3.01	150	150	0.00
ND	427	425	(0.47)	141	155	9.93
OK	553	548	(0.90)	361	415	14.96
OR	928	1,020	9.91	400	405	1.25
SD	456	510	11.84	155	190	22.58
TX	674	770	14.24	510	570	11.76
UT	2,300	2,740	19.13	395	420	6.33
WA	1,340	1,340	0	550	490	(10.91)
WY	744	815	9.54	150	160	6.67
Average	1,314.05	1,479.73	10.26	449.18	481.36	9.51
Average % change in annual rental rates 1997-2000			7.03			4.90

Source: USDA- NASS

Table 3.4. Average pastureland and cropland annual rental rates and comparisons of rental rates to sale prices between pasture and cropland, 2000, for the states west of the Mississippi River.

State	Pastureland Sale Price as % of Cropland Sale Price	Annual Cropland Rent ($/acre)	Annual Cropland Rent as % of Cropland Sale Price	Annual Pastureland Rent ($/acre)	Annual Pastureland Rent as % of Pastureland Sale Price	Pastureland Rent as % of Cropland Rent
AZ	8.11	135.00	3.14	-*	-	-
AR	91.94	50.00	4.63	-	-	-
CA	21.65	300.00	5.03	-	-	-
CO	41.45	-	12.80	-	-	-
ID	71.11	120.00	10.26	-	-	-
IA	36.18	115.00	6.08	29.00	4.46	25.22
KS	56.24	35.50	5.33	12.80	3.41	36.06
LA	112.04	51.90	4.68	14.00	1.22	26.97
MN	33.03	77.90	6.13	17.50	4.27	22.46
MO	63.46	60.00	4.80	20.00	2.53	33.33
MT	41.48	17.30	3.78	4.80	2.34	27.75
NE	19.61	66.00	5.95	11.30	4.91	17.12
NV	12.94	-	-	-	-	-
NM	11.28	-	-	2.00	1.33	-
ND	33.02	35.50	8.35	9.50	6.13	26.76
OK	65.28	26.00	4.74	7.80	1.88	30.00
OR	43.10	67.00	6.57	-	-	-
SD	33.99	39.80	7.80	11.00	5.79	27.64
TX	75.67	21.00	2.73	6.00	1.05	28.57
UT	17.17	51.00	1.86	-	-	-
WA	41.04	160.00	11.94	-	-	-
WY	20.16	-	44.00	-	-	-
Average	43.18	79.38	5.77	12.14	3.28	27.44

*- indicates insufficient data

Source: USDA- NASS

Table 3.5. Number of farms reporting acreage in other pastureland and rangeland[1], by state, according to the US Census of Agriculture, 1978 to 1997.

State	1978	1982	1987	1992	1997
Arizona	2,338	2,163	2,399	2,385	2,203
Arkansas	13,390	11,827	12,936	10,642	12,288
California	12,056	13,463	14,211	11,949	12,952
Colorado	12,685	11,872	11,875	11,949	12,952
Idaho	7,689	6,744	6,923	6,247	6,517
Iowa	25,868	24,254	22,415	20,629	18,756
Kansas	38,748	34,510	32,362	29,949	29,854
Louisiana	6,141	5,996	6,419	5,656	6,380
Minnesota	20,134	19,794	18,166	15,969	15,503
Missouri	29,480	30,729	32,093	28,224	28,740
Montana	14,230	13,237	13,675	13,129	13,941
Nebraska	28,279	24,997	24,299	21,554	22,460
Nevada	962	1,010	1,034	1,024	1,027
New Mexico	6,789	6,424	6,803	6,767	6,570
North Dakota	19,285	15,644	16,025	14,565	14,541
Oklahoma	41,903	36,590	36,122	33,391	36,763
Oregon	9,215	8,546	9,178	8,621	9,415
South Dakota	20,392	18,474	17,957	17,326	16,858
Texas	79,178	78,443	83,251	78,805	84,875
Utah	4,576	4,096	4,502	4,391	4,619
Washington	8,257	7,600	7,994	6,934	6,886
Wyoming	5,062	5,381	5,467	5,453	5,968
Total	406,657	381,794	386,106	355,559	370,068

[1] Excludes pastureland that is classified in cropland and woodland pasture.

United States Grasslands and Related Resources: An Economic and Biological Trends Assessment

Chapter 4: Summary and Conclusions

Richard Conner, Andrew Seidl, Larry VanTassell, and Neal Wilkins

Vast expanses of prairies, savannas, and steppes once dominated much of the current arable land in the US. These were grasslands, the largest vegetation formation in North America. During settlement and subsequent development, these grasslands represented a substantial ecological resource that sustained a large portion of the US economy. Through time, the ecological and economic functions of these lands have changed. The root causes of these changes are almost as diverse as the affected lands. Much of the historical grassland area has been converted to other land use – perhaps irreversibly. Much of what remains is degraded to the point that it is no longer capable of supporting the same level or variety of ecological and economic services. However, many natural grassland systems are resilient and they may realize much of their ecological and economic potential subsequent to recovery and restoration efforts.

In sum, the current literature and research regarding grasslands support the following conclusions and recommendations.

- Grasslands provide important ecological functions and services. They include nutrient cycling, carbon sequestration, watershed, wildlife habitat and source of biodiversity. All are dramatically reduced with the conversion of grasslands to other land uses.

- Grasslands are economically important. They are a major source of forage for livestock, particularly beef cattle, provide a source of high quality water, are the basis for wildlife-based recreational activities, and provide untold benefits in open space and scenic amenities among other benefits.

- Most of the historical and remnant grasslands are under private ownership, necessitating the explicit inclusion of landowners in any policy solution to future grassland protection and stewardship.

- Grasslands once accounted for about half of the landmass of the 48 contiguous United States. Largely, they had been converted to other land uses by 1950, primarily cropland.

- Over the last 50 years grasslands have continued to disappear, but conversion to land uses other than cropland have become much more prevalent.

- Grassland types on private lands vary considerably in their historic loss rates. Historically, the earliest and most extreme grassland losses tend to be concentrated in those grassland types most conducive to cropland conversion (e.g., tallgrass prairies). Most recently, grassland types that tend to convert to marginal croplands have faced considerable losses (e.g., mixed- and shortgrass prairies).

- Significant amounts of former cropland have been converted back to use as grazing lands; albeit with significantly reduced ecological function compared to unconverted grasslands.

- Conversion of grasslands to other land cover and/or poor grazing management on some of the remaining grasslands has resulted in significant losses in wildlife habitat and biodiversity.

- Despite an overall decrease in the rate of grassland losses over the last 50 years, some groups of wildlife species (e.g., grassland birds and prairie dog associates) appear to be decreasing at a rate faster than the decrease in grassland area.

- Several government policies and programs supporting agriculture have, and do yet, provide significant economic incentives for private landowners to convert grassland to cropland and/or retain marginal cropland instead of converting it back to grassland.

- Rapid population growth coupled with increasing wealth, advancing communications technology, and other socio-economic factors are dramatically increasing the demand for fragmenting grasslands and/or converting them into urban and ex-urban residential, recreational and industrial developments. Relatively low returns to farming and/or ranching activities on grasslands provide the potential for a ready supply of convertible lands to meet these increasing developmental demands.

- In many areas, continuing economic and population growth will result in increasing grassland fragmentation and loss unless government policy provides mechanisms and financial incentives to facilitate grassland retention and/ or restoration (e.g., conservation easements).

- In many areas, retention and/or restoration of grasslands under private ownership could be enhanced by revising government policies to ensure that they do not provide incentives to retain as cropland those lands that might otherwise be restored to grassland or convert grassland to cropland. Further, programs could be expanded that provide incentives to retain or restore native wildlife habitat and encourage wildlife-based land use enterprises (e.g., USDA-NRCS – EQIP).

This report provides an overview of the historical importance of grasslands in the United States from an economic and biological perspective (Chapter 1). This overview is followed by an assessment of the recent trends in US grasslands and related resources (Chapter 2). Chapter 3 addresses the forces of change in the ecological and economic status of US grasslands. Finally, Chapter 4 briefly points to the lessons learned in the previous three chapters and suggests potential courses of action to address these lessons. The objectives of this report are to inform and improve the quality of public discourse and decision-making surrounding issues of US grasslands. This report is submitted in the hopes of achieving these important objectives.

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Appendix A

Land Use Definitions

<u>Major Land Use Statistics</u>

Grassland pasture and range is defined in the Major Land Use reports as (Vesterby and Krupa 2001, p. 39):

> …all open land used primarily for pasture and grazing, including shrub and brush land types of pasture, grazing land with sagebrush and scattered mesquite, and all tame and native grasses, legumes, and other forage used for pasture or grazing.

Grassland pasture and range differ from cropland pasture in that the latter is assumed to be in long-term rotation or could be cropped without additional improvement. Vesterby and Krupa (2001) state that grassland pasture and range is not always distinguishable from other types of pasture and range. Grassland pasture and range also is distinguished in the MLU reports from forest-use land grazed. Forest-use land grazed "consists mainly of forest, brush-grown pasture, arid woodlands, and other areas within forested areas that have grass or other forage growth" (Vesterby and Krupa 2001, p. 41).

National Resource Inventory

Under the NRI, land used for livestock grazing can be categorized as cropland, pastureland, rangeland or forestland. Grazing land is classified as cropland if it is in a rotation with row or close-grown crops. Forestland is often used for grazing by livestock, but is differentiated from rangeland or pastureland by type of surface cover. According to the Summary Report 1997 National Resources Inventory (USDA/NASS 2000, p. 83-84),

> [forest land is a] *Land cover/use* category that is at least 10% stocked by single – stemmed woody species of any size that will be at lease 4 meters (13 feet) tall at maturity. Also included is land bearing evidence of natural regeneration of tree cover (cut over forest or abandoned farmland) and not currently developed for nonforest use. Ten percent stocked, when viewed from a vertical direction, equates to an aerial canopy of leaves and branches of 25% or greater.

Pastureland is defined in the Summary Report 1997 National Resources Inventory (USDA/NASS

2000, p. 86) as,

> [a] *Land cover/use* category of land managed primarily for the production of introduced forage plants for livestock grazing. Pastureland cover may consist of a single species in a pure stand, a grass mixture or a grass-legume mixture. Management usually consists of cultural treatments: fertilization, weed control, reseeding, or renovation, and control of grazing. For the NRI, this includes land that has a vegetative cover of grasses, legumes, and/or forbs, regardless of whether or not it is being grazed by livestock.

Conversely, rangeland is defined in the Summary Report 1997 National Resources Inventory (USDA/NASS 2000, p. 87) as,

> [a] *Land cover/use* category on which that climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheat grass, are planted and such practices as deferred grazing, burning, chaining, and rotational grazing are used, with little or no chemicals or fertilizer being applied. Grasslands, savannas, many wetlands, some deserts, and tundra are considered to be rangeland. Certain communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland.

Census of Agriculture

Three types of "pastureland" are included in the census estimates. These definitions are quite similar to those used by the MLU estimates. The category used in this report is "other pastureland and rangeland" and is defined by the Census of Agriculture (USDA/NASS 2000) as any pastureland not included in cropland and woodland pasture. Cropland used for pasture or grazing includes land that could be used for crops without additional improvement, or cropland that is used for rotational pasture. Woodland includes "natural or planted woodlots or timber tracts, cutover and deforested land with young growth which has or will have value for wood products" (USDA/NASS 1997). Land covered by sagebrush or mesquite is considered to be other pastureland and rangeland.

Great Trinity Forest Management Plan

Grasslands

Risks Associated with Rangeland Health and Sustainability

Risks Associated with Rangeland Health and Sustainability

Risk Management for Texans Series

RLEM No. 5 August 2000

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Introduction

Texas rangelands are a multiple use natural resource. From rangelands meat and fiber are produced, most of the wildlife in the state are found, and the majority of the water used by our cities, agriculture and industry is captured for storage in lakes or underground aquifers. Also, rangelands provide recreational opportunities such as hiking, off road recreational vehicle use, birding, camping, etc. as well as providing aesthetic beauty to the landscape. The health and sustainability of Texas rangelands are important to every citizen of this state.

What is Healthy Rangeland?

Healthy rangelands as compared to unhealthy rangelands usually have a greater diversity of plant and animal species. Plant communities are dominated by perennial plants as compared to annuals. Healthy rangelands have minimum erosion, because the soil surface has sufficient plant cover to protect it from the impact of raindrops. This plant cover also serves to slow the movement of water across the soil surface, resulting in greater water infiltration rates as compared to unhealthy rangelands. Healthy rangelands produce a greater and more dependable quantity of herbaceous forage for use by livestock and wildlife. And most importantly, healthy rangelands ecological processes, including the hydrologic cycle, nutrient cycle and energy flow are all functioning, supporting healthy biotic populations and communities.

What are the Risks of Unhealthy Rangelands?

Unhealthy rangelands have accelerated loss of soil through excessive water or wind erosion. This soil loss increases sedimentation of streams, rivers and above ground aquifers, reducing their storage capacity and life. Unhealthy rangelands also have reduced recharge of underground aquifers due to lower infiltration rates. Soil loss from accelerated erosion reduces the volume of soil available for storage of water and thus the production potential for livestock and wildlife. Unhealthy rangelands have less diverse populations of animals and plants which reduces the ecosystems resilience to adverse conditions. Unhealthy rangelands generally produce less forage for livestock. Unhealthy rangeland have reduced habitat value, essential as cover and food for wildlife. Unhealthy rangelands function poorly or are have completely dysfunctional basic ecological processes required to sustain the ecosystem over time. In many cases, mis-management resulting in unhealthy rangelands is irreversible.

What are Some Warning Signs of Unhealthy Rangeland?

Pedicelled plants: Grass plants, each setting on a small pedicel of soil, is a warning sign of sheet erosion on the site. The plant root system and crown protects the soil directly underneath, but soil between plants is lost downslope with each rainfall event. Soil depth is important for the storage of water for plant growth between rainfall events. It is possible, with unprotected soil to loose over an inch of topsoil during a single rainstorm event, which in turn may take centuries to replace through natural processes.

Bare Ground: Large areas or increasing areas of bare ground are a symptom of unhealthy rangeland. The soil must be covered with vegetation or mulch to protect the soil surface from the impact of raindrops. Unprotected soil becomes dislodged during rainfall events, and moves downslope into gullies, streams and rivers. Unprotected soil is susceptible to forming crusts, due to a loss of structure and organic matter at the soil surface, which reduces water infiltration, recharge of underground aquifers and the quantity of water stored in the soil profile for plant growth.

Browse Lines: A distinct absence of woody plant vegetation from ground-line to a height that browsers like goats and deer can reach, is an indication of excessive use of this component of the plant community. Too heavy use of any part of a plant community will result in reduced plant diversity and lower overall range health. The strength of rangeland ecosystems is their diversity, in both animals and plants. Diversity protects both the health and sustainability of the system over time.

Gullies and Steep Denuded Stream Banks: Gullies and steep stream banks devoid of vegetation are another sign of excessive erosion and poor rangeland health. Vegetation on stream banks hold soil and slow water movement during high stream-flow events, while dissipating stream-flow energy. Treatment to counteract the formation of gullies and steep stream banks should not only include slowing water movement through these areas, but also careful examination and correction of the factors that led to their development in the first place.

Plant Communities Dominated By Annual Plants: Unfortunately, if rangelands are abused through over-use, the plant communities will change from perennial species to annual species. Annual species have life cycles that permit them to take advantage of short-term, favorable growing conditions. Unfortunately they do not provide the soil surface with dependable, continuous protection from raindrop impact, or provide dependable forage for livestock and wildlife.

How Do I Monitor for these Warning Signs?

Monitoring rangelands are important because it improves the owner/managers ability to make proper and timely decisions. Rangelands are very complex. Any given pasture may be composed of several different range sites, each with different plant communities. Each plant community has its own mix of grass, forb and woody plant species. This mix of species changes over time due to the impact of weather, seasons, brush and weed management, and grazing pressure by livestock and wildlife. Any monitoring system should key on changes in this plant community and any observable symptoms of accelerated erosion. The owner/manager must monitor these changes to insure 1)management is not causing damage to soil, water quality and the rangeland resource base, and 2) that past decisions are producing expected results.

Rangelands can be monitored using a variety of methods. Some of the more common techniques include vegetation sampling, excluding small areas from grazing or photo points. The latter method is one of the easiest to use by most individuals. By comparing photographs and detailed notes for the exact same location over time, change and current rangeland health can be observed and documented. The photographs, notes and interpretations serve as a permanent record for each location and situation. These observations and photographic record are necessary to establish the cause for changes in resource conditions. Photo points provide a means of monitoring rangeland health with a minimum of input in terms of time and expense.

When comparing photographs for a specific photo point over time, look for changes in the amount of forage, brush, weeds, bare ground, litter and evidence of erosion; for changes in the types of plants found in the photographs (plot); and for the absence or presence of specific plants. Records, i.e. grazing use, brush management and rainfall will be invaluable in interpreting these photographs. For detailed information on how to set up and interpret photo points to monitor range health obtain publication L-5216 "Range Monitoring with Photo Points" from the local county Extension agent or through the Internet (http://texaserc.tamu.edu/catalog/topics/Rangelands.html).

Support provided by the TAEX Risk Management Initiative.

Great Trinity Forest Management Plan

Grasslands

Range Monitoring with Photo Points

Texas Agricultural Extension Service
The Texas A&M University System
L-5216
9-98

Range Monitoring with Photo Points

Allan McGinty and Larry D. White*

Photo points provide a way for owner/managers to monitor rangeland health with a minimum of time and expense. Photo points, which are simply periodic photographs of specific range sites, can help owner/managers make better management decisions.

Any given pasture is usually composed of several different range sites, each with different plant communities of grasses, forbs and woody plants. This mix of plant species within each range site changes over time because of weather, seasons, brush and weed management, and grazing pressure by livestock and wildlife. The kinds of plants, their quality and quantity within each community dictate the rangeland's potential to produce livestock, wildlife, water and other products.

Managers must monitor changes in these plant communities to ensure that:

- Management is not damaging the soil, water quality or range resource base; and
- Past decisions are producing expected results.

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By comparing photographs and detailed notes on the same location over time, managers can see what changes have occurred. Photographs, notes and interpretations serve as a permanent record of each situation for future consideration. The manager's observations and other information are necessary to establish the causes of changes in resource conditions.

How often to monitor

There are two types of photo-point monitoring situations:

- Annual photos for long-term monitoring of range condition and health over years; and
- Seasonal photos for monitoring short-term management impacts such as stocking rates, changes in forage standing crop, or responses to weed and brush control practices.

When to take photographs

Photographs that best illustrate the situation should be taken at least once a year and at the same time each year. A good time for annual photographs is in fall before the first killing frost. Shoot more often if you want to monitor more closely. For seasonal monitoring, consider taking photographs at late winter or spring green-up, mid-summer and at frost or before and after grazing a pasture or when controlling brush.

Location and number of photo points

Individual pastures can be composed of many range sites, or areas supporting different types of plant communities. Identify these range sites using county soil survey manuals or with help from the local county Extension agent or Natural Resources Conservation Service personnel. All major range sites should be monitored using photo points. The actual number within each range site depends on the acreage involved and the purpose of monitoring. In most cases, shooting two to five photo points per range site gives acceptable results.

To monitor grazing, do not choose photo points close to water or in the back of the pasture. Select those that represent the range site in general and the use the site receives by grazing animals. Locate other

Scene photographs show the general landscape.

photo points to monitor specific “problem” situations (such as stream bank erosion, sensitive riparian areas, recovery following wildfire).

Remember: The photo points you choose now will be used to characterize a much larger area for a long time. Selecting areas that truly represent the range site as a whole is critical to an effective monitoring program.

Choose sites that are reasonably accessible, because you will be returning year after year. Photo points can be located along ranch roads, which also can be used for spotlight deer surveys and routine pasture observations. Balance accessibility with the need for representative photo points.

Setting up a photo point

After selecting the location of a specific photo point, mark it permanently by driving a steel fence post or metal stake (re-bar) into the ground. Spray the marker with highly visible paint. A nearby fence post can also be sprayed to help locate the plots. Pile rocks around the re-bar to prevent injuries to animals or vehicles. Identify the location of each photo point on a ranch/pasture map or aerial photograph.

Take detailed notes describing the site for each photo point. This may include compass bearing and distance from a highly visible landmark or GPS coordinates if available.

With a felt pen and a yellow paper pad (white is too bright), make a plot sign to include in the photo plot/scene. Include some identification (pasture name, range site, etc.) concerning the specific plot/scene being photographed and the date. Other information can be included, but to be legible, keep it as short as possible.

Types of photos

Two types of photographs, vertical and scene, are generally used. Photographs taken from a “near” vertical position are best to show details of soil, litter and vegetation. These vertical photos will show changes in plant cover, litter, bare ground and erosion in spaces between plants, for small areas within permanently located plots. Detailed vertical photos are very specific and less representative of the landscape than scene photographs.

Scene photographs show much larger areas, including the general landscape, brush, grass, terrain and soil. If the scene is photographed with the bottom of the photo no farther than 10 feet away, the foreground can show herbaceous species, cover, litter, bare ground, etc.

Vertical photographs

Establish one to several photo points in an area by placing a plot frame on the ground. A convenient frame can be made by two 6-foot folding carpenter’s rulers folded at their 3-foot position and placed to face each other, collectively forming a square. PVC pipe joined with elbows also may be used. After placing the plot on the ground, mark the corners by driving 1-foot sections of re-bar rods into two opposite plot corners. This allows the exact relocation of the plot for future observations. Place the plot sign on the ground next to the plot frame before photographing.

Stand so that your shadow is not cast over the photo plot. Take the picture by standing as close to the plot frame as possible while still including all the plot frame and the yellow pad in the picture. Try to shoot as vertical a picture as possible.

Scene photographs

Landscape (scene) photographs also can be taken from the steel post or re-bar marker. Simply stand at the post and take one picture facing each of the cardinal directions, using a compass to frame each shot accurately. If you wish to take only a single scene photograph at each location, place the plot identification at the base of the steel post or re-bar. When shooting the photograph, stand about 10 feet from the plot marker in a predetermined and recorded direction. Include the plot identification and plot marker in the bottom of the photograph.

Repeating photographs

- Identify on your work calendar the dates that repeat photographs should be taken.
- Organize the photos for easy viewing and so that subsequent years may be added in sequence on the same storage sheet.
- Have an updated map showing the location of each photo point.
- Carry the map and previous photographs of the plots to be photographed when re-photographing the plots. Use the previous photograph to locate the exact scene or photo location.
- Reshoot the photograph with proper plot identification encompassing exactly the same scene using the same procedures.
- Use a data information sheet to record any observations before leaving each location. This data information sheet should include the plot ID, date, pasture and any notes concerning species of plants present, general observations, concerns, etc.

Interpreting photographs

When comparing photographs for a specific photo point over time, look for:

- Changes in the cover or density of desirable or undesirable plants and amount of litter on the ground;
- Changes in the amount of bare ground visible; and
- Evidence of erosion, such as loss of soil between plants.

Records such as those detailing grazing use, brush management and rainfall are invaluable in interpreting these photographs.

Storing slides and photographs

If you use slide film, write the date, photo point number and management unit on the edge of the slides after they are developed. If print film is used, record the same information on an adhesive label and affix the label to the back of the print. Prints (3-by-5-inch) can be stored in sheets holding five photos per page or use one 3-by-5-inch card to index each print on the page.

Photos taken with a digital camera can be processed as either prints or slides or maintained as graphic files. Digital photos can easily be sent to others over the Internet. Keep the data sheets/information and maps for each location with the photographs.

Equipment needed

Steel fence posts
Sections (12 to 18 inches) of re-bar rod
Hammer or post driver
Spray paint
Camera (35 mm preferred) or digital camera
Film (100 ASA preferred)
Two 6-foot folding rulers or 3-by-3-foot PVC frame (for vertical plots)
Farm or ranch map or aerial photograph
Yellow pad
Felt marking pen
Three-ring binder
Non-acidic, non-PVC print/slide storage sheets
Data sheets
Pen or pencil

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