

Appendix S1

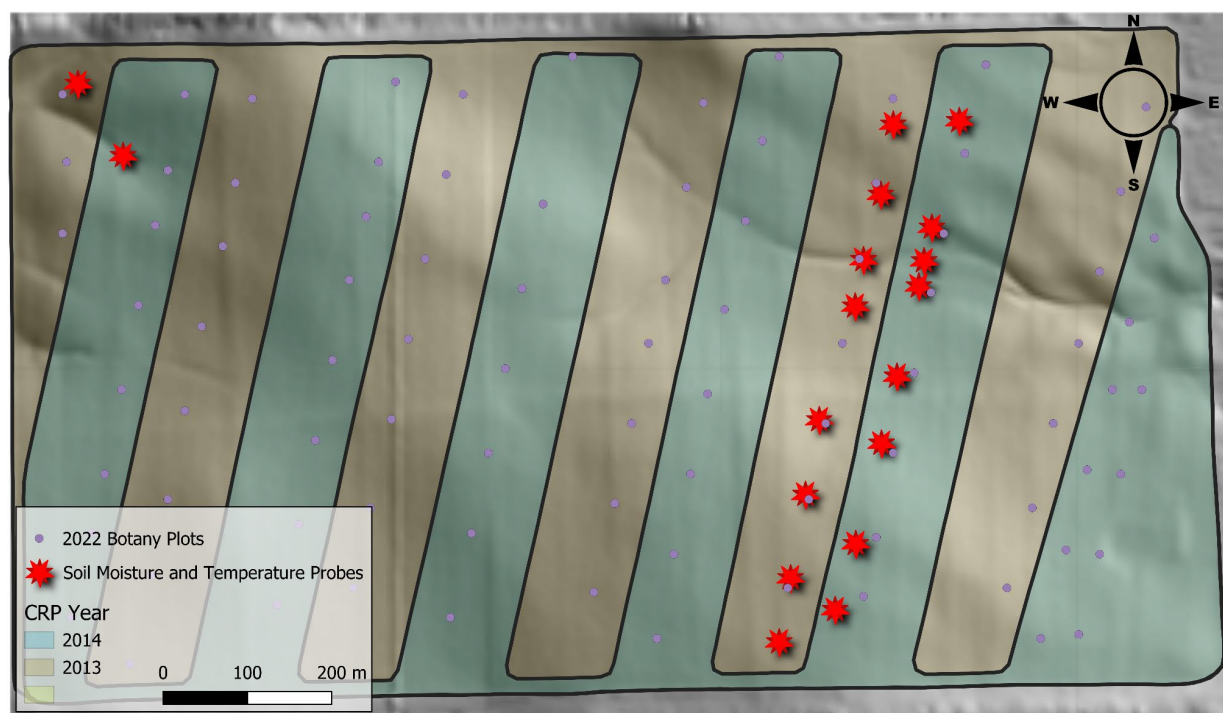


Figure S1. The study site. The background is a 5m digital elevation model, stars indicate the locations of soil temperature and moisture probes, dots indicate the location of 2022 botany plots, and the shaded areas indicate the year that the CRP seeding application was conducted. Probe locations were chosen to represent the range of topographic complexity while also allowing for the comparison of the effect of management. .

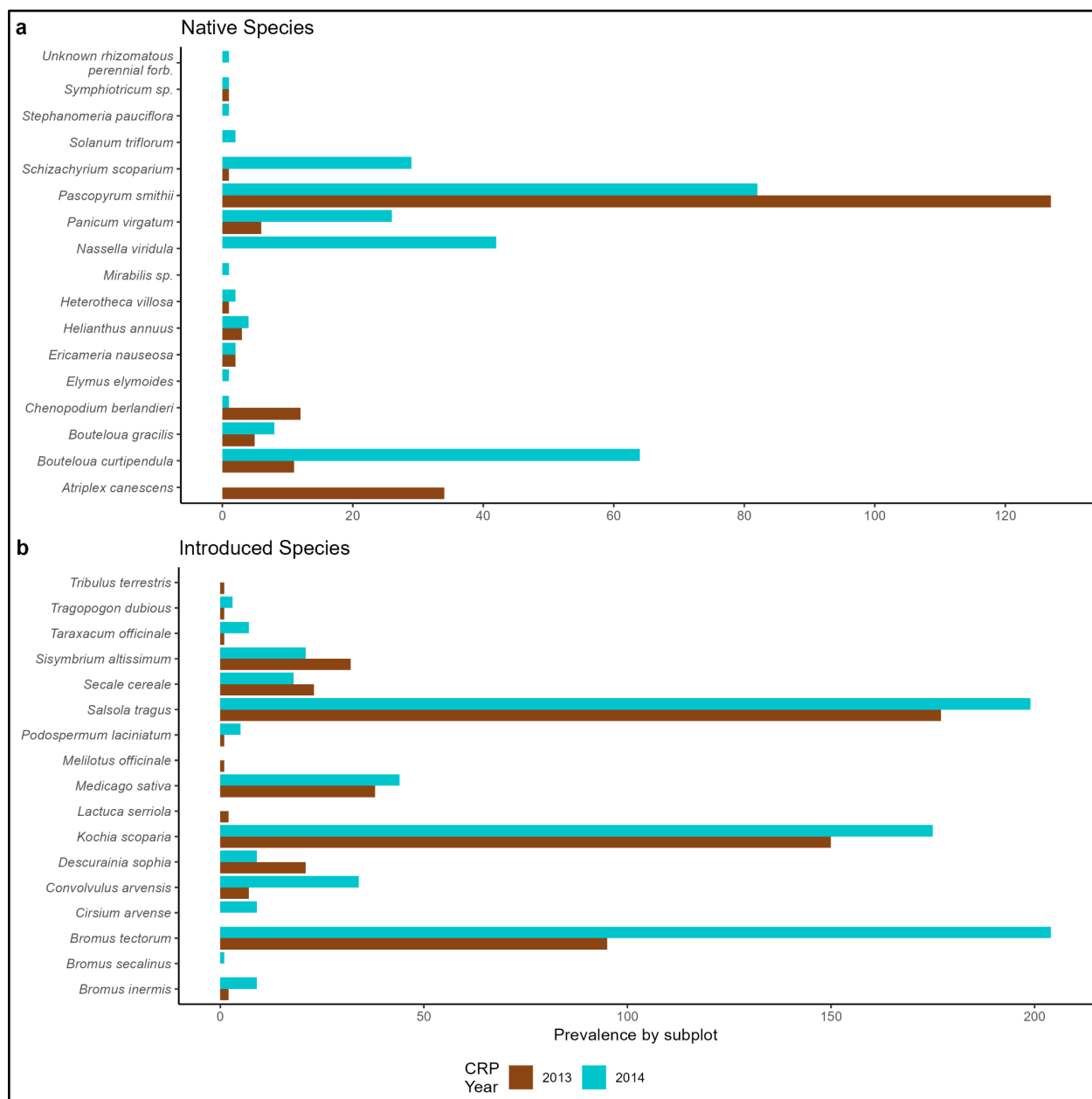
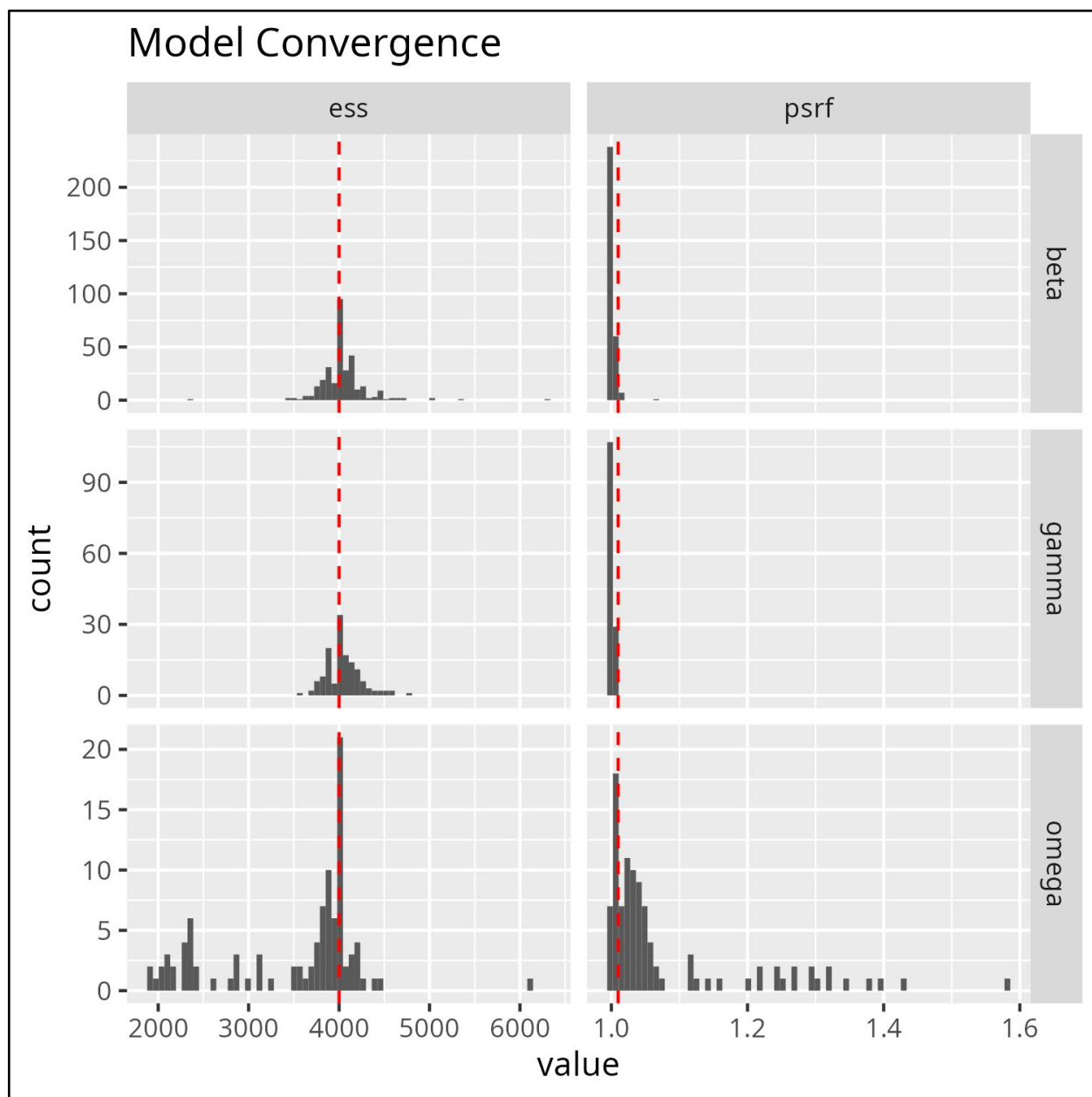


Figure S2. Species prevalence. Prevalence (number of 0.1m² plots in which a species was encountered) for each plant species encountered across the study site for native species (a) and introduced species (b).



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Figure S3: Model convergence diagnostics. The potential scale reduction factor (PSRF) measures the convergence among chains, and being closer 1.0 is ideal. The vertical red dashed line lies at 1.001, a sensible target for most values to fall under. Effective sample size (ESS) measures autocorrelation between successive iterations within each chain, and higher values are better. Ideally ESS matches the number of posterior samples (indicated by the vertical red dashed line), but that is not fully necessary. Betas are the parameters for environmental filters, gammas are the parameters for the traits, and omegas are the parameters for the species associations.

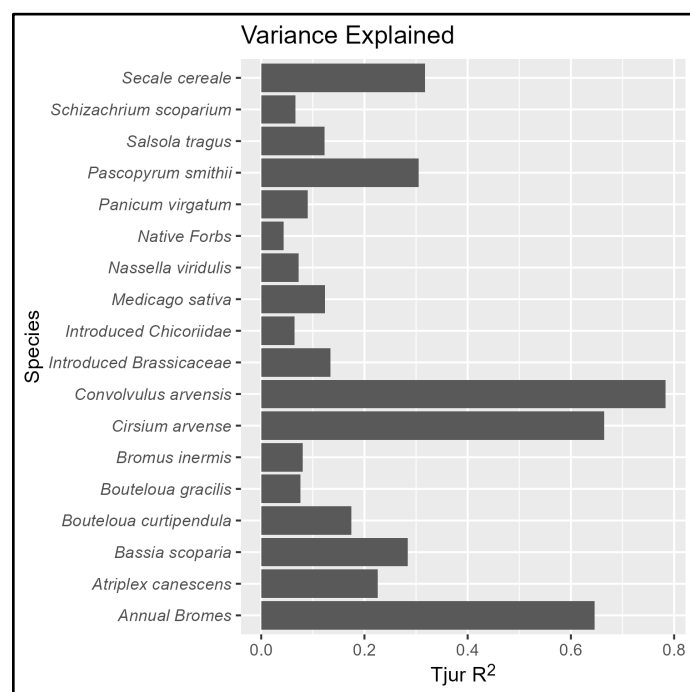
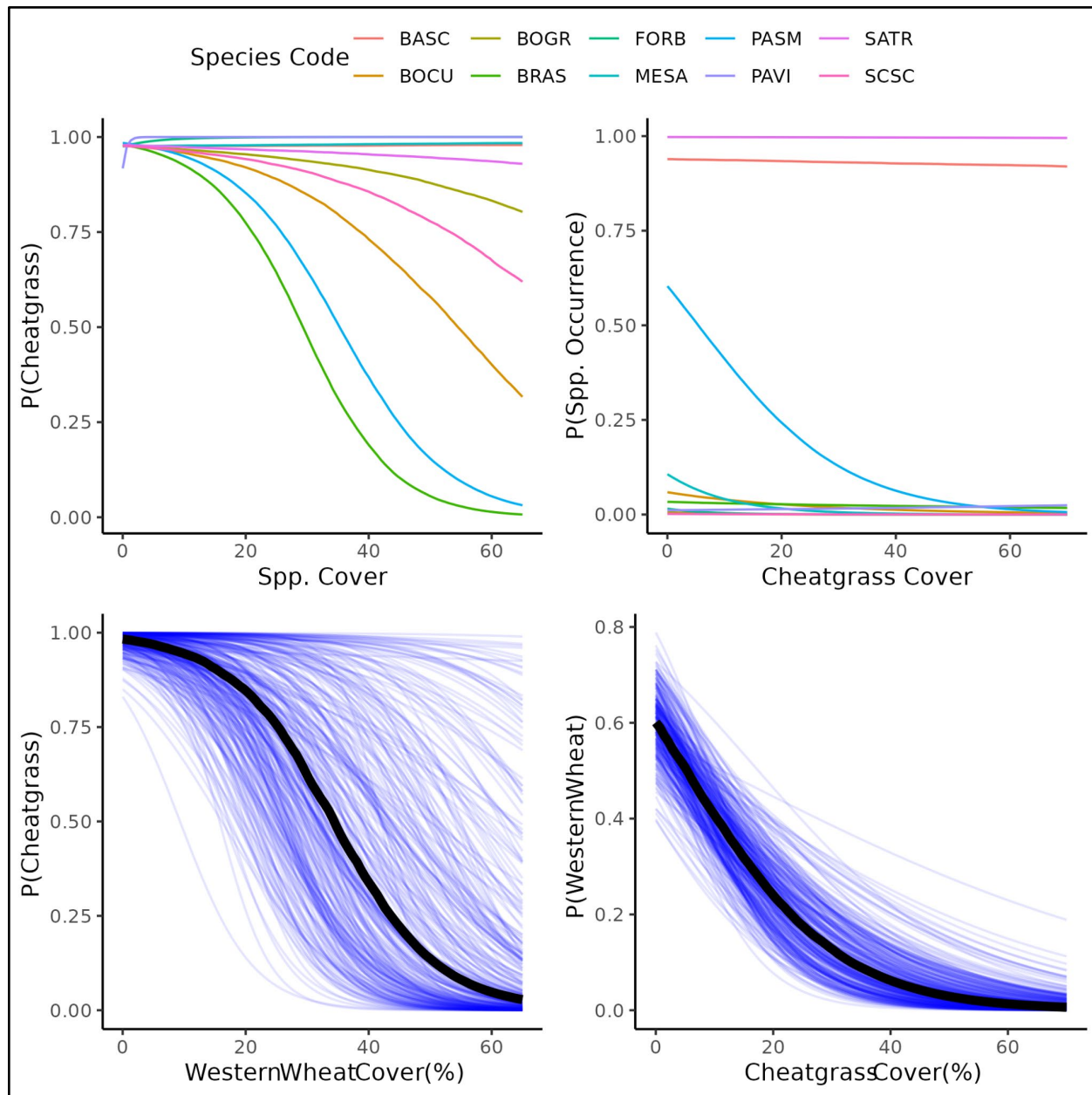


Figure S4: R^2 values from the Joint Species Distribution Model for each species or species group.

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Figure S5. Western wheatgrass and cheatgrass interactions, compared to other species. This is using abundance data on the X axes to estimate the occurrence of a given species. Western wheatgrass and cheatgrass had strong effects on each others' occurrence, compared to other species. This was consistent with field observations. Abbreviations are defined in Table S1.

Table S1: All species encountered. Many species were encountered outside of the 0.1 m² quadrats used for the JSMD. Therefore these species were not assigned to groups, but were still used in the diversity calculations. Nomenclature follows the United States Department of Agriculture's Plant Database (<https://plants.usda.gov>).

Family	Genus	Specific epithet	Group		CRP Mix	origin	Pure Live
			Code	Group Name			Seed (kg/ha)
Asteraceae	<i>Gutierrezia</i>	<i>sarothrae</i>	GUSA	<i>Gutierrezia sarothrae</i>	no	native	
Asteraceae	<i>Ericameria</i>	<i>nauseosa</i>	ERNA	<i>Ericameria nauseosa</i>	no	native	
Asteraceae	<i>Heterotheca</i>	<i>villosa</i>	HEVI	<i>Heterotheca villosa</i>	no	native	
Asteraceae	<i>Helianthus</i>	<i>annuus</i>	HEAN	<i>Helianthus annuus</i>	no	native	
Asteraceae	<i>Stephanomeria</i>	<i>pauciflora</i>	FORB	Native Forbs	no	native	
Asteraceae	<i>cf Aster</i>	d_081_herb_05	FORB	Native Forbs	no	native	
Asteraceae	<i>Antennaria</i>	sp.	ANSP	<i>Antennaria</i> sp	no	native	
Asteraceae	<i>Artemisia</i>	<i>arbuscula</i>	ARAR	<i>Artemisia arbuscula</i>	no	native	
Chenopodiaceae	<i>Atriplex</i>	<i>canescens</i>	ATCA	<i>Atriplex canescens</i>	yes	native	0.2676
Chenopodiaceae	<i>Chenopodium</i>	<i>berlandieri</i>	FORB	Native Forbs	no	native	
Malvaceae	<i>Sphaerelcea</i>	<i>coccinea</i>	SPCO	<i>Sphaerelcea coccinea</i>	no	native	
Papaveraceae	<i>Argemone</i>	<i>cf hispida</i>	ARHI	<i>Argemone cf hispida</i>	no	native	
Poaceae	<i>Bouteloua</i>	<i>curtipendula</i>	BOCU	<i>Bouteloua curtipendula</i>	yes	native	0.6244

Poaceae	<i>Panicum</i>	<i>virgatum</i>	PAVI	<i>Panicum virgatum</i>	yes	native	0.1784
				<i>Schizachyrium</i>			
Poaceae	<i>Schizachyrium</i>	<i>scoparium</i>	SCSC	<i>scoparium</i>	yes	native	0.3568
Poaceae	<i>Nassella</i>	<i>viridula</i>	NAVI	<i>Nassella viridula</i>	yes	native	0.7136
Poaceae	<i>Pascopyrum</i>	<i>smithii</i>	PASM	<i>Pascopyrum smithii</i>	yes	native	1.784
Poaceae	<i>Bouteloua</i>	<i>gracilis</i>	BOGR	<i>Bouteloua gracilis</i>	yes	native	0.1784
Poaceae	<i>Elymus</i>	<i>elymoides</i>	ELEL	<i>Elymus elymoides</i>	no	native	
Solanaceae	<i>Solanum</i>	<i>triflorum</i>	FORB	Native Forbs	no	native	
Nyctaginaceae	<i>Mirabilis</i>	sp	FORB	Native Forbs	no	native	
	Rhizomatous						
unknown	perennial forb	d_141_herb_09	FORB	Native Forbs	no	native	
<hr/>							
				Introduced			
Asteraceae	<i>Scorzonera</i>	<i>laciniata</i>	LACT	Cichorioideae	no	introduced	
				Introduced			
Asteraceae	<i>Taraxacum</i>	<i>officinale</i>	LACT	Cichorioideae	no	introduced	
				Introduced			
Asteraceae	<i>Tragopogon</i>	<i>dubious</i>	LACT	Cichorioideae	no	introduced	
Asteraceae	<i>Cirsium</i>	<i>arvense</i>	CIAR	<i>Cirsium arvense</i>	no	introduced	
Asteraceae	<i>Onopordium</i>	<i>acanthium</i>	ONAC	<i>Onopordium acanthium</i>	no	introduced	
Asteraceae	<i>Lactuca</i>	<i>serriola</i>	LASE	<i>Lactuca serriola</i>	no	introduced	
				Introduced			
Brassicaceae	<i>Sisymbrium</i>	<i>altissimum</i>	BRAS	Brassicaceae	no	introduced	
				Introduced			
Brassicaceae	<i>Descurainia</i>	<i>sophia</i>	BRAS	Brassicaceae	no	introduced	
Chenopodiaceae	<i>Salsola</i>	<i>tragus</i>	SATR	<i>Salsola tragus</i>	no	introduced	
Chenopodiaceae	<i>Bassia</i>	<i>scoparia</i>	BASC	<i>Bassia scoparia</i>	no	introduced	
Convolvulaceae	<i>Convolvulus</i>	<i>arvensis</i>	COAR	<i>Convolvulus arvensis</i>	no	introduced	
Fabaceae	<i>Medicago</i>	<i>sativa</i>	MESA	<i>Medicago sativa</i>	yes	introduced	0.3568
Fabaceae	<i>Melilotus</i>	<i>officinale</i>	MEOF	<i>Melilotus officinale</i>	no	introduced	
Poaceae	<i>Bromus</i>	<i>tectorum</i>	BROM	Introduced Annual	no	introduced	

<i>Bromus</i>						
Poaceae	<i>Secale</i>	<i>cereale</i>	SECE	<i>Secale cereale</i>	no	introduced
Poaceae	<i>Bromus</i>	<i>inermis</i>	BRIN	<i>Bromus inermis</i>	no	introduced
Introduced Annual						
Poaceae	<i>Bromus</i>	<i>secalinus</i>	BROM	<i>Bromus</i>	no	introduced
Poaceae	<i>Agropyron</i>	<i>cristatum</i>	AGCR	<i>Agropyron cristatum</i>	no	introduced
Zygophyllaceae	<i>Tribulus</i>	<i>terrestris</i>	TRTE	<i>Tribulus terrestris</i>	no	introduced

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764 Table S2: R packages used in the analysis.

Package	Purpose	Citation
sf	Spatial vector data management	Pebesma 2018
terra	Raster data management	Hijmans 2023a
raster	Raster data management	Hijmans 2023b
vegan	Diversity and NMDS	Oksanen et al 2022
SPEI	Calculating SPEI	Beguería and Vicente-Serrano 2023
microclima	Calculating air temperature	Mosedale et al 2023
NicheMapR	Calculating air temperature	Kearney 2022

topmodel	Calculating TWI	Buytaert 2022
tidyverse	Data wrangling	Wickham et al 2019
lubridate	Date wrangling	Grolemund and Wickham 2011
vroom	Data wrangling	Hester et al 2023
Hmsc	Joint species distribution modeling	Tikhonov et al 2023
gghmsc	Visualization	Mahood et al 2024
snow	parallelization	Tierney et al 2021
fields	spatial process models	Nychka et al 2021
ggpubr	visualization	Kassambara 2023
ggcorrplot	visualization	Kassambara 2022
ggthemes	visualization	Arnold 2021
ggtext	visualization	Wilke 2021
ggrepel	visualization	Slowikowski 2023
ggmcmc	visualization	Fernandez i Marin 2016
geomtextpath	visualization	Cameron and van den Brand 2022

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766 **Table S3.** Species included in the CRP mix.

Common Name	Scientific Name	Pure Live Seed Applied (kg/ha)	Origin
Western wheatgrass	<i>Pascopyrum smithii</i>	1.784	native

Green needlegrass	<i>Nassella viridula</i>	0.7136	native
Sideoats gramma	<i>Bouteloua</i> <i>curtipendula</i>	0.6244	native
Alfalfa	<i>Medicago sativa</i>	0.3568	introduced
Little bluestem	<i>Schizachyrium</i> <i>scoparium</i>	0.3568	native
Fourwing Saltbush	<i>Atriplex canescens</i>	0.2676	native
Blue gramma	<i>Bouteloua gracilis</i>	0.1784	native
Switchgrass	<i>Panicum virgatum</i>	0.1784	native

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768 Table S4 life history traits of species used in the JSMD analysis.

species group	Mean height	introduced	perennial	woody	graminoid	rhizomatous	Photosynthetic pathway
Invasive Annual <i>Bromus</i>	19	yes	no	no	yes	no	c3
<i>Bassia scoparia</i>	11	yes	no	no	no	no	c3
<i>Salsola tragus</i>	10	yes	no	no	no	no	c4
<i>Pascopyrum smithii</i>	22	no	yes	no	yes	yes	c3
<i>Bouteloua</i> <i>curtipendula</i>	24	no	yes	no	yes	no	c4
<i>Medicago sativa</i>	27.5	yes	yes	no	no	no	c3

Invasive annual Brassicaceae	21	yes	no	no	no	no	c3
<i>Nasella viridulis</i>	41.5	no	yes	no	yes	no	c4
Invasive Chicorioideae	10.5	yes	yes*	no	no	no	c3
Native Forbs	6	no	yes	no	no	no	c4
<i>Cirsium arvense</i>	12	yes	yes	no	no	yes	c3
<i>Convolvulus arvensis</i>	8.5	yes	yes	no	no	yes	c3
<i>Panicum virgatum</i>	27.5	no	yes	no	yes	no	c4
<i>Schizachyrium scoparium</i>	19	no	yes	no	yes	no	c4
<i>Atriplex canescens</i>	115	no	yes	yes	no	no	c4
<i>Bouteloua gracilis</i>	19	no	yes	no	yes	no	c4
<i>Bromus inermis</i>	33	yes	yes	no	yes	yes	c3
<i>Secale cereale</i>	38.5	yes	no	no	yes	no	c3

769 * two species (5 occurrences) are perennial/biennial, one species (1 occurrence) is annual/biennial

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771 **Table S5:** Precipitation (mm) measured at the study site. Highest monthly values are bold.

772 Highest and lowest years are italicized and bold.

Year	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	Mean
Jan	7	1	10	5	1	7	0	0	3	2	1	9	21	3	11	19	9	6	0	3	6
Feb	20	7	8	3	6	2	0	0	10	11	13	7	7	16	12	7	17	3	7	8	8
Mar	6	45	2	33	22	37	13	7	18	8	0	15	26	5	44	29	24	46	29	23	22
Apr	7	64	28	47	9	20	17	69	94	26	13	70	4	56	59	57	16	32	21	48	38

Year	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	Mean
May	42	55	33	37	26	29	41	43	79	119	45	47	82	153	46	111	95	66	47	68	63
Jun	33	43	55	104	6	11	50	83	51	35	15	17	52	51	38	4	33	44	43	21	39
Jul	9	4	28	6	28	62	9	51	75	94	91	43	101	57	12	32	41	21	3	17	39
Aug	16	44	35	14	10	37	105	31	37	5	0	40	24	20	23	54	8	17	11	9	27
Sep	23	11	53	3	16	24	37	12	2	17	40	111	31	2	8	35	5	25	13	11	24
Oct	11	1	24	74	20	0	12	132	18	56	21	21	12	54	10	26	16	15	15	7	27
Nov	10	6	8	6	9	3	2	10	24	10	4	5	16	23	4	9	10	20	8	10	10
Dec	0	8	0	1	28	7	6	18	8	12	3	9	10	22	8	4	1	21	11	8	9
Sum	183	289	285	334	181	238	293	456	418	396	247	394	386	462	276	388	275	316	210	232	313

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