Appendix S1

Journal: Ecological Applications

Manuscript type: Article

Title: Antecedent climate drives divergent, long-term restoration outcomes in the Western Great Plains, USA.

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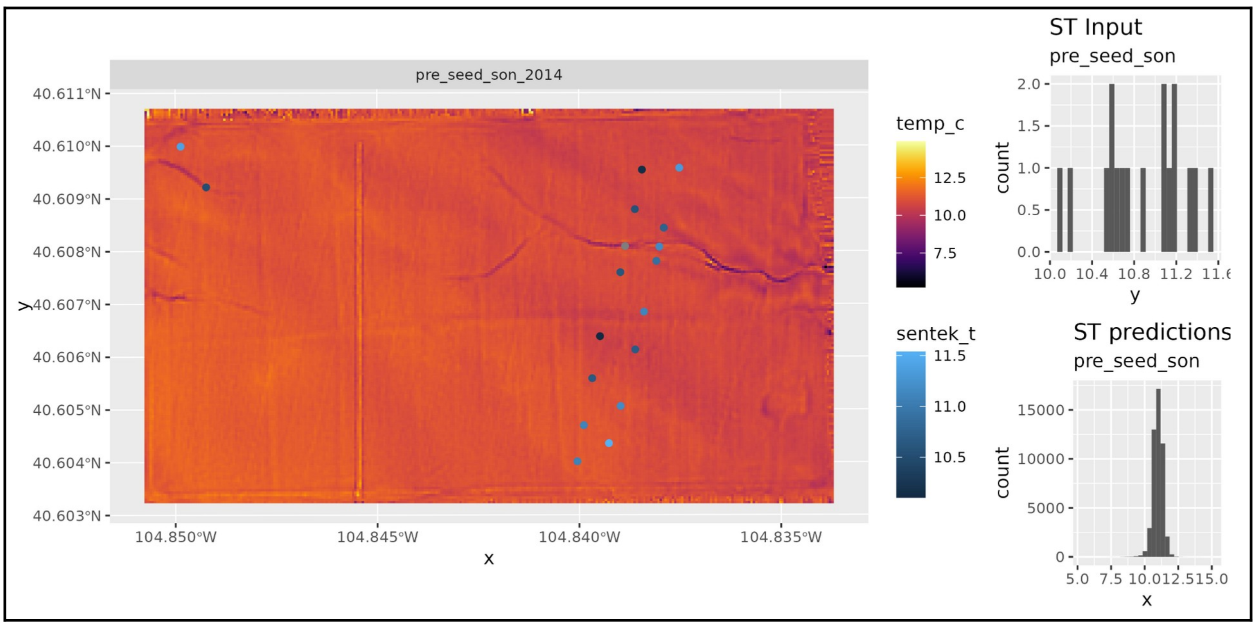


Figure S1. One of the surfaces created by spatial process modelling. Blue dots indicate the Sentek sensor locations. Figures for all surfaces used in the analysis, along with the code and data to recreate them, are available in the GitHub repository.

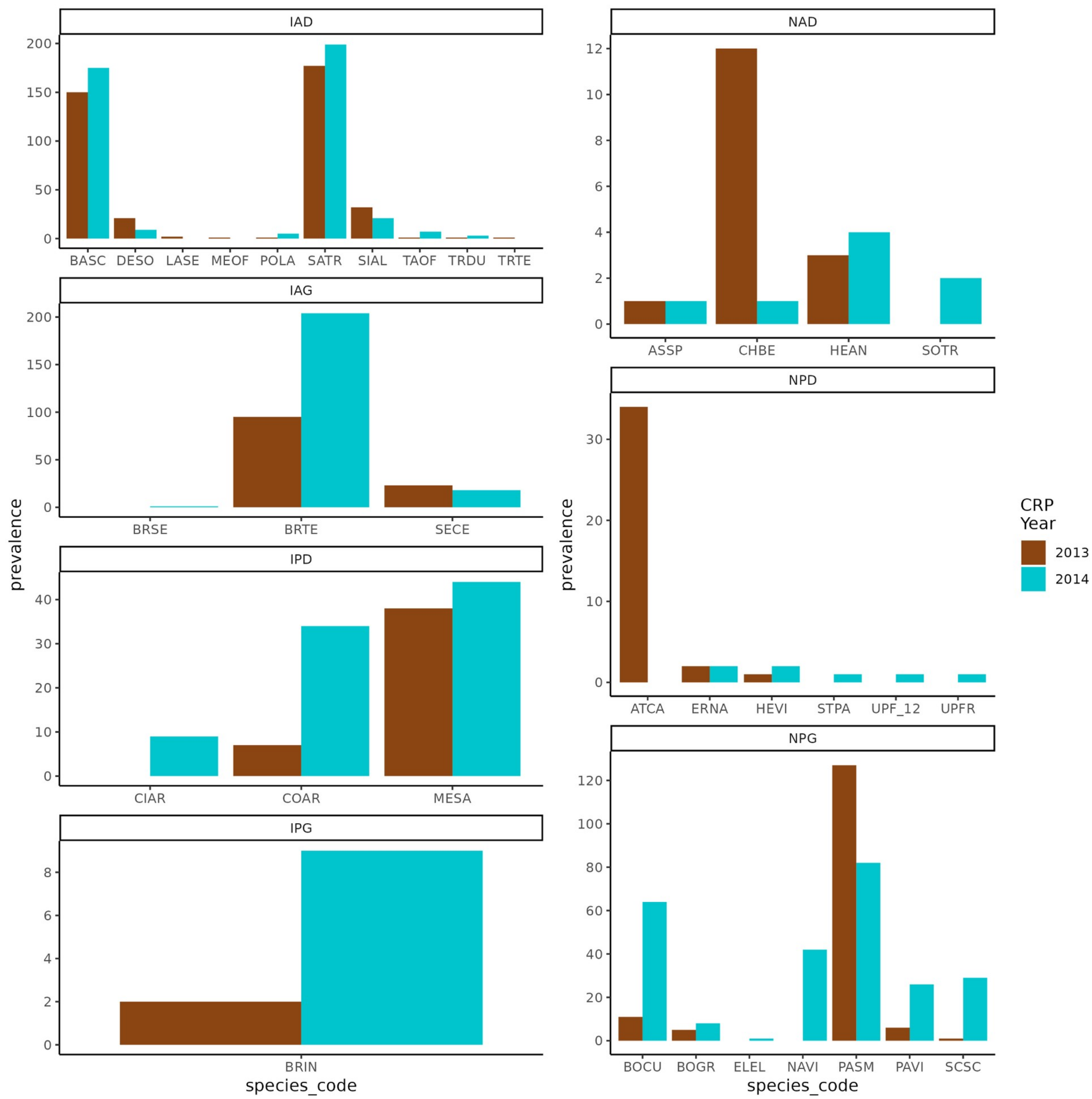
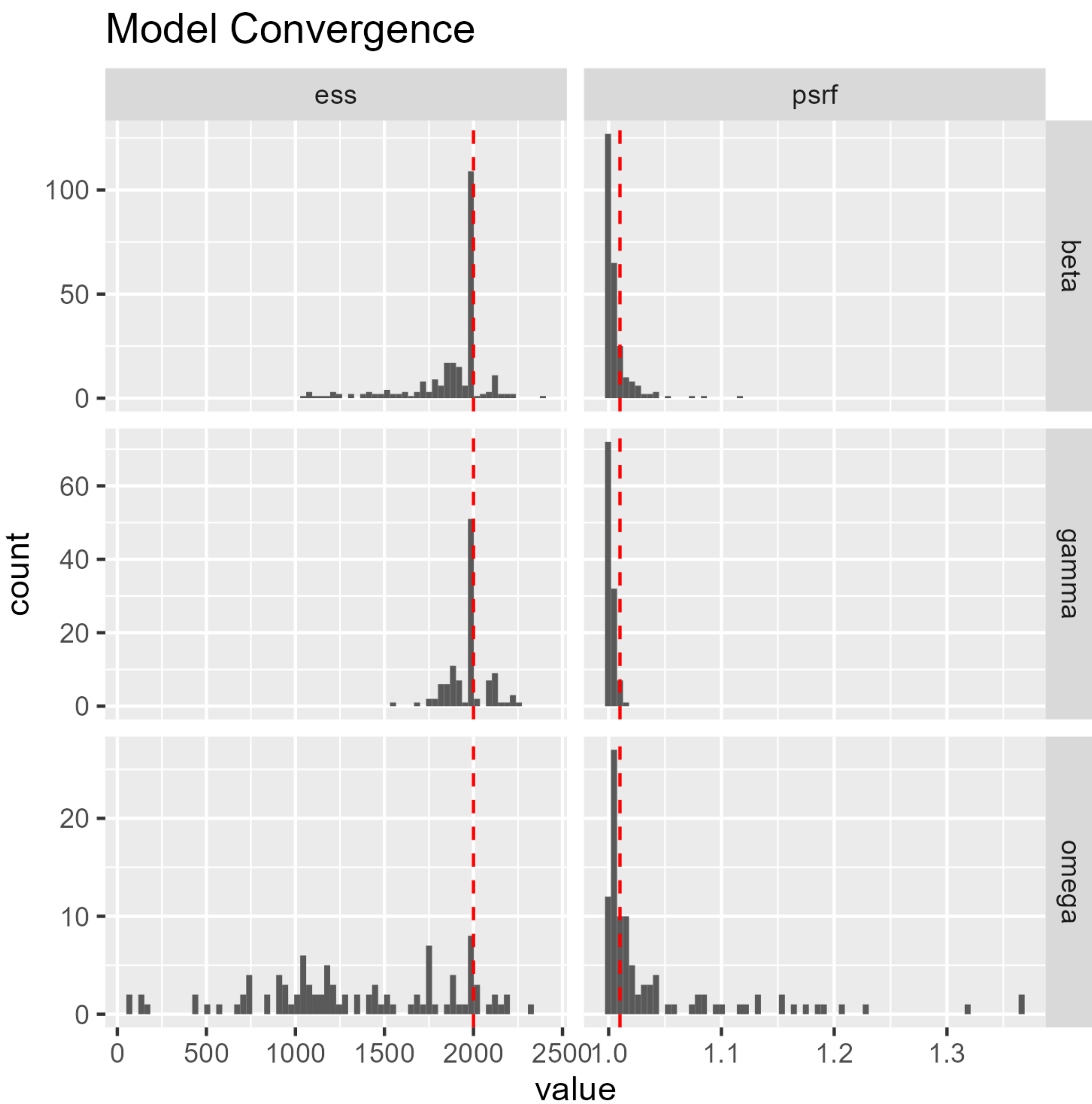


Figure S2. Species prevalence. Prevalence (number of plots in which a species was encountered) for each plant species encountered across the study site. Abbreviations: N = native, A = annual, P = perennial, D = dicot, G = graminoid, I = introduced.


Model Convergence
ess
psrf
beta
gamma
omega
count
value
0
50
100
20
40
60
10
0
500
1000
1500
2000
2500
1.0
1.1
1.2
1.3

644

FIgure S3: Model convergence diagnostics. The potential scale reduction factor (PSRF) measures the convergence among chains, and being closer 1.0 is ideal. 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, but that is not fully necessary. Beta is the parameters for environmental filters, gammas are the parameters for the traits, and omega is the parameters for the species associations.

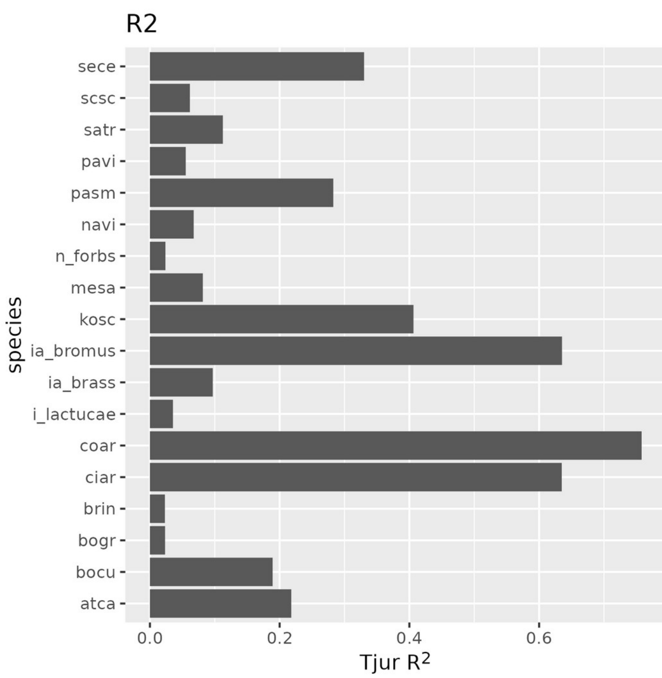


Figure S4: R2 values for each species or species group.

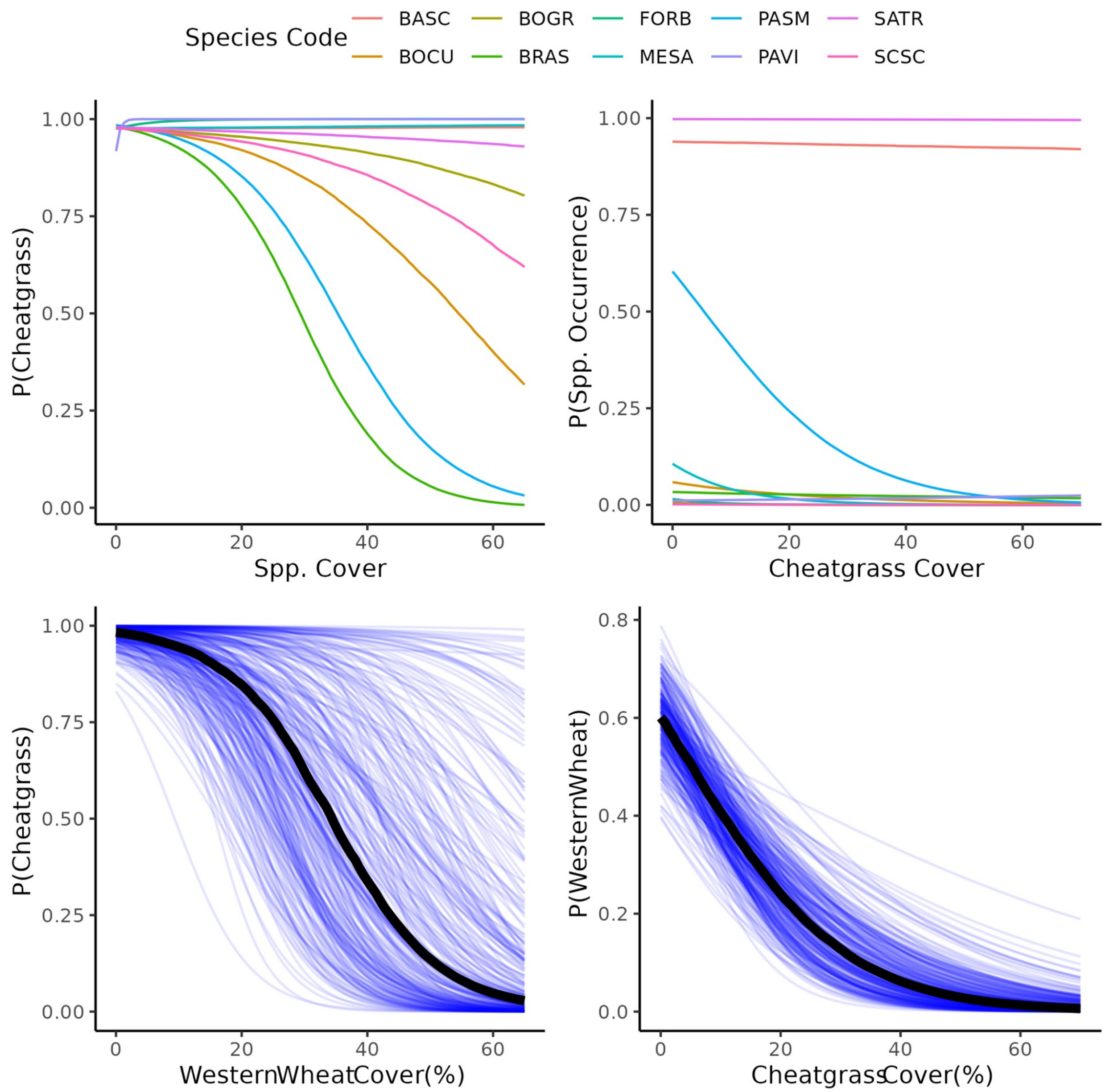


Figure S5. Western Wheatgrass and Cheatgrass interactions, compared to other species. This is using abundance data on the y axes to estimate the occurrence of a given species. P. smithii and cheatgrass had strong effects on each others' occurrence, compared to other species. THis was consistent with field observations.

Table S1: All species encountered. Many species were encountered outside of the 0.1 m2 quadrats used for the JSDM, and so were not assigned to groups. Those species were still used in the diversity calculations.

Family	Genus	Specific epithet	Group Code	Group Name	CRP Mix	origin	Seed Applied (kg/ha)
Asteraceae	*Gutierrezia*	*sarothrae*	GUSA	*Gutierrezia sarothrae*	no	n	
Asteraceae	*Ericameria*	*nauseosa*	ERNA	*Ericameria nauseosa*	no	n	
Asteraceae	*Heterotheca*	*villosa*	HEVI	*Heterotheca villosa*	no	n	
Asteraceae	*Helianthus*	*annuus*	HEAN	*Helianthus annuus*	no	n	
Asteraceae	*Stephanomeria*	*pauciflora*	FORB	Native Forbs	no	n	
Asteraceae	cf *Aster*	d_081_herb_05	FORB	Native Forbs	no	n	
Asteraceae	*Antennaria*	sp.	ANSP	*Antennaria* sp	no	n	
Asteraceae	*Artemisia*	*arbuscula*	ARAR	*Artemisia arbuscula*	no	n	
Chenopodiaceae	*Atriplex*	*canescens*	ATCA	*Atriplex canescens*	yes	n	0.2676
Chenopodiaceae	*Chenopodium*	*berlandieri*	FORB	Native Forbs	no	n	
Malvaceae	*Sphaerelcea*	*coccinea*	SPCO	*Sphaerelcea coccinea*	no	n	
Papaveraceae	*Argemone*	cf *hispida*	ARHI	*Argemone cf hispida*	no	n	
Poaceae	*Bouteloua*	*curtipendula*	BOCU	*Bouteloua curtipendula*	yes	n	0.6244
Poaceae	*Panicum*	*virgatum*	PAVI	*Panicum virgatum*	yes	n	0.1784
Poaceae	*Schizachyrium*	*scoparium*	SCSC	*Schizachyrium scoparium*	yes	n	0.3568
Poaceae	*Nassella*	*viridula*	NAVI	*Nassella viridula*	yes	n	0.7136
Poaceae	*Pascopyrum*	*smithii*	PASM	*Pascopyrum smithii*	yes	n	1.784

Poaceae	*Bouteloua*	*gracilis*	BOGR	*Bouteloua gracilis*	yes	n	0.1784
Poaceae	*Elymus*	*elymoides*	ELEL	*Elymus elymoides*	no	n	
Solanaceae	*Solanum*	*triflorum*	FORB	Native Forbs	no	n	
unknown	Perennial_forb	d_012_herb_01	FORB	Native Forbs	no	n	
unknown	Rhizomatous_perennial_forb	d_141_herb_09	FORB	Native Forbs	no	n	
Asteraceae	*Podospermum*	*laciniatum*	LACT	Introduced Cichorioideae	no	i	
Asteraceae	*Taraxacum*	*officinale*	LACT	Introduced Cichorioideae	no	i	
Asteraceae	*Tragopogon*	*dubious*	LACT	Introduced Cichorioideae	no	i	
Asteraceae	*Cirsium*	*arvense*	CIAR	*Cirsium arvense*	no	i	
Asteraceae	*Onopordium*	*acanthium*	ONAC	*Onopordium acanthium*	no	i	
Asteraceae	*Lactuca*	*serriola*	LASE	*Lactuca serriola*	no	i	
Brassicaceae	*Sisymbrium*	*altissimum*	BRAS	Introduced Brassicaceae	no	i	
Brassicaceae	*Descurainia*	*sophia*	BRAS	Introduced Brassicaceae	no	i	
Chenopodiaceae	*Salsola*	*tragus*	SATR	*Salsola tragus*	no	i	
Chenopodiaceae	*Bassia*	*scoparia*	BASC	*Bassia scoparia*	no	i	
Convolvulaceae	*Convolvulus*	*arvensis*	COAR	*Convolvulus arvensis*	no	i	
Fabaceae	*Medicago*	*sativa*	MESA	*Medicago sativa*	yes	i	0.3568
Fabaceae	*Melilotus*	*officinale*	MEOF	*Melilotus officinale*	no	i	
Poaceae	*Bromus*	*tectorum*	BROM	Introduced Annual *Bromus*	no	i	

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

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	Kearney 2022

	temperature	
topmodel	Calculating TWI	Buytaert 2022
tidyverse	Data wrangling	Wickham et al 2019
lubridate	Date wrangling	Grolemond and Wickham 2011
vroom	Data wrangling	Hester et al 2023
Hmsc	Joint species distribution modeling	Tikhonov et al 2023
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

Table S3. Species included in the CRP mix.

Common Name	Scientific Name	Amount Applied (kg/ha)	Origin
Western wheatgrass	*Pascopyrum smithii*	1.784	native
Green needlegrass	*Nassela viridula*	0.7136	native

Sideoats gramma	*Bouteloua curtipendula*	0.6244	native
Alfalfa	*Medicago sativa*	0.3568	introduced
Little bluestem	*Schizachyrium scoparium*	0.3568	native
Fourwing Saltbush	*Atriplex canescens*	0.2676	native
Blue gramma	*Bouteloua gracilis*	0.1784	native
Switchgrass	*Panicum virgatum*	0.1784	native

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