Bruce Maxwell, MSU

Montana Invasive Species Council

CHANGING CLIMATE AND RANGE EXPANSION: Annual Wheatgrass (*Eremopyrum triticeum*) as an example of winter annual non-native plant invasion

Invasive Potential of a Winter Annual Predicted to Increase with Climate Change

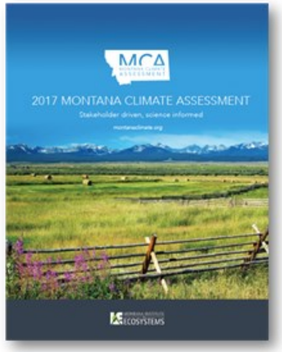
15th Biennial Scientific Conference on the Greater Yellowstone Ecosystem

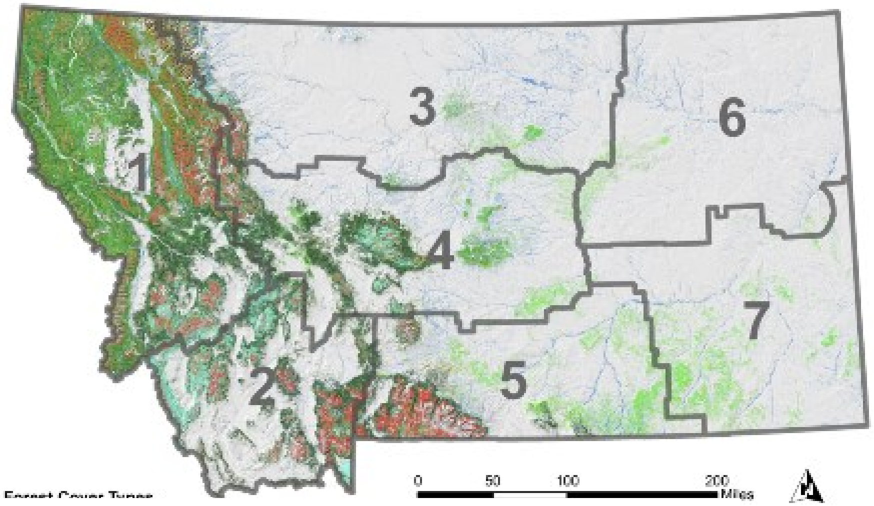
May 16th, 2022

Hannah Duff and Bruce Maxwell

Montana State University

Montana Climate Regions = Agriculture Regions

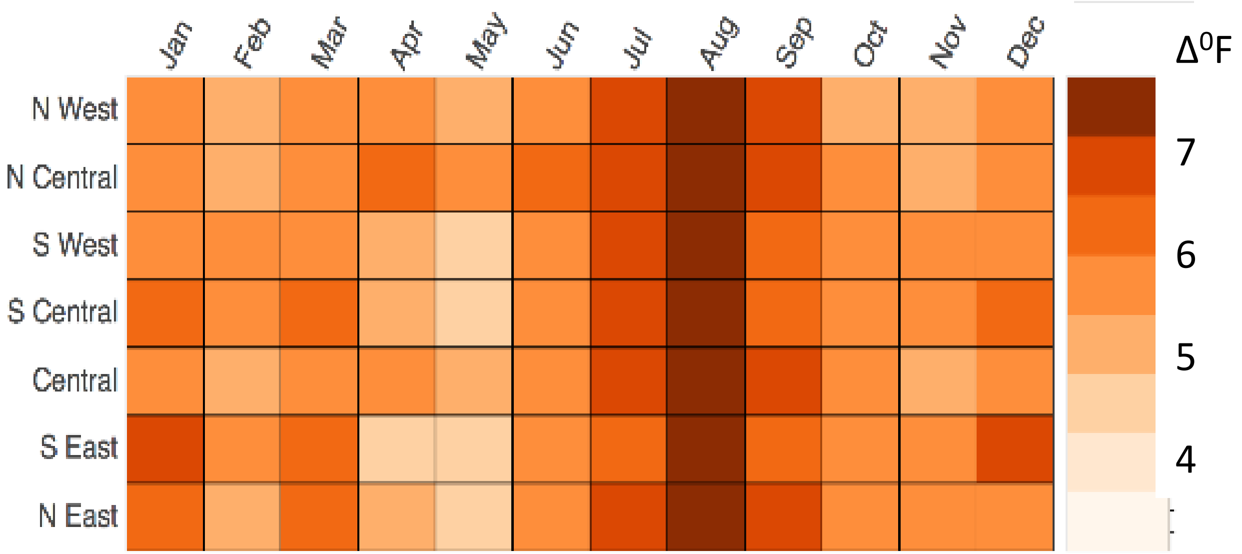




Montana Climate Office

Monthly Temperature Change Projections

RCP 8.5 (2040-2060)



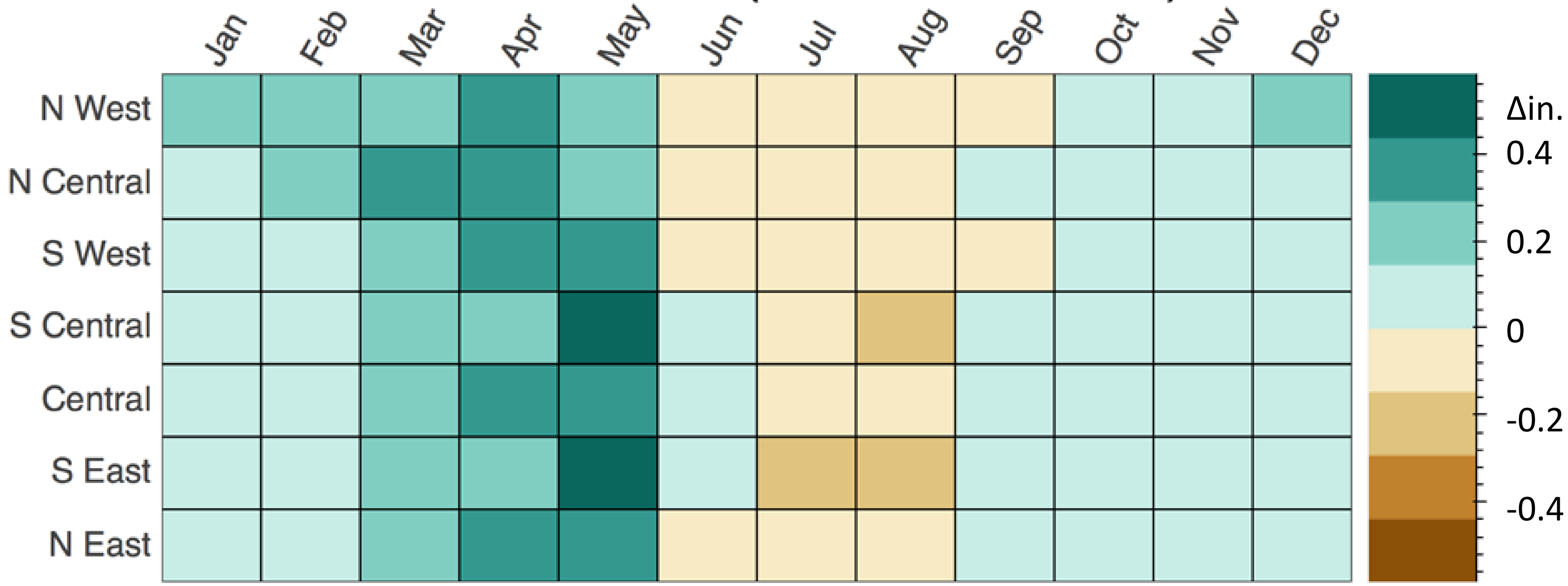
- Winter: 5 to 7°F
- Summer: 6 to 7.5°F

(100% model agreement)

Montana Institute on Ecosystems

Projected Change In Monthly Precipitation

RCP 8.5 (2040-2060)

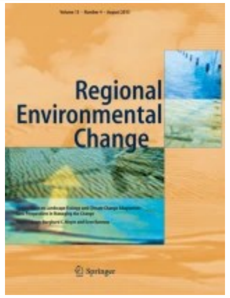


Model agreement: 85%

MONTANA INSTITUTE ON ECOSYSTEMS

Regional Environmental Change (2020) 20: 60
https://doi.org/10.1007/s10113-020-01647-0

ORIGINAL ARTICLE



Future distribution of invasive weed species across the major road network in the state of Montana, USA

Arjun Adhikari[1,2] · Lisa J. Rew[3] · Kumar P. Mainali[4,5] · Subodh Adhikari[6] · Bruce D. Maxwell[7]

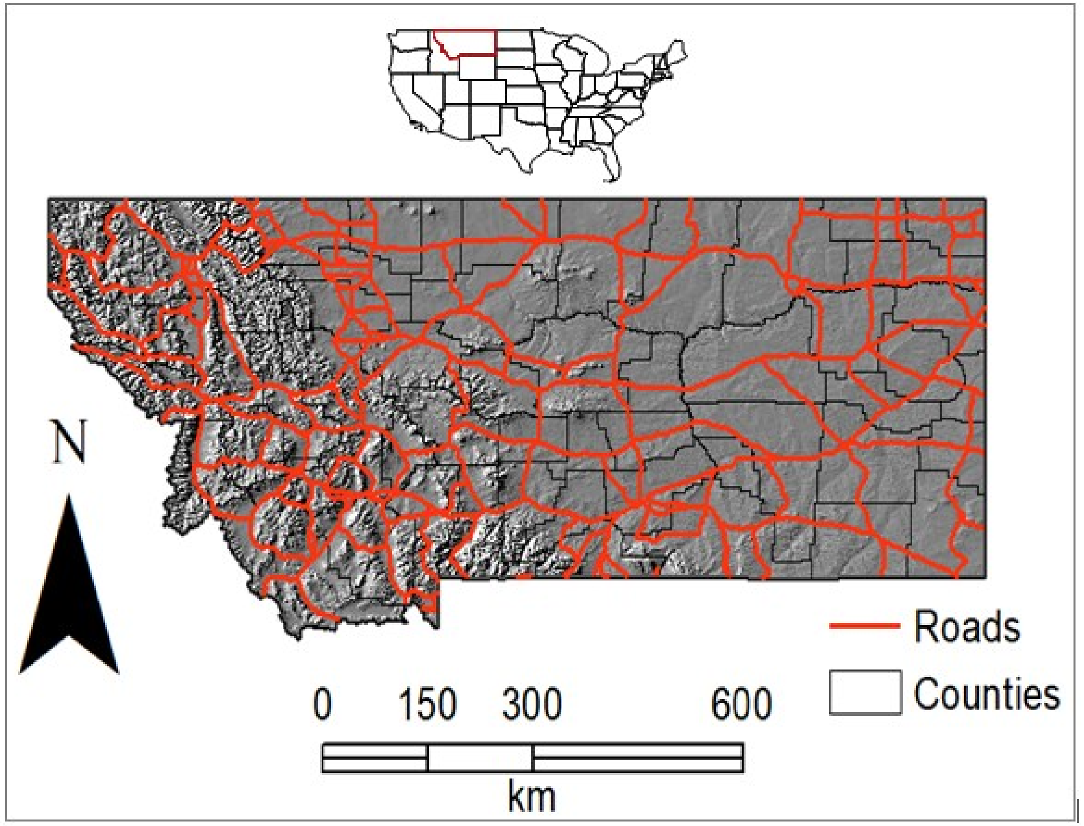
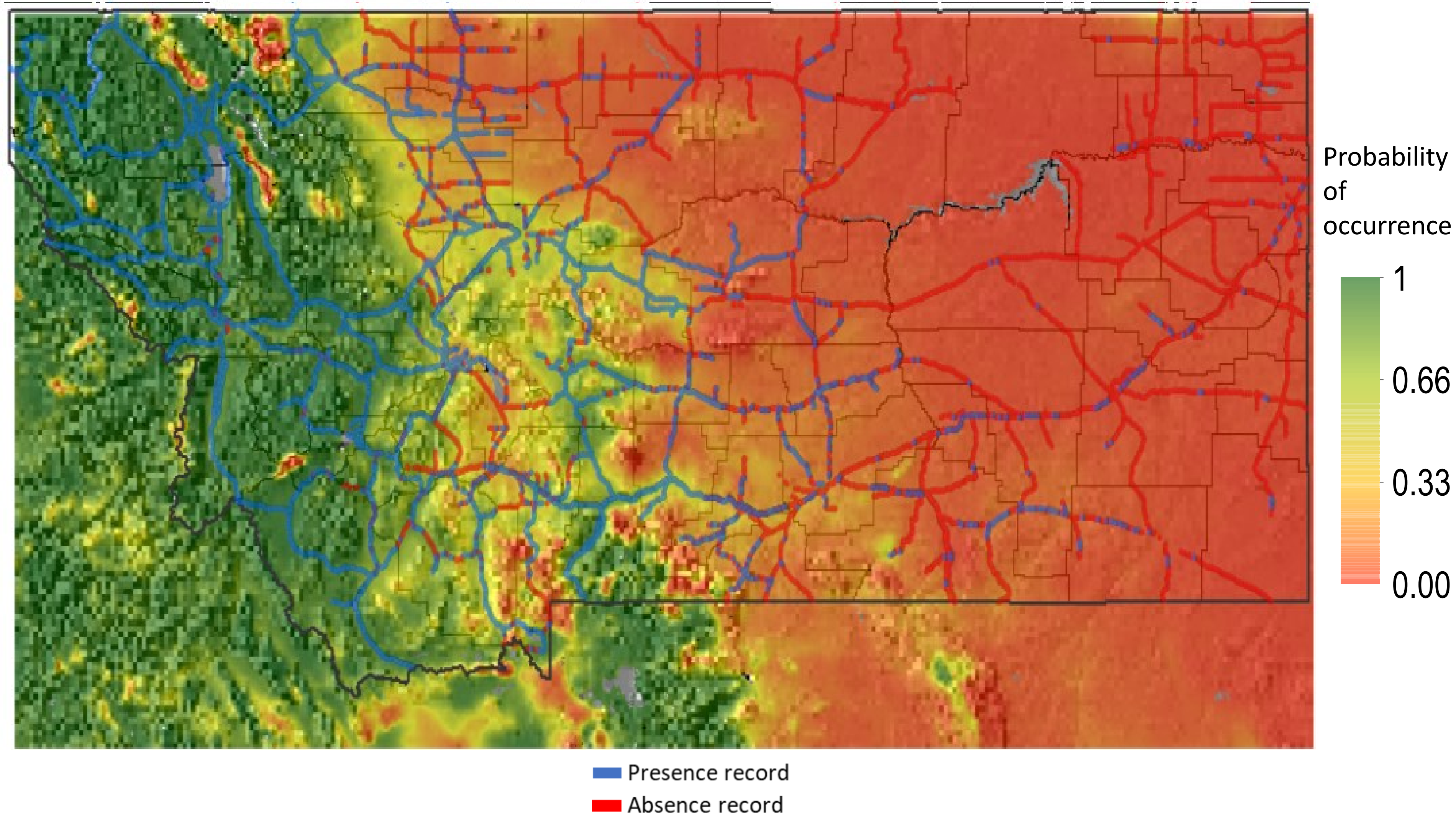


Figure 1. Map of study area showing major roads of Montana State, USA. The presence and absence records of eleven weed species were collected along the roadsides during 2004-2005 inventory work.

Predicted species occurrence based on climate variables
Ensemble models trained with DOT highway presence/absence data

Spotted Knapweed

RCP8.5 2040



Adhikari et al. 2020. Future distribution… Regional Environmental Change 20:60







Table 1. Selected invasive weed species from Montana Road network, their common names, number of observation of their presence records, AUC values, current habitat, and future habitat suitability of 11 species projected by ensemble models. All species are listed under noxious weed (PRIORITY 2B) in Montana.

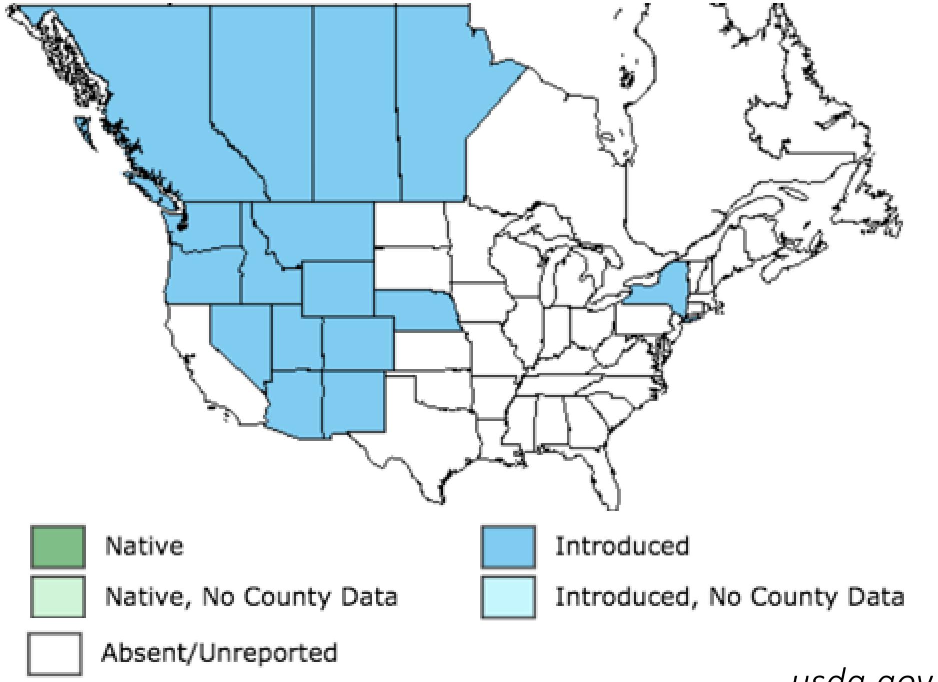
Species	AUC	Current habitat (km^2)	Future habitat (km^2)	Change in habitat (proportion)
Cardaria draba	0.96	6937	6016	−0.13
Centaurea maculosa	0.93	14988	11041	−0.26
Cirsium arvense	0.91	15091	22201	0.47
Convolvulus arvensis	0.77	14369	22504	0.57
Cynoglossum officinale	0.88	7348	8897	0.21
Euphorbia esula	0.92	8825	1050	−0.88
Hypericum perforatum	0.85	3590	26826	6.47
Leucanthemum vulgare	0.96	5160	7312	0.42
Linaria dalmatica	0.92	9286	8243	−0.11
Potentilla recta	0.85	4229	10584	1.5
Tanacetum vulgare	0.89	5491	5778	0.05

Adhikari et al. 2020. Future distribution… Regional Environmental Change 20:60

Annual Wheatgrass

(*Eremopyrum triticeum*)

Young et al. 2005



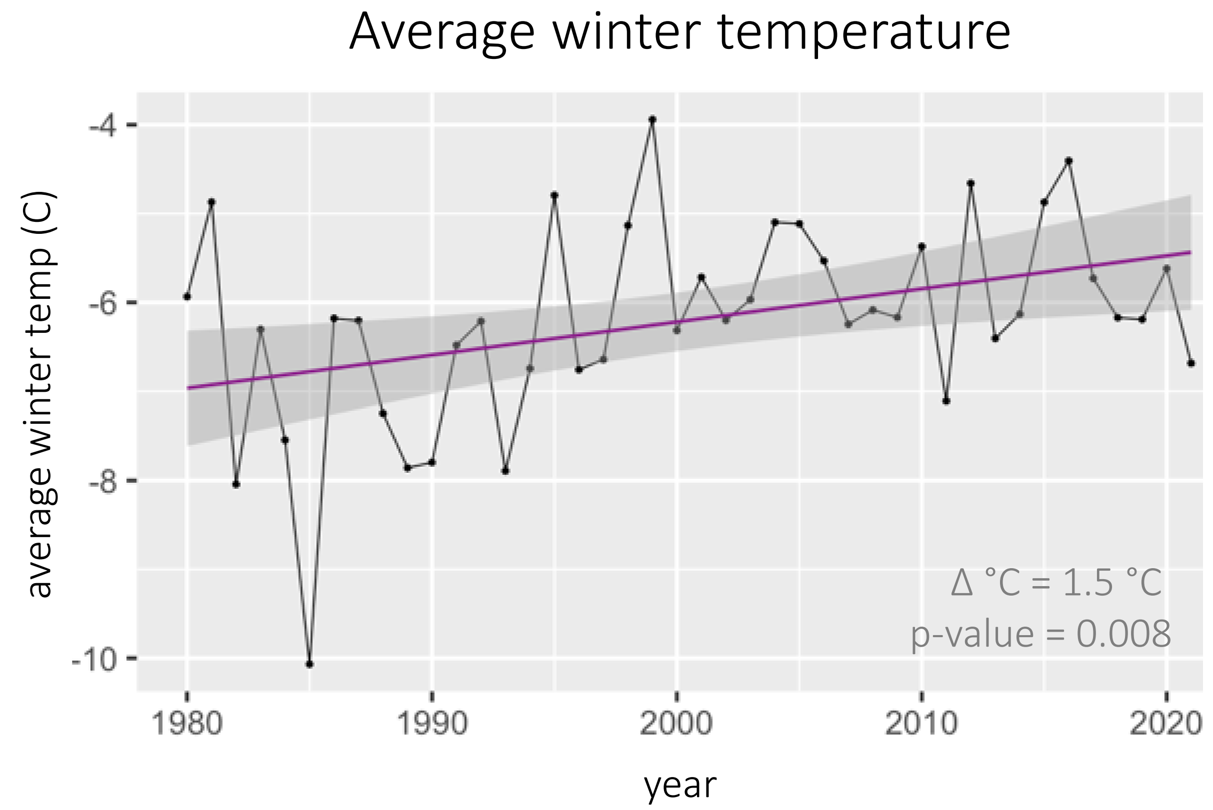
usda.gov

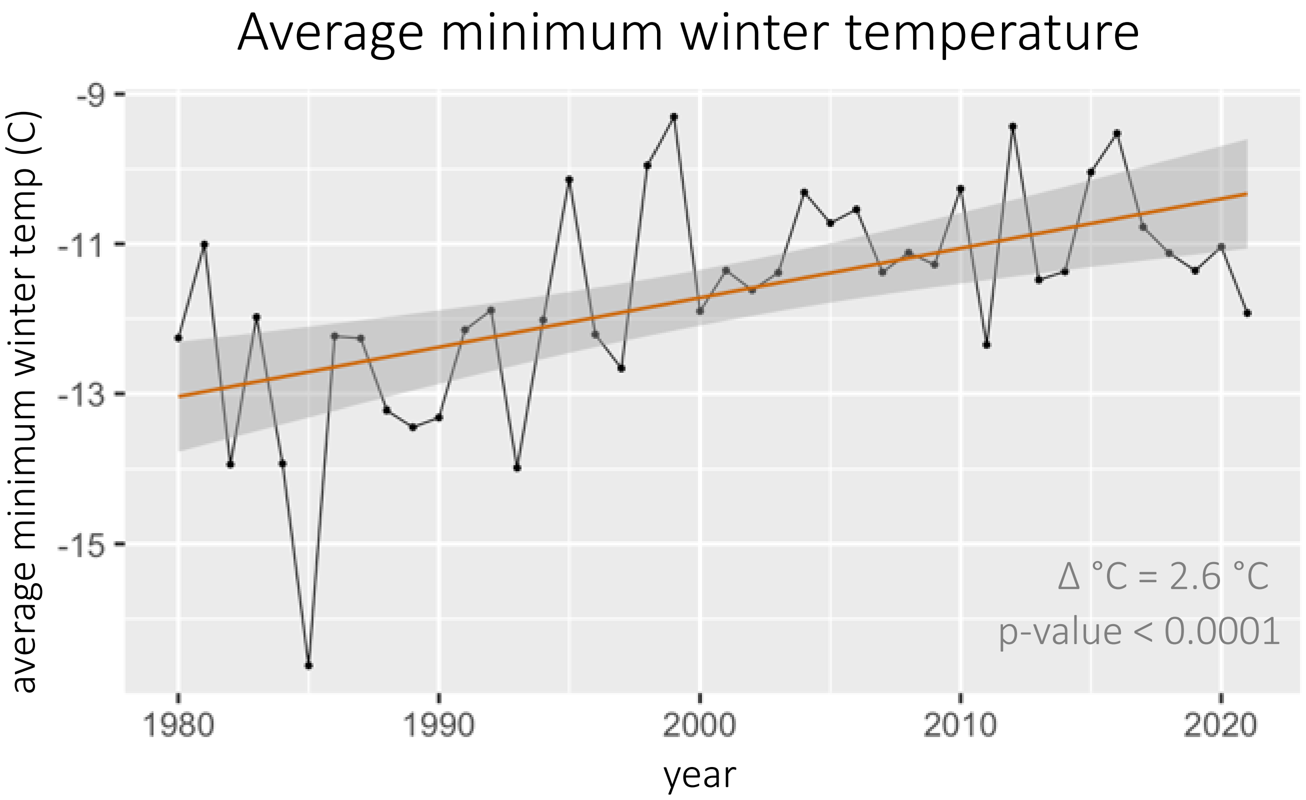
Grows well at

- elevations below 1,676 meters
- annual precipitation less than 25.4 cm

Banner et al. 2005

Warming Winter Temperatures in Yellowstone National Park



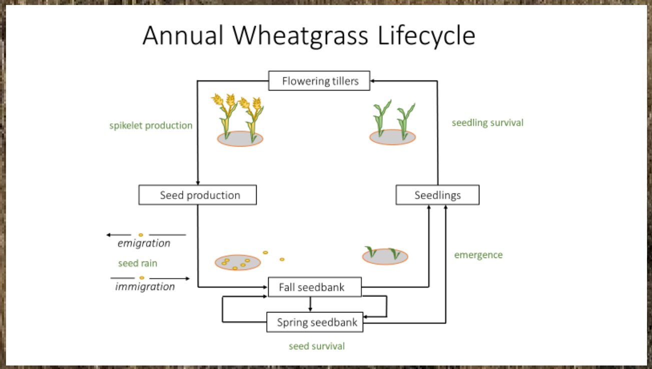


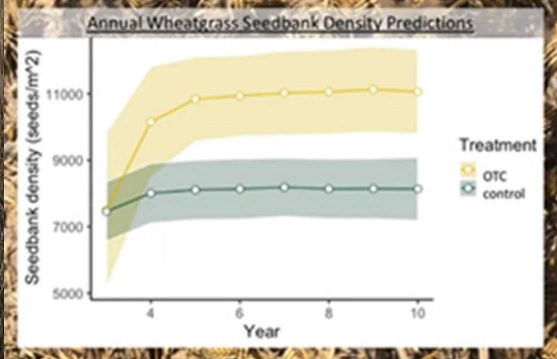
Whitlock et al., 2017; Daymet Version 4

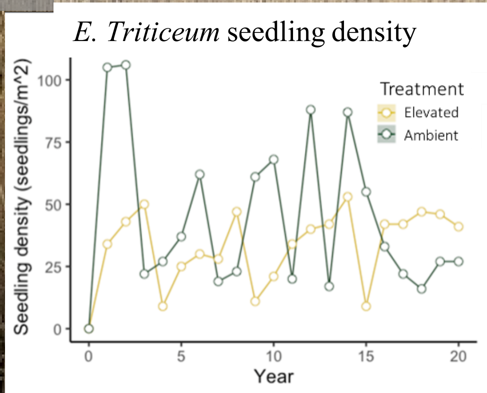
Lifecycle demographics over 4 years were monitored in field treatments and used to parameterize a lifecycle model

OTC: Elevated

Control: Ambient







Wand et al., 1999
Frei et al., 2020

Effects of Fire on Annual Wheatgrass

Effects of Fire on Annual Wheatgrass

Not Burned

Burned

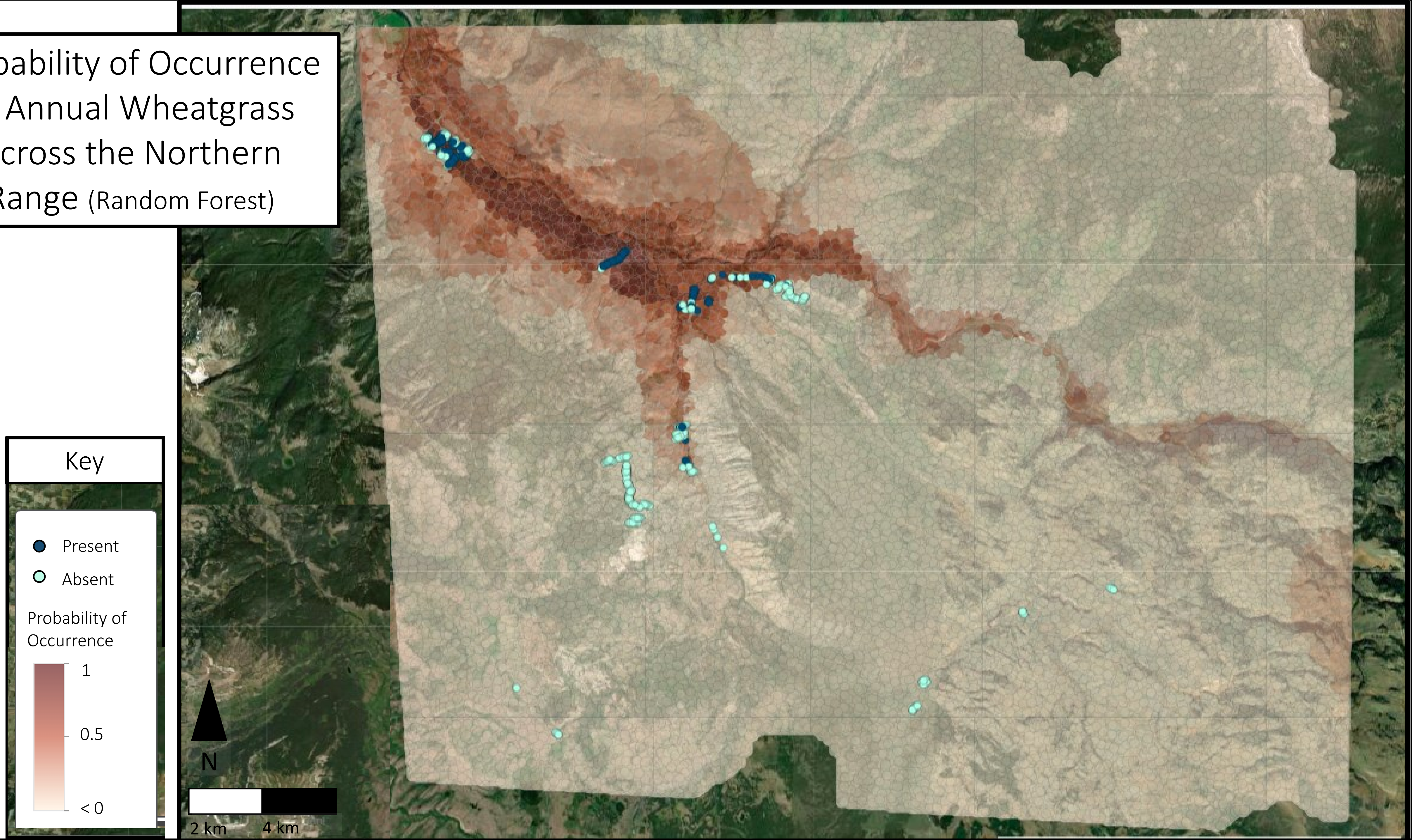
Viable

TZ test: 27% viable (n=30)

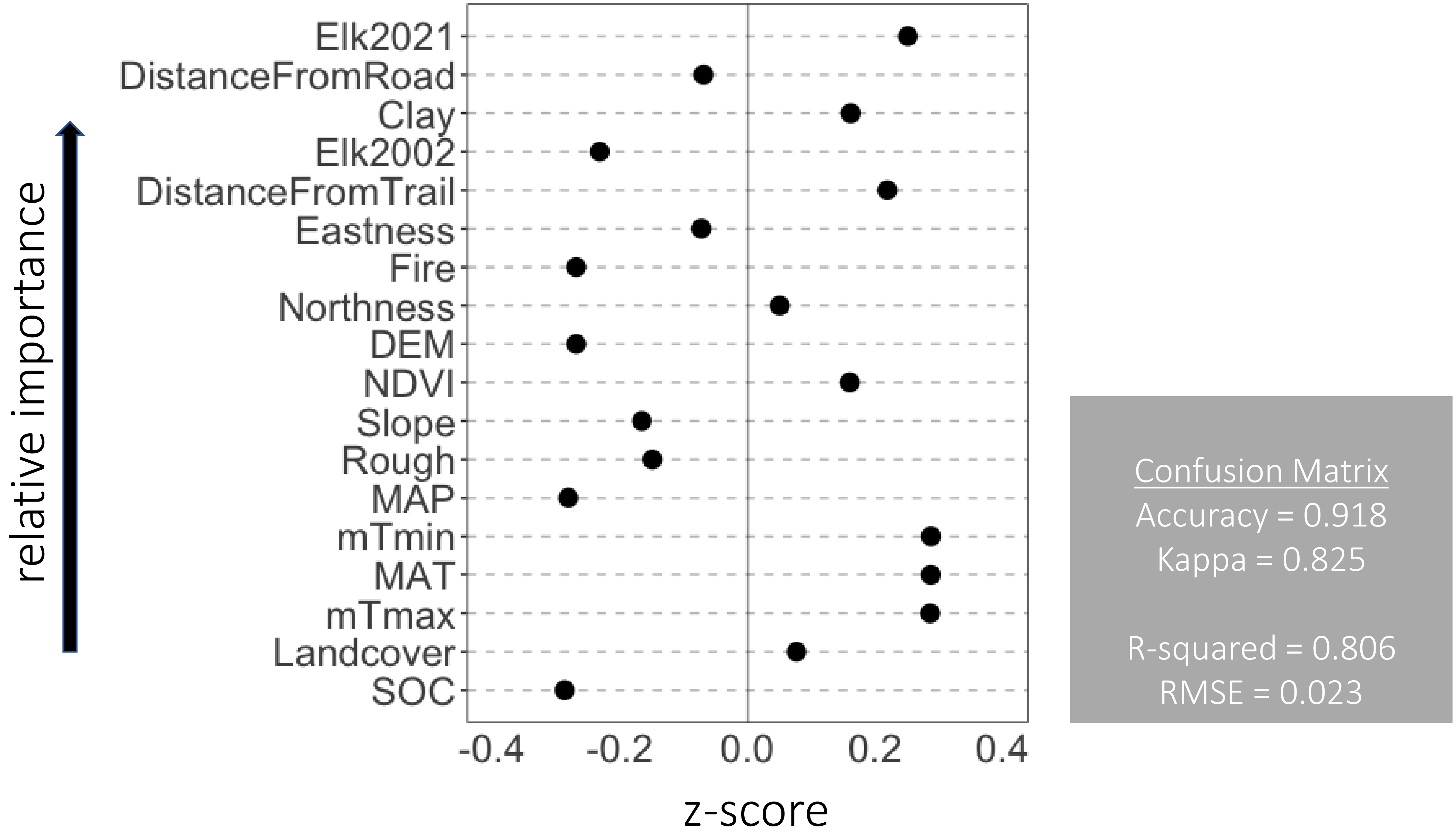
Not Viable

TZ test: 0% viable (n=30)

Probability of Occurrence of Annual Wheatgrass Across the Northern Range (Random Forest)



Effect Size Plot for Random Forest Model Predicting Range Expansion



Summary

“Higher order effects among multiple drivers acting simultaneously create challenges in predicting future response…”

“…extrapolating these complex impacts across entire networks of species interactions yields unanticipated effects on ecosystems.”

“…challenge will be to determine how biotic and abiotic context alters the direction and magnitude of GEC effects on biotic interactions.”

Lessons learned:

Site-specificity is key for predicting future range expansion with climate change.
Only through effective on-site monitoring will predictions of range expansion be accurate.

Tylianakis, J. M., Didham, R. K., Bascompte, J., & Wardle, D. A. (2008). Global change and species interactions in terrestrial ecosystems. *Ecology letters*, *11*(12), 1351-1363.

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