

Ecosphere

Innovation in rangeland monitoring: annual, 30m, plant functional type percent cover maps for US rangelands, 1984–2017

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Appendix S1

Table S1. The top 40 variables per class used in Random Forests land cover predictions. CY and PY are previous year and current year. P is percentile. Dash (-) denotes seasonal difference.

Rank	AFG Variables	PFG Variables	SHR Variables	BG Variables
1	NDVI (Spring - Summer)	Longitude	Elevation	NBR2 (Summer Minimum)
2	MSAVI (Spring - Summer)	NBR2 (Summer Minimum)	Longitude	TC5 (Summer Mean)
3	Precipitation (Summer CY)	NBR2 (Summer Mean)	Latitude	TC5 (Summer Maximum)
4	TCg (Spring - Summer)	NBR2 (Summer Max)	Band 6 (Fall Mean)	NBR2 (Summer Mean))
5	Longitude	MSAVI (Summer - Fall)	Min Temperature (P90 CY)	NDVI (Spring Mean)
6	TC4 (Summer Maximum)	Precipitation (Spring PY)	NBR2 (Fall Mean)	TC5 (Spring Mean)
7	EVI (Spring - Summer)	Precipitation (Spring CY)	Min Temperature (P90 PY)	NBR2 (Spring Mean)
8	SAVI (Spring - Summer)	SAVI (Summer - Fall)	TC4 (Spring Maximum)	NBR2 (Spring Minimum)
9	TC4 (Summer Mean)	NDVI (Summer Maximum)	Min Temperature (P50 CY)	NDVI (Spring Maximum)
10	Precipitation (Spring - Fall PY)	NDVI (Summer - Fall)	TC4 (Fall Maximum)	Band 7 (Summer Mean)
11	Precipitation (Summer PY)	SAVI (Summer Maximum)	TC4 (Summer Mean)	TC5 (Spring Maximum)
12	MSAVI (Summer - Fall)	EVI (Summer Maximum)	TC4 (Summer Maximum)	Band 3 (Summer Mean)
13	Min Temperature (P10 PY)	NDVI (Summer Mean)	NBR2 (Spring Maximum)	Band 2 (Summer Mean)
14	TC6 (Summer - Fall)	NBR2 (Spring Mean)	Max Temperature (P90 CY)	NBR2 (Fall Mean)
15	SAVI (Summer - Fall)	EVI (Summer - Fall)	Max Temperature (P50 CY)	NBR2 (Spring Maximum)
16	Max Temperature (P90 PY)	Elevation	NBR2 (Spring Minimum)	TCb (Summer Mean)
17	Elevation	Min Temperature (P10 PY)	Max Temperature (P90 PY)	NBR2 (Summer Maximum)
18	Max Temperature (P50 CY)	NBR2 (Spring Max)	MSAVI (Fall Mean)	Band 4 (Spring Mean)
19	TC6 (Spring Maximum)	NBR2 (Spring Maximum)	TCw (Fall Minimum)	TC5 (Fall Mean)
20	Precipitation (Spring PY)	TC5 (Summer Mean)	EVI (Spring Maximum)	Band 4 (Summer Mean)
21	TC4 (Spring Maximum)	EVI (Spring Maximum)	Max Temperature (P10 CY)	EVI (Spring Mean)
22	Max Temperature (P10 PY)	TCg (Summer Mean)	Max Temperature (P50 PY)	TC5 (Fall Maximum)
23	Max Temperature (P90 CY)	Max Temperature (P10 PY)	Band 6 (Spring Mean)	TCg (Spring Mean)
24	NDVI (Spring Maximum)	NBR2 (Fall Mean)	Min Temperature (P10 PY)	NBR2 (Fall Maximum)
25	Max Temperature (P50 PY)	Min Temperature (P10 CY)	NBR2 (Summer Minimum)	TCg (Spring Maximum)
26	TCg (Spring Minimum)	Precipitation (Summer - Fall)	NBR2 (Summer Maximum)	SAVI (Spring Mean)
27	Water Deficit (PY)	Latitude	Min Temperature (P50 PY)	MSAVI (Spring Maximum)
28	Precipitation (Annual PY)	TCg (Summer - Fall)	Precipitation (Spring - Fall PY)	Slope
29	NDVI (Summer Mean)	EVI (Summer Mean)	Precipitation (Fall PY)	TCg (Summer Mean)
30	TCg (Spring Maximum)	TCG (Spring Maximum)	Min Temperature (P10 CY)	TCb (Spring Maximum)
31	Min Temperature (P10 CY)	SAVI (Spring Mean)	TCw (Spring Minimum)	Band 7 (Spring Mean)
32	TC4 (Fall Maximum)	Max Temperature (P10 CY)	Height Above Nearest Drainage	NBR (Summer Mean)
33	Longitude	NDMI (Spring Minimum)	Precipitation (Spring CY)	Band 5 (Summer Mean)
34	Precipitation (Fall PY)	NDMI (Fall Minimum)	NBR2 (Summer Mean)	Height Above Nearest Drainage
35	TC4 (Spring - Summer)	Band 3 (Summer Mean)	TCb (Fall Minimum)	TC6 (Summer Mean)
36	NBR2 (Fall Minimum)	TCw (Fall Minimum)	TC4 (Spring Mean)	SAVI (Spring Maximum)
37	Precipitation (Summer - Fall CY)	Precipitation (Summer PY)	SAVI (Fall Mean)	TCg (Fall Maximum)
38	Max Temperature (P10 CY)	Water Deficit (PY)	Max Temperature (P10 PY)	Band 5 (Spring Mean)
39	TC4 (Summer Minimum)	Band 2 (Summer Mean)	Precipitation (Spring PY)	NBR2 (Fall Minimum)
40	EVI (Spring Maximum)	Band 6 (Spring Mean)	NBR2 (Spring Mean)	TC4 (Summer Mean)

Methods for estimating land cover prediction confidence

To estimate confidence intervals we examined the variability of out-of-bag (OOB) predictions using an infinitesimal jackknife approach (Wager et al. 2014), a method available within the *ranger* Random Forests package. Samples are bagged multiple times during model training and for each bagging instance the prediction is retained providing a collection of predictions for each OOB sample. This collection of predictions for each OOB sample allows a standard error estimation for each field plot. Figure S1 displays the results of that analysis where every NRI-AIM field plot's cover value is plotted with its OOB prediction RMSE. A loess smoother is fit to the results (blue line) for clarity since many plots display higher RMSEs yet a majority display low RMSE values, particularly for lower field plot cover values.

The plots indicate errors scaled somewhat with increasing field plot cover values for AFG, SHR, and BG, but remained relatively constant for PFG. The increase in error with field plot cover for AFG, SHR, and BG can be partially attributed to the skewed distribution of cover values in the NRI-AIM field plots. Only 7%, 2%, and 9% of the field plots had measured cover values over 50% for AFG, SHR, and BG respectively, resulting in minimal samples with high cover values used in model training. All classes displayed RMSE ranges across cover values relatively equivalent to the summarized RMSEs in Table 3.

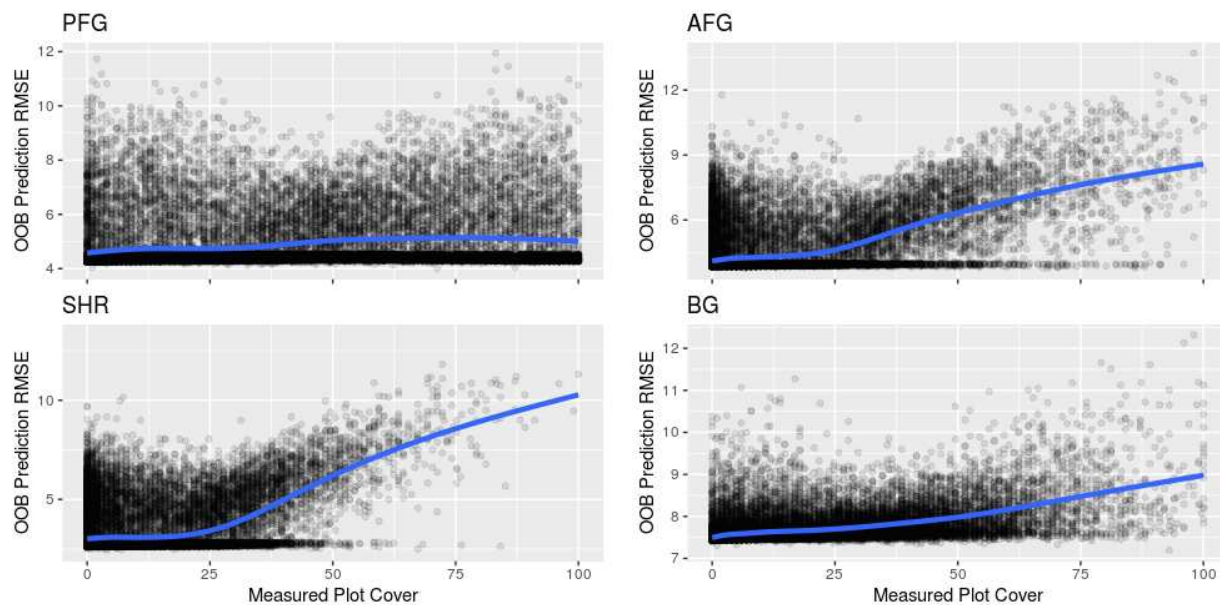


Figure S1. Measured plot cover versus the OOB prediction RMSE for each of the 27,643 NRI-AIM field plots used in *ranger* Random Forests model training and prediction. Blue line is a loess smoother fit to the results to clarify the density of points at low RMSE values.

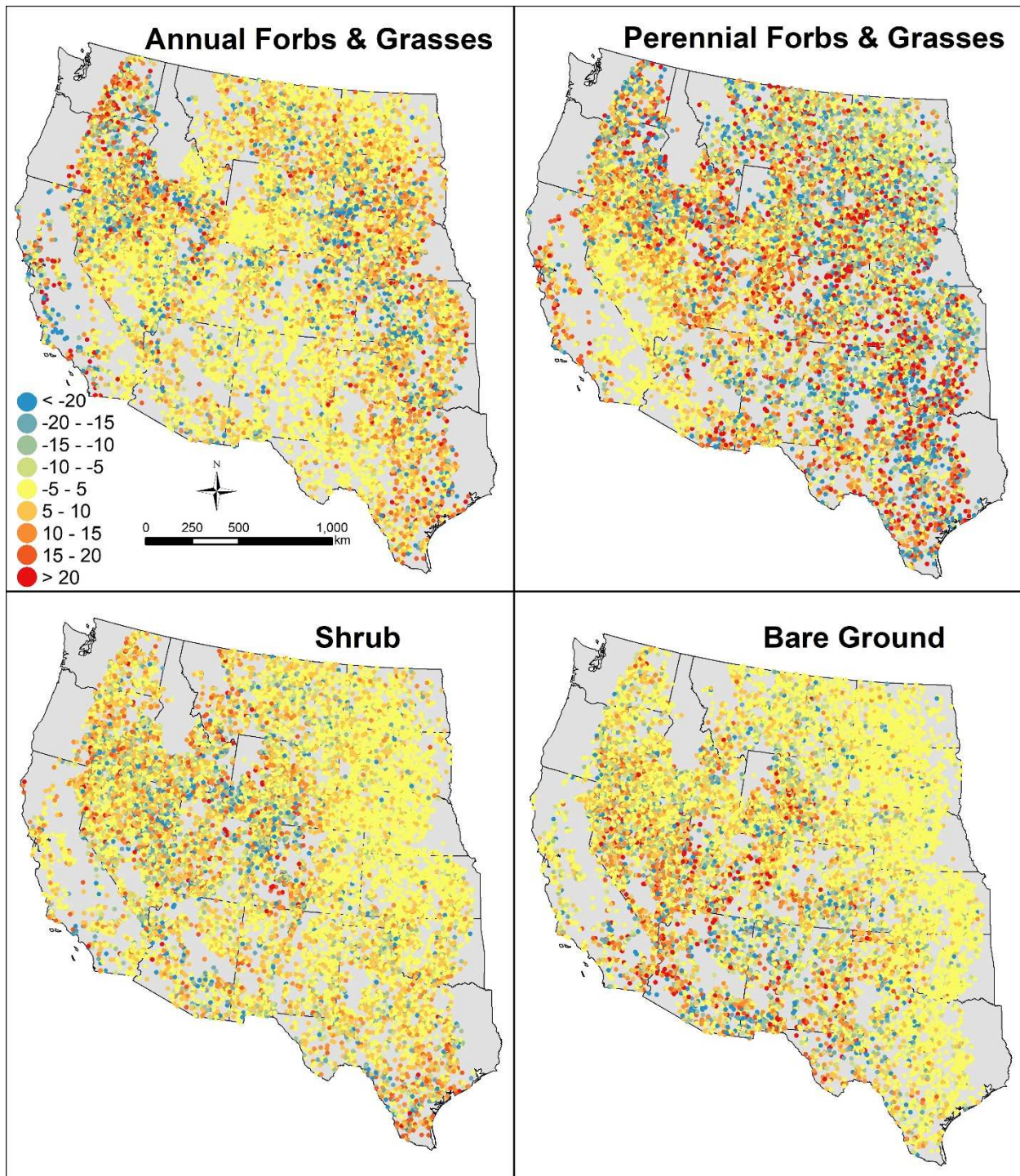


Figure S2. Difference between per plot percent land cover predictions from out-of-bag (OOB) samples and field plot measures using the Random Forests model within the R *ranger* package. Negative values indicate where predictions under-estimated field plot percent cover and positive values indicate over-estimation.