Predicting Woody Plant Encroachment Risk on Sonoran Desert Rangelands

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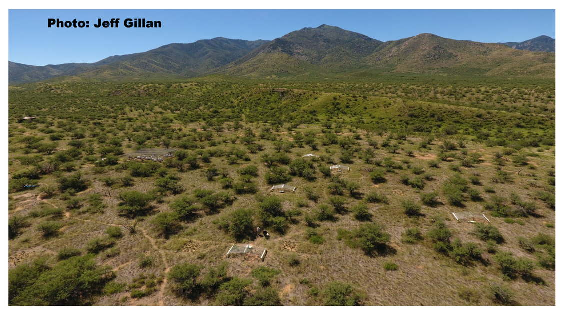
Background



- Sonoran Desert grasslands like those at the Santa Rita Experimental Range (SRER) have seen substantial increases in shrub establishment in the past century.[1]
- Brush management (BM) via mechanical, herbicidal, cultural, and/or burning treatments are widely used to reduce shrub cover and induce herbaceous plant growth. Knowing when and where to target BM treatments could aid in decision making.

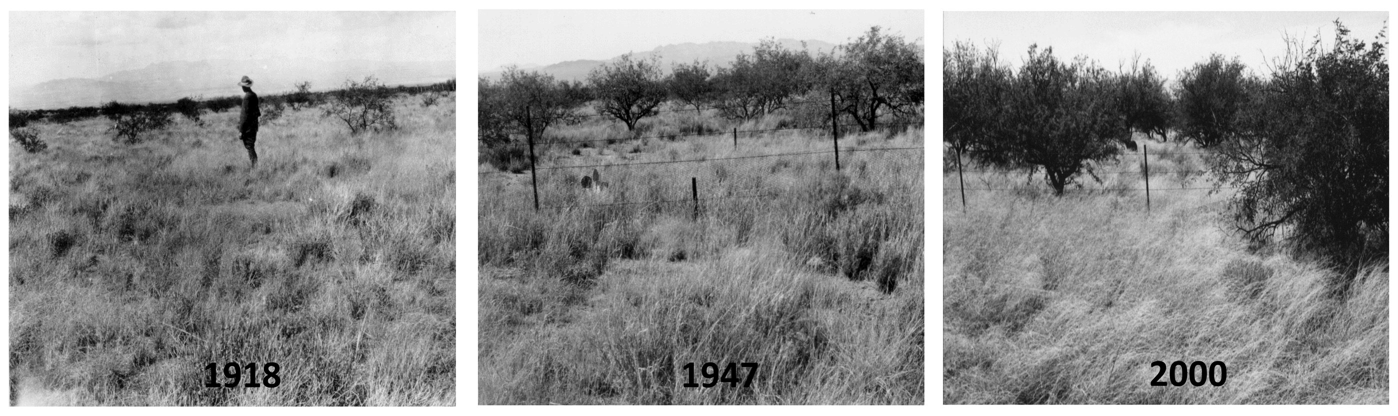


Figure 1. Repeat photography (1918, 1947, 2000) of velvet mesquite cover at the SRER Desert Grassland Station exclosure (SRER Repeat Photography Archive, Station 091).

Objectives

- Determine the extent to which sites at SRER are
  (i) at risk for further woody plant encroachment (WPE) and/or
  (ii) at their maximum bioclimatic potential woody cover

Methods

- NAIP (National Agricultural Imagery Program) imagery used in an unsupervised classification (e.g., ISODATA) procedure to calculate SRER woody cover.
- NAIP-derived woody cover and Landsat 8 vegetation indices relationship (Figure 2) used in modeling WPE risk (Figure 3).

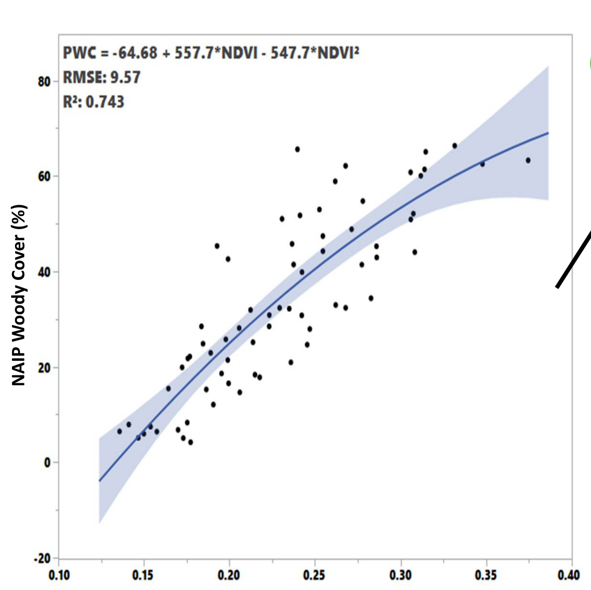


Figure 2. Best relationship between classified 2015 NAIP (1m) woody cover (PWC) to 2015 Landsat 8 (30m) vegetation indices (e.g., NDVI (Normalized Difference Vegetation Index)) for the SRER developed as in Holifield Collins et al., 2015[2].

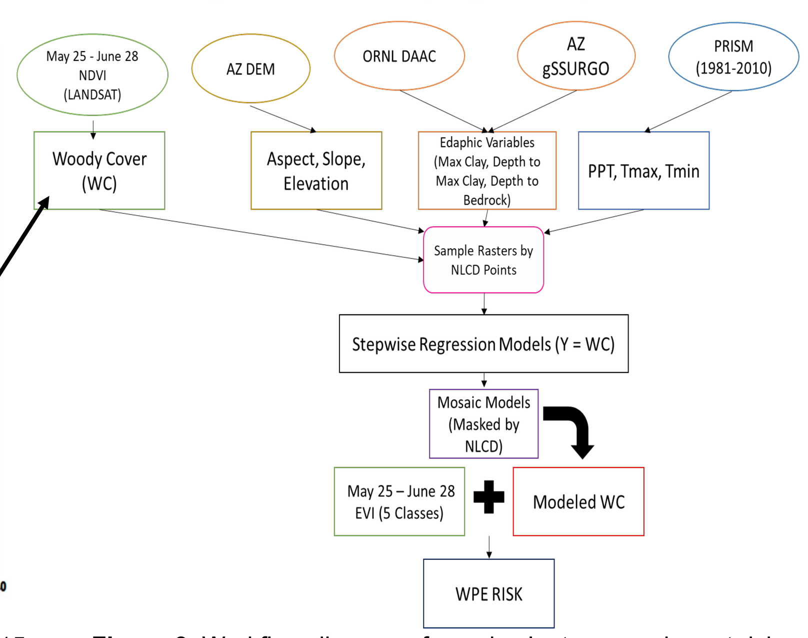


Figure 3. Workflow diagram of woody plant encroachment risk model development. 2015 **NDVI** = Normalized Difference Vegetation Index; **DEM** = Digital Elevation Model; **ORNL DAAC** = Oak Ridge National Laboratory Distributed Active Archive Center; **gSSURGO** = NRCS gridded Soil Survey Geographic Database; **PRISM** = Parameter-elevation Regressions on Independent Slopes Model; **PPT** = precipitation; **Tmax** = maximum Temperature; **Tmin** = minimum Temperature; **NLCD** = National Land Cover Database; 2016 **EVI** = Enhanced Vegetation Index

- Separate stepwise regression models for shrub/scrub and herbaceous National Land Cover Database land cover classes were used to predict woody cover based on bioclimatic variables (Table 1).

Table 1. Model cross-validation for each land cover class. Significant ($p < 0.01$) model variables were Max Clay, Depth to Bedrock, PPT, and Tmax (Herbaceous land cover class also included Tmin).

Class	Source	R^2	RMSE	N
Shrub/scrub	Training	0.32	11.77	781
	Validation	0.35	12.56	790
Herbaceous	Training	0.29	11.16	837
	Validation	0.23	11.56	885

RMSE = Root Mean Square Error, N = sample number

- The two land cover class models were mosaicked together to form one complete predicted woody cover raster for the SRER.
- Using the Enhanced Vegetation Index (EVI) as a vegetation biomass proxy, EVI and predicted woody cover (PWC) rasters were combined, so that:

↑ PWC	&	↑ EVI	=	Low Risk
↓ PWC	&	↓ EVI	=	Low Risk
↔ PWC	&	↔ EVI	=	Moderate Risk
↑ PWC	&	↓ EVI	=	High Risk

- Sites near their bioclimatic woody cover max potential = high PWC and high EVI

Product

Table 2. Area summary of recent (2016) WPE risk levels on the SRER.

WPE Risk Level	Hectares	Acres
Low	4,845	11,972
Slightly Low	6,603	16,317
Moderate	7,497	18,526
Slightly High	1,598	3,948
High	180	444
Total	**20,723**	**51,207**

- **9,275 ha (22,918 ac) or ~45% estimated to be at moderate to high levels of risk for further WPE**
- **Assessing WPE risk may aid to prioritize where to conduct future BM treatments (see Map Utility Scenario below)**

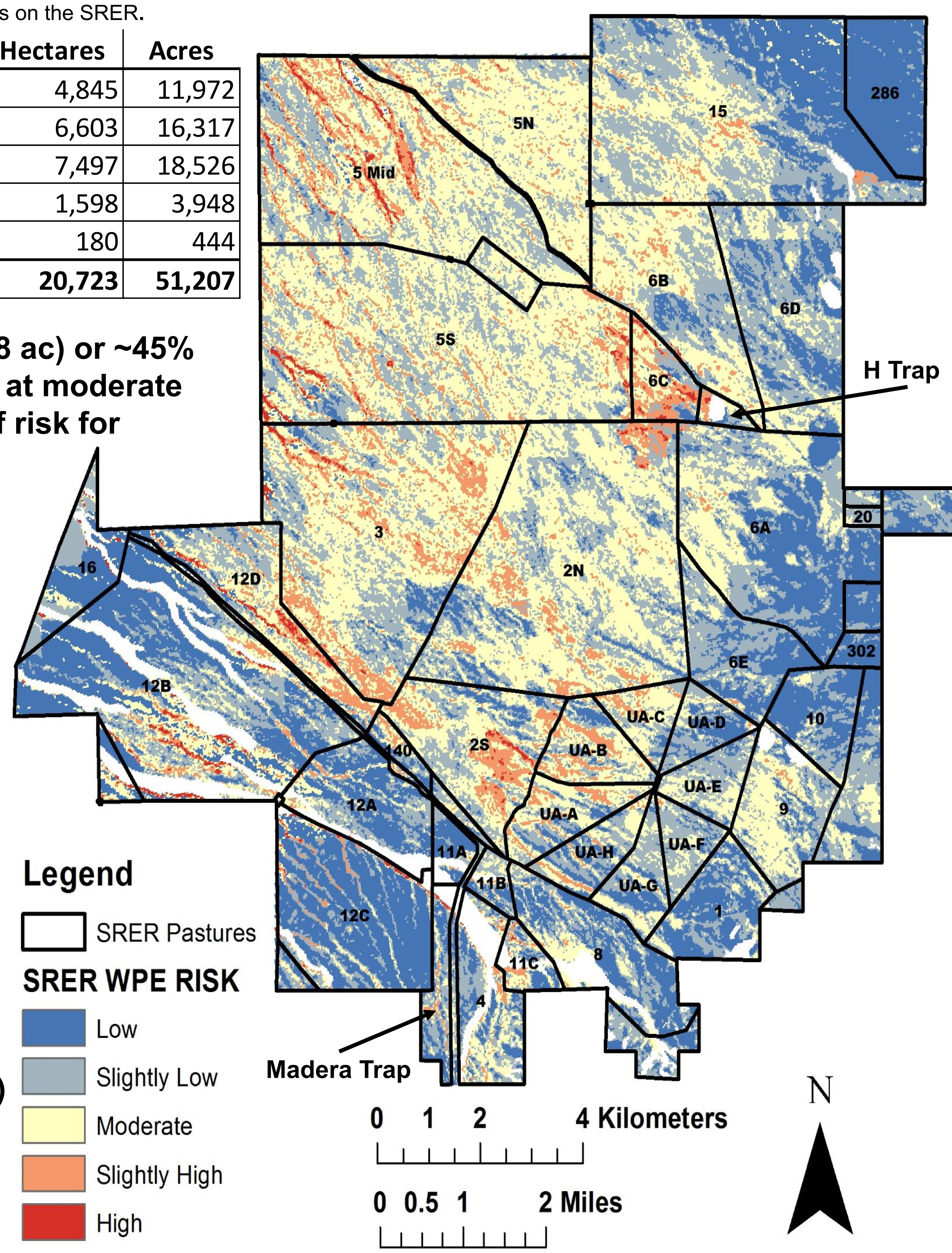


Figure 4. Risk map of recent (2016) WPE in pastures on the SRER. Risk classes were produced using Jenks Natural Breaks. White areas are sandy washes and rock outcrops without clay data and were excluded from analysis.

Map Utility Scenario

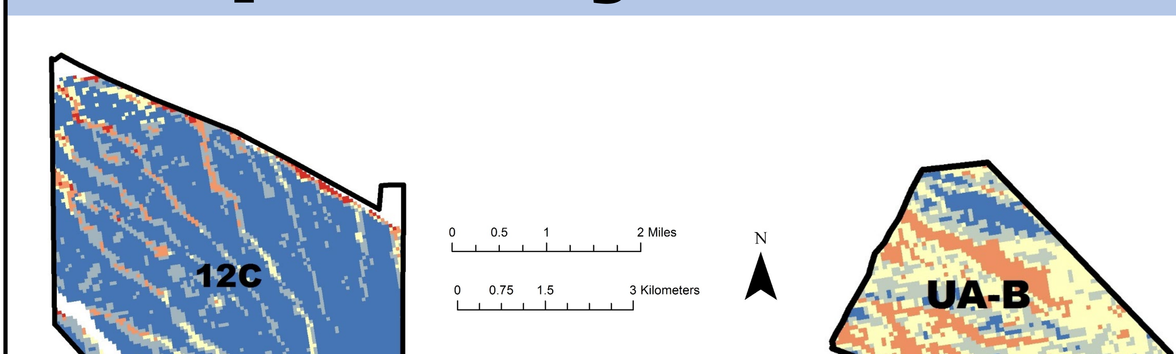


Table 3. Summary of recent (2016) WPE risk level for landscapes in SRER pasture 12C.

WPE Risk Level	Hectares	Acres
Low	498	1,231
Slightly Low	130	322
Moderate	37	91
Slightly High	25	63
High	8	20
Total	**699**	**1,726**

Table 4. Summary of recent (2016) WPE risk level for landscapes in SRER pasture UA-B.

WPE Risk Level	Hectares	Acres
Low	23	56
Slightly Low	59	145
Moderate	98	243
Slightly High	49	121
High	0	0
Total	**228**	**564**

- Pasture 12C would be lower priority for BM efforts/woody cover monitoring compared to UA-B despite having high-risk areas
- Quantitatively prioritize areas within UA-B for targeted BM if funds are limited

Future Work

- Use Canopy Height Models to improve NAIP woody cover classification and Landsat 8 vegetation indices relationship
- Create historical models of woody cover and WPE risk at multiple time-steps to evaluate the change in cover/risk through time
- Utilize SRER long-term vegetation transect data to compare woody cover changes
- Adapt the prototypic SRER WPE risk model for county, state, regional, etc. applications and incorporate into existing tools like DroughtView (https://droughtview.arizona.edu/)

References

1. McClaran, M. P. 2003.RMRS-P-30. USDA FS, Rocky Mountain Research Station, Tucson, AZ.
2. Holifield Collins et al. 2015. *JARS*, 9(1), 096057.

Acknowledgements

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