



Monitoring the Status of Forests and Rangelands in the Western United States Using Ecosystem Performance Anomalies

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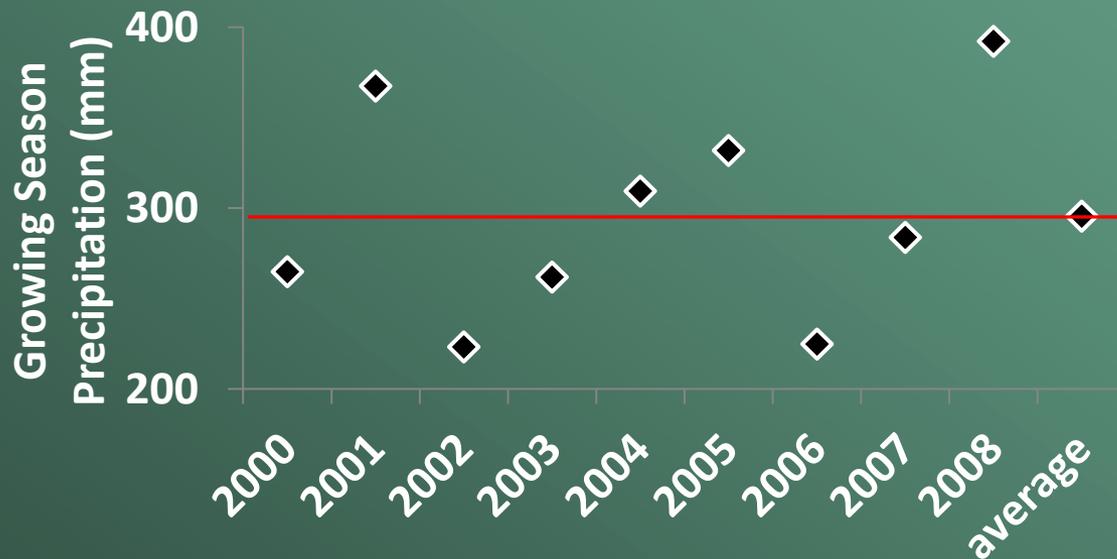
Ecosystem Performance

Annual ecosystem performance (our proxy of ANPP) is dependent on a complex interplay of biotic and abiotic factors.

- Weather
- Disturbance
- Management
- Soil fertility
- Topography

Temporal Variation of a Site

Efforts to distinguish the long term effects of land management (and disturbance) on ecosystem performance are difficult because their influence is often confounded by interannual variation in weather.



Spatial Variation between sites:

The differences in performance between sites cannot be directly linked to management or disturbance histories, due to the inherent spatial differences in site and weather conditions.



Expected Ecosystem Performance

- Previous studies have aimed to overcome these issues (aka climate vs. grazing impasse) by comparing actual to expected ecosystem performance (EEP) (e.g. Holm et al. 2003; Wessles et al. 2006; Wylie et al. 2008; Wylie et al. 2012).
- Years/sites with higher precipitation, or other favorable weather conditions, will have a higher EEP.

Measuring Actual Ecosystem Performance

- Ecosystem performance is often assessed with the NDVI averaged over the growing season (GSN).
- Strong relationship between GSN and ground-measured biomass productivity (Wang et al. 2005) and with carbon flux tower measured gross primary productivity (Gu et al. 2012).

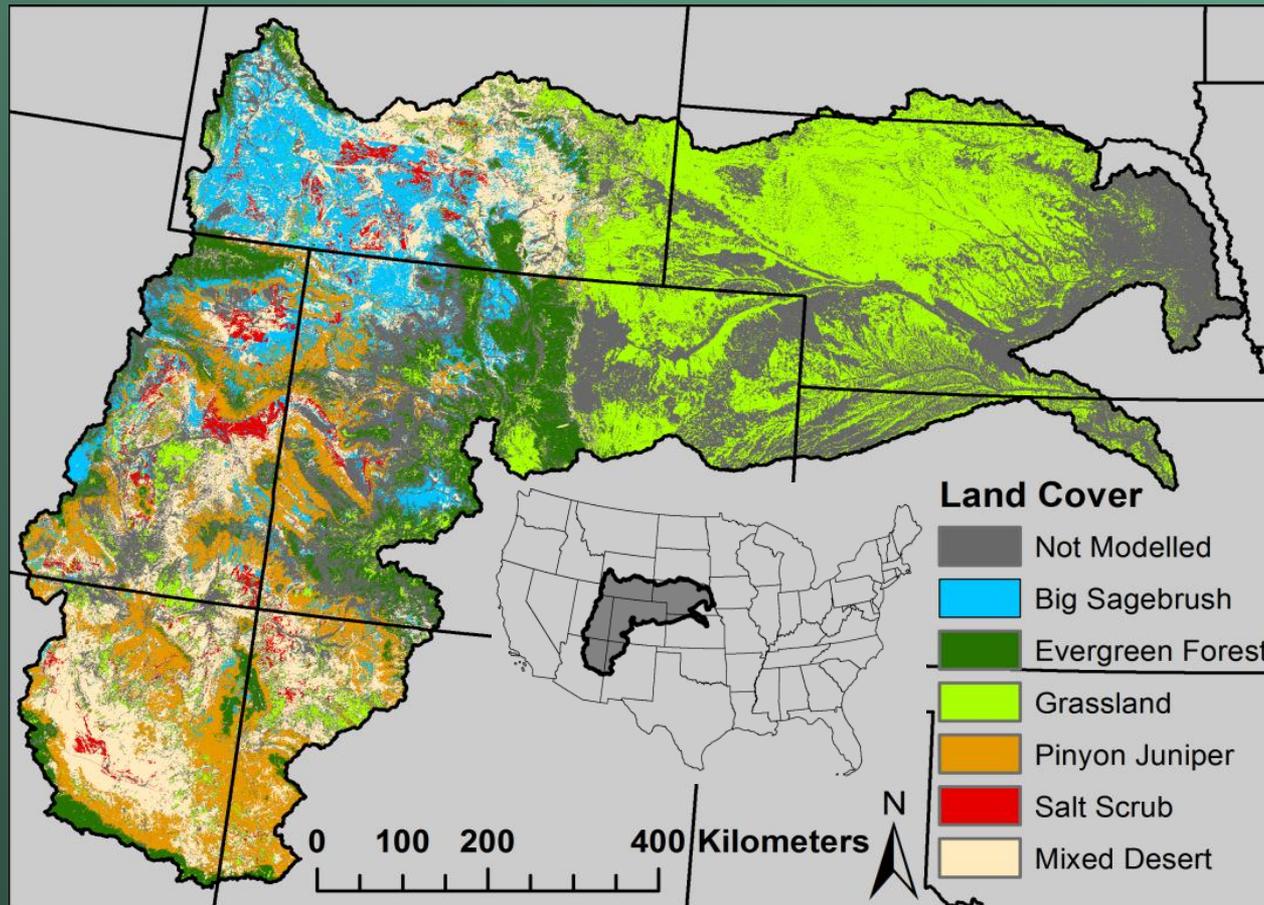
Ecosystem Performance Anomalies

- The difference between GSN and EEP yields the Ecosystem Performance Anomaly
- EPA provides a quantitative measure of ecosystem condition in each pixel
- Identification and quantification of EPA enables earlier detection of vegetation dynamics nearing an ecological threshold, management impacts

Objectives

- Determine EPA from 2000 to 2009 within the greater Platte and upper Colorado River basins at 250 meter resolution to serve as a proxy for range condition and quantify the influence of disturbance and land management on ecosystem performance in several western U.S. ecosystems.
- Provide tools for users to access these data online

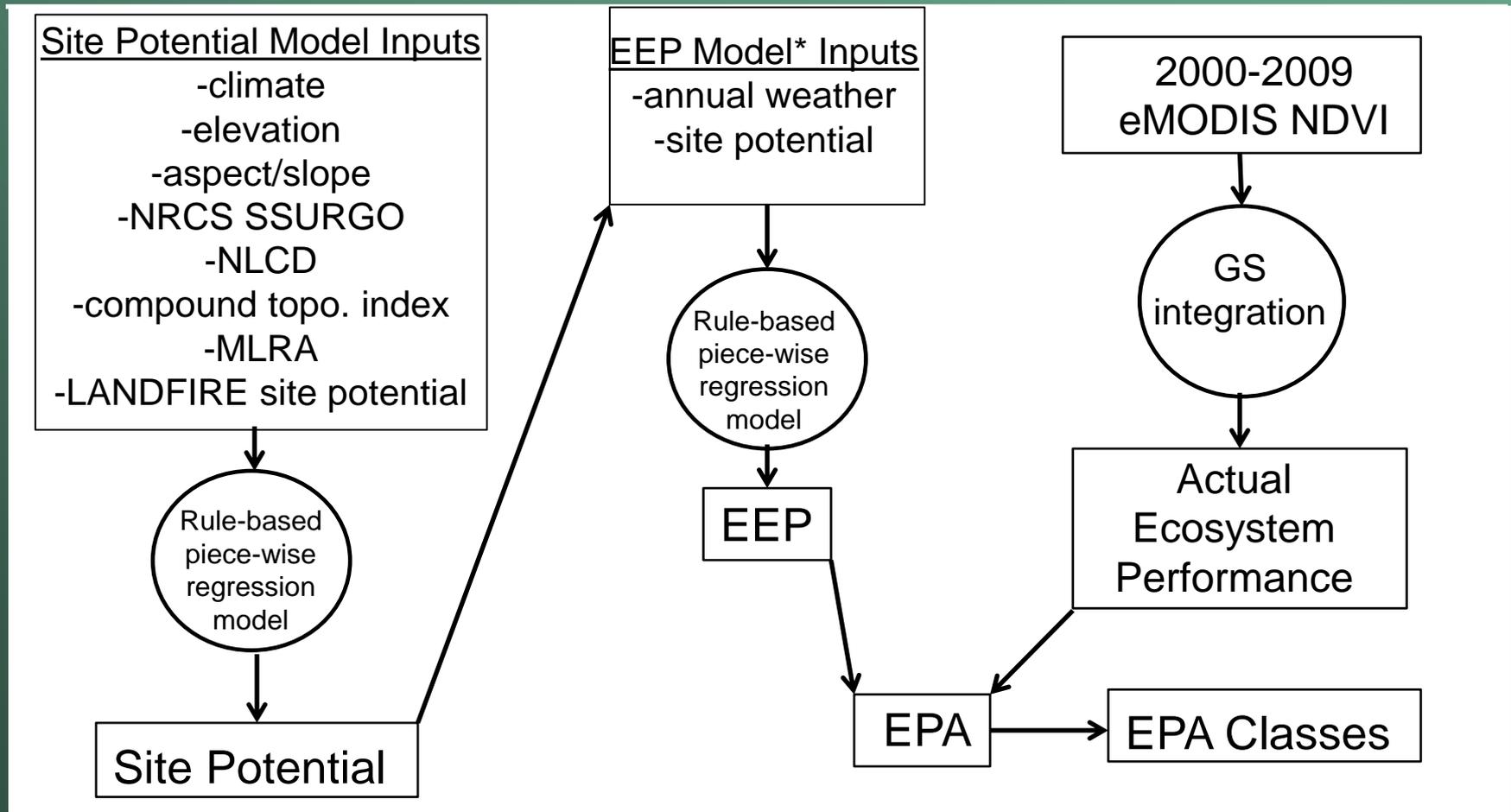
Study Area



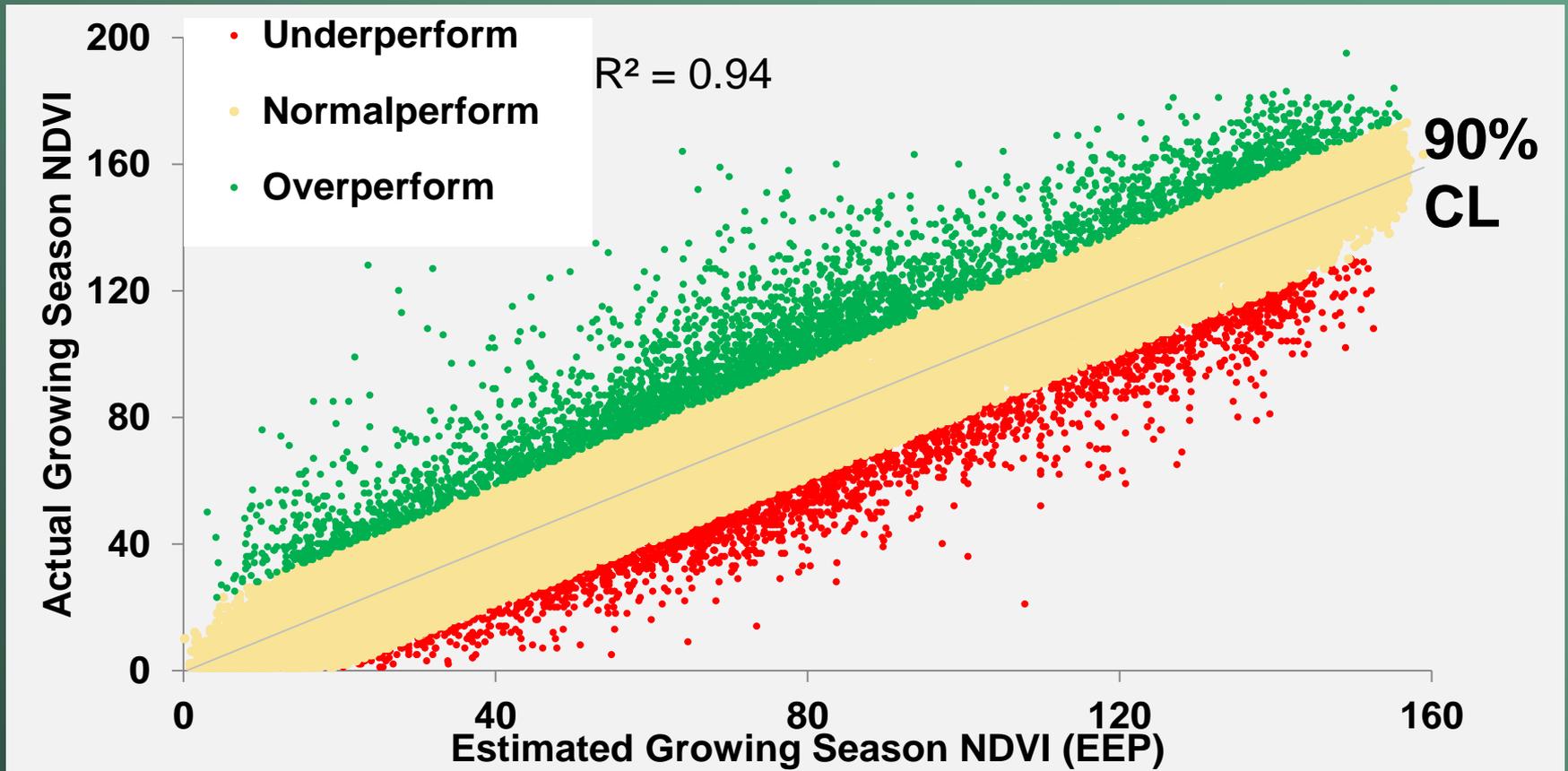
Integrated from:

- NLCD
- SSURGO:
eco site
- Re-GAP

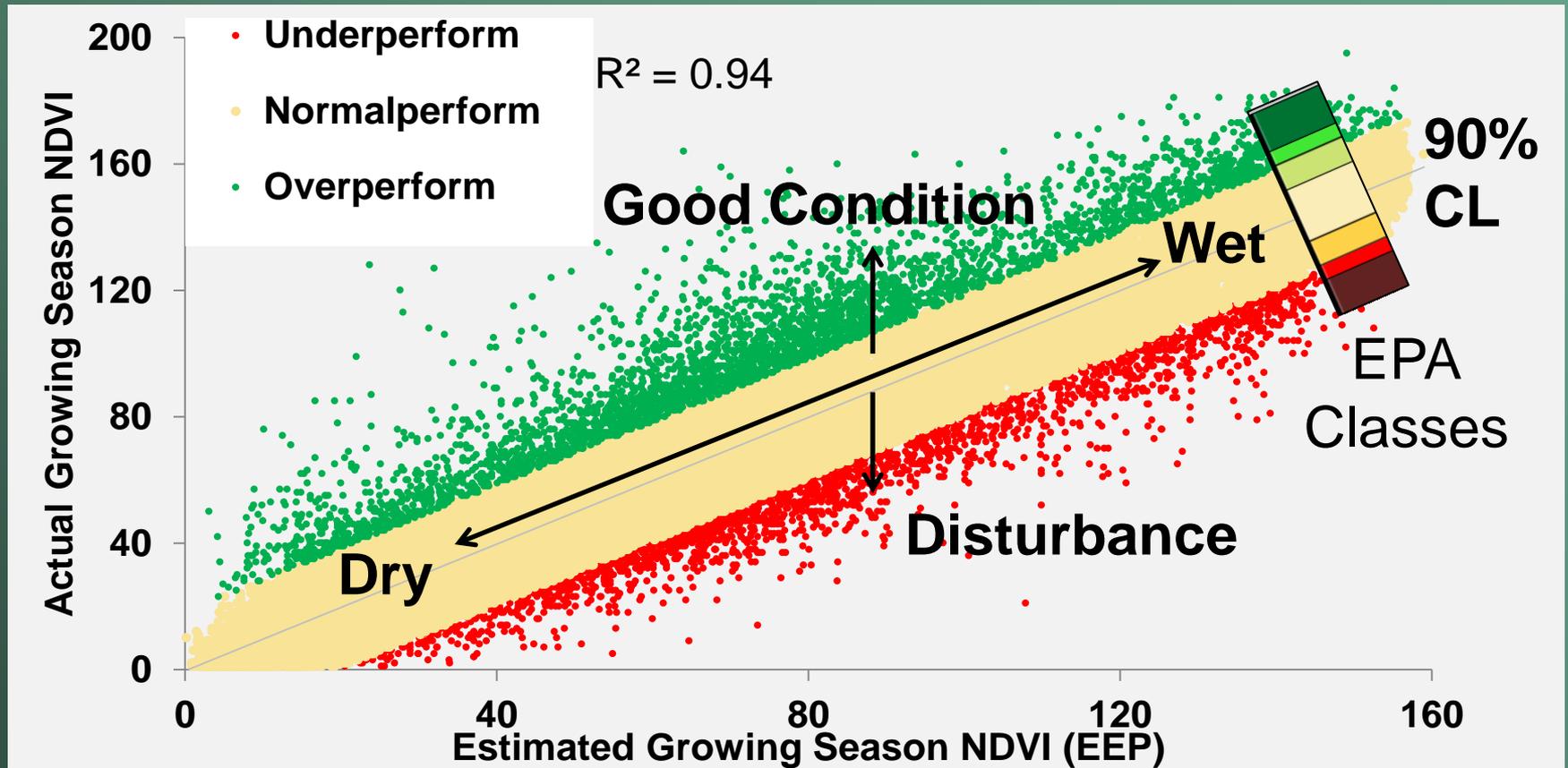
Methodology, from Wylie et al. 2012



EEP:GSN Regression



EEP:GSN Regression

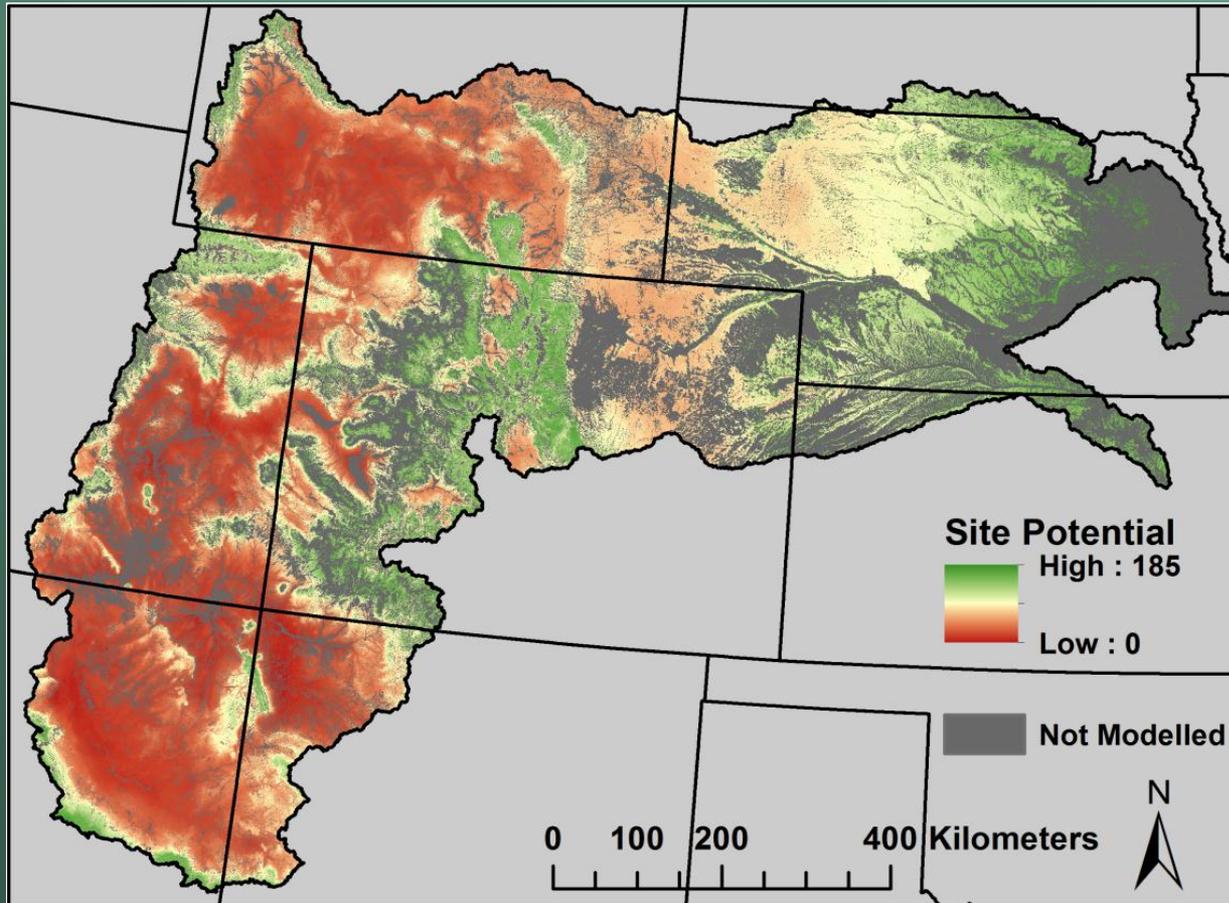


Summary of Metrics

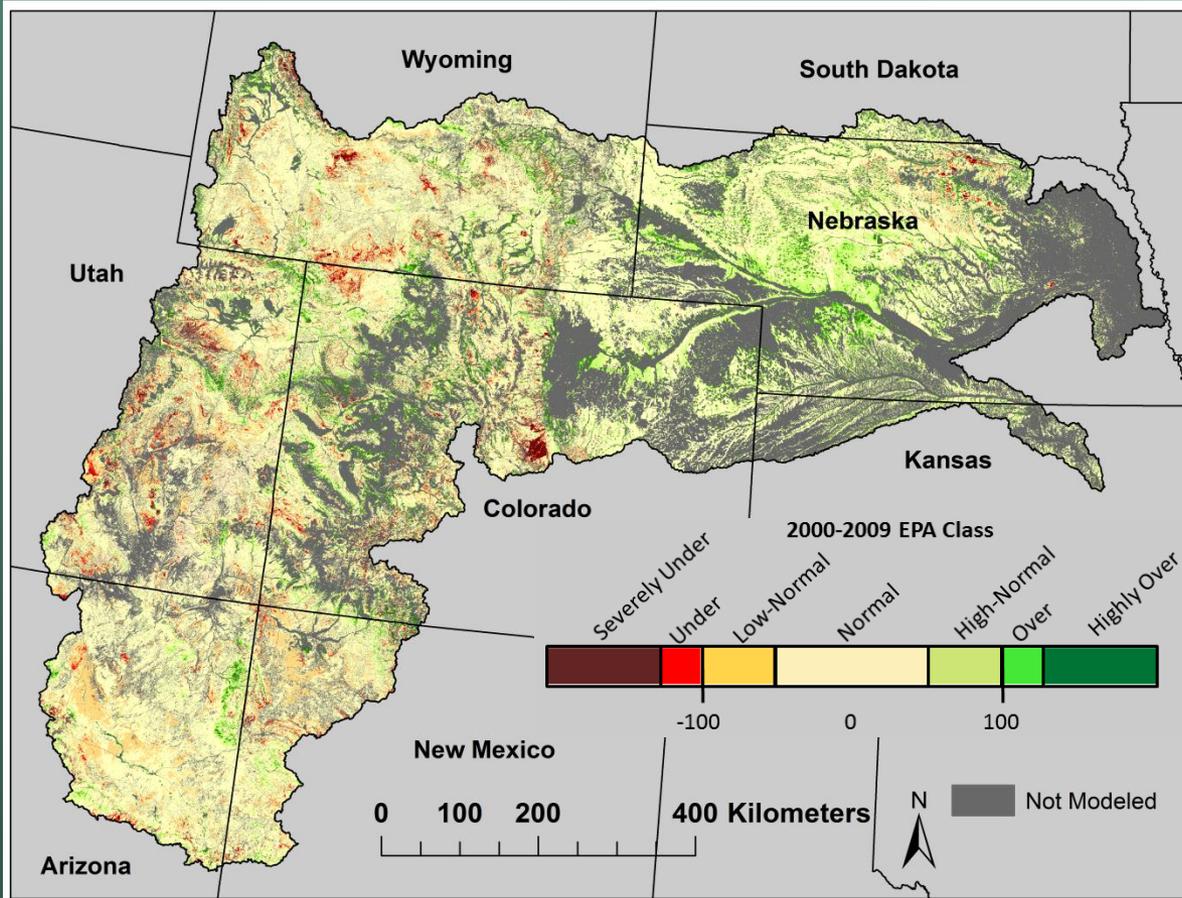
Metric	Stands for...	Measures	Units
GSN	Growing Season NDVI	actual ecosystem performance	NDVI
Site Potential	N/A	long term average performance	GSN
EEP	Expected Ecosystem Performance	yearly GSN	GSN
EPA	Ecosystem Performance Anomaly	GSN – EEP	EEP:GSN confidence

*NDVI is a unitless ratio of the absorption of NIR to red light

Results: Site Potential



2000-2009 Average EPA



Percentage of Each Land Cover in Each EPA Class

EPA Class	EPA Range	Salt Scrub	Big Sagebrush	Evergreen Forest	Piñon-juniper	Grass -land	Mixed Desert	Study Area
Severely Under	< -125*	0.6	0.5	6.1	1	0.6	0.6	1.5
Under	-100:-125*	0.5	2.4	3.4	3.1	0.5	2.7	1.9
Low Normal	-100:-50	26.7	13.1	21.7	14.2	4.2	22.7	13.8
Normal	-50: 50	63.6	69.2	57.5	66.2	63.5	60.1	63.3
High Normal	50: 100	6	9.9	9.6	9.8	21.4	6.7	12.9
Over	100: 125*	0.1	1.2	0.8	3.1	4.4	1.8	2.5
Highly Over	> 125*	2.5	3.7	0.8	2.6	5.3	5.4	4.1

90% normal EPA

Examples of factors causing negative EPA values



Examples of factors causing negative EPA values



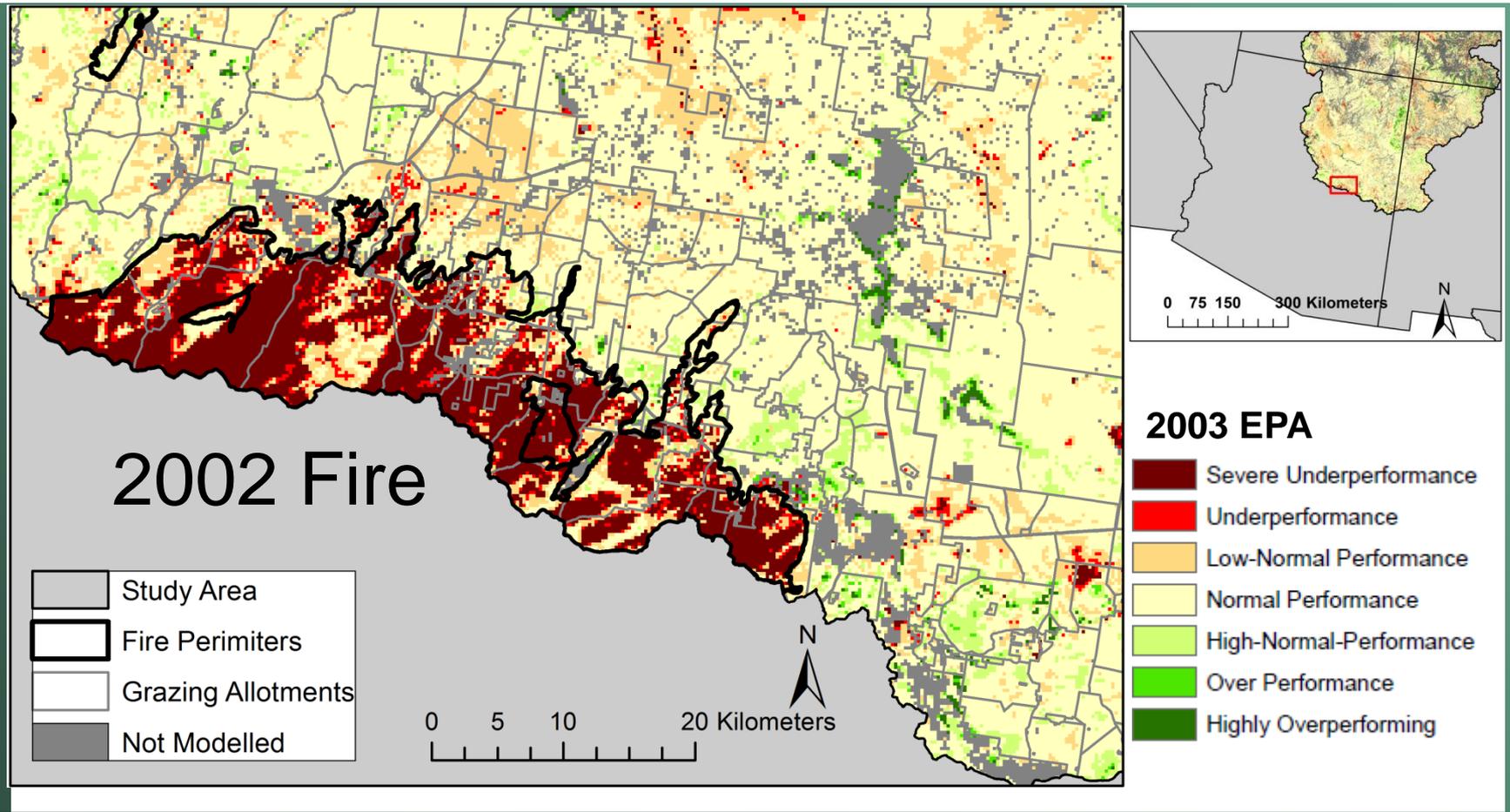
Examples of factors causing negative EPA values



Examples of factors causing negative EPA values

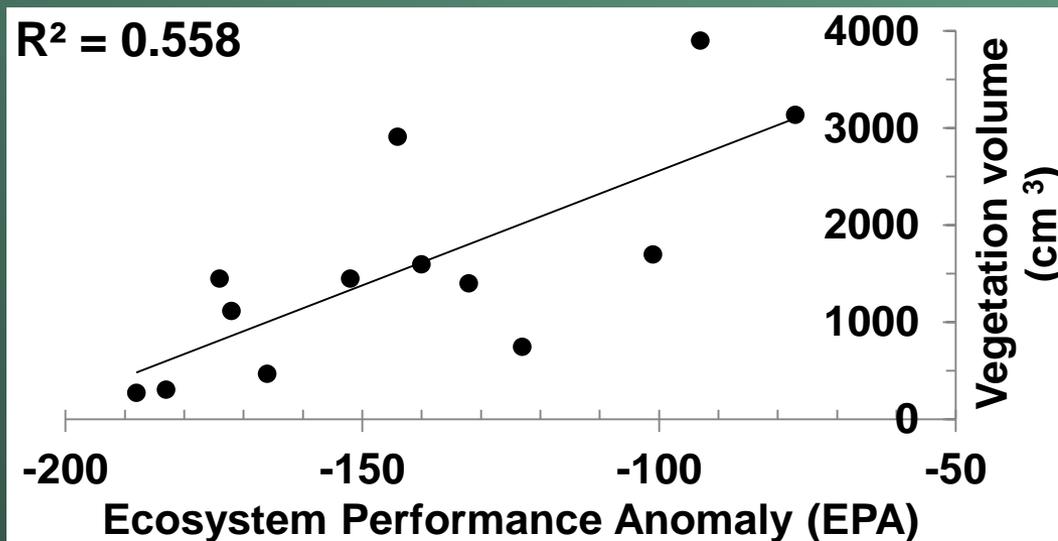


EPA Examples in Arizona



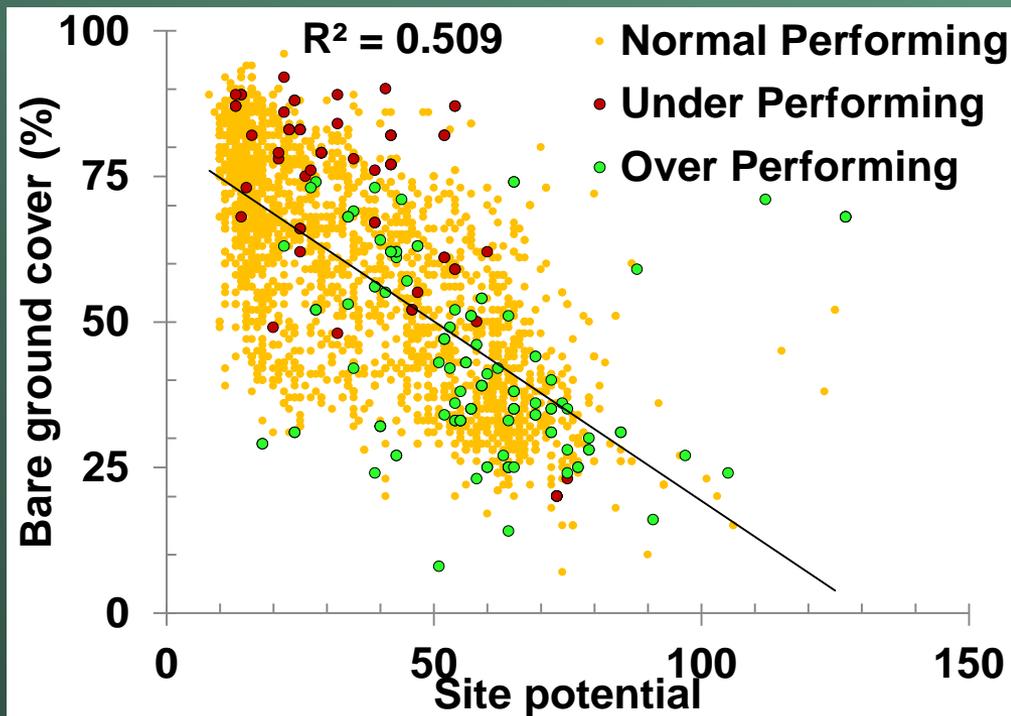
Case Study 1: Sandhills Grazing

EPA Performance Class	EPA	Veg. Height (cm)	Veg. Cover (%)	Bare Ground (%)	Litter Cover (%)	Veg. Volume (cm ³)
Under (n = 6)	-182.0	13.7	59.5	26.5	13.9	849.4
Normal (n = 9)	-97.0	30.0	67.9	20.2	12.0	1934.3
<i>P</i> -value	< 0.01	0.031	0.19	0.26	0.25	< 0.01



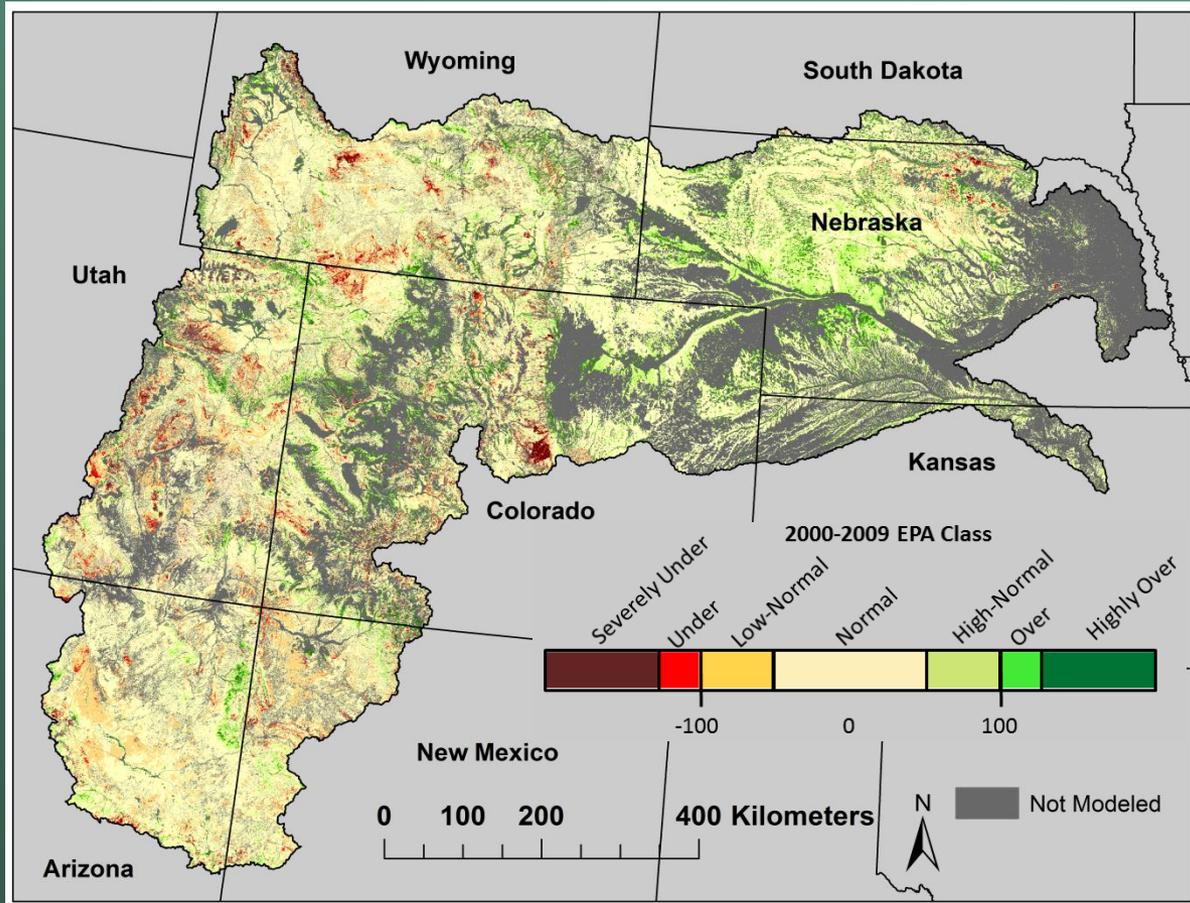
Case Study 2: Bare Ground Cover

Sample (n = 2628) of Wyoming rangelands using Homer et al. (2012) data.

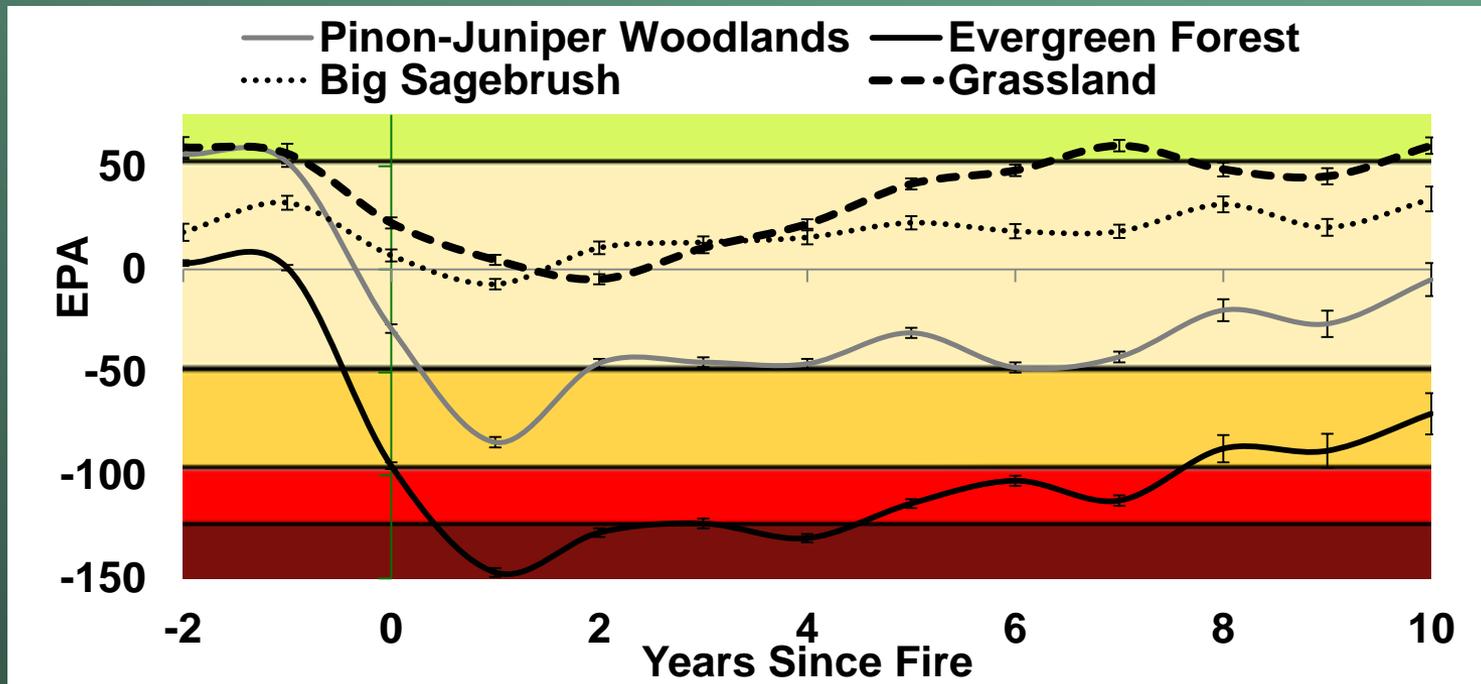


- 90% of underperforming pixels and 21% of overperforming pixels were above the regression line.
- Bare ground cover averaged 69.7, 58.1, and 42.2% in under, normal, and over-performing sites.

Case Study 3: Fire



Case Study 3: Fire (Recovery)



Management Applications

- Verify field observations
- Prioritize sites for field data collection
- Vulnerability to shift in plant communities.
- Site potential/EEP: stocking rate

Management Applications

- Provide examples of ecological reference areas, where rangeland plant communities are properly functioning.
- Document the condition of rangeland relative to standards, and highlight areas in which vegetation conditions are degraded.
- EPA trends analysis
- Model future EEP

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