Normalized Difference Vegetation Index for Restoration Monitoring

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Impacts of rangeland condition

- Carbon sequestration and SOM preservation
- Water quality, sedimentation, and erosion
- Wildlife cover and sage grouse habitat
- Livestock weight gains

OBJECTIVES

- Tracking of range condition
  - Past, current, future
- Facilitate adaptive management & restoration

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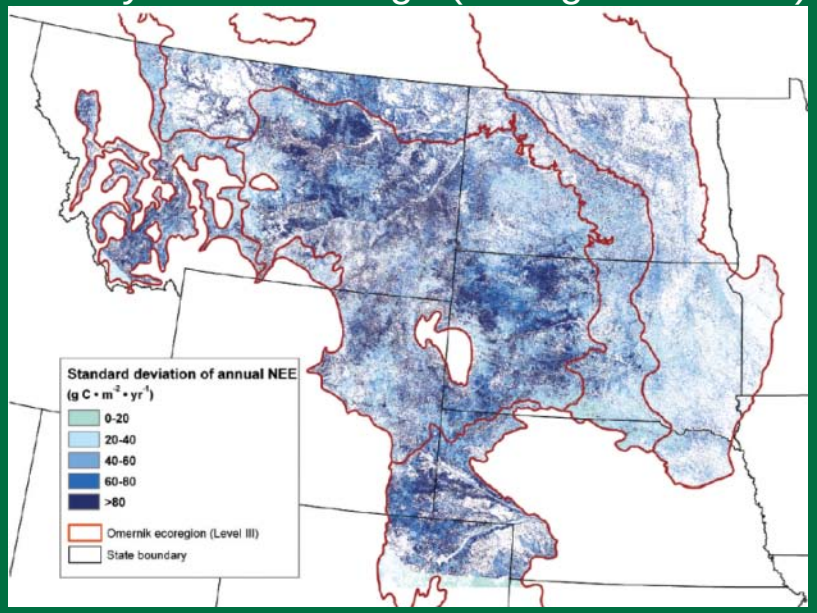
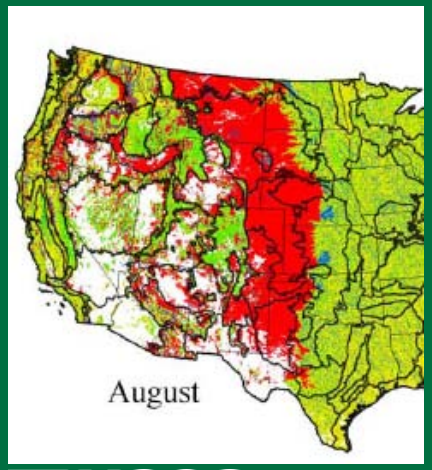
Rangeland production variability

- **Moisture-limited rangelands exhibit high interannual variations in productivity**
  - **Can make management effects less evident**

Grassland 2000-2006 variability in Net Ecosystem Exchange (Zhang et al. 2010)





Vegetation variability from White et al. (2005)

Relative vegetation variability

- 1st Quartile (minimum)
- 2nd Quartile
- 3rd Quartile
- 4th Quartile (maximal)

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Separation of rangeland weather variation and nonweather variations

- Allows for more consistent historical trend analysis in 1) weather-related variations and 2) nonweather-related variations
- Management effects are de-trended from weather variations
- Weather variations are de-trended from management and disturbance variations

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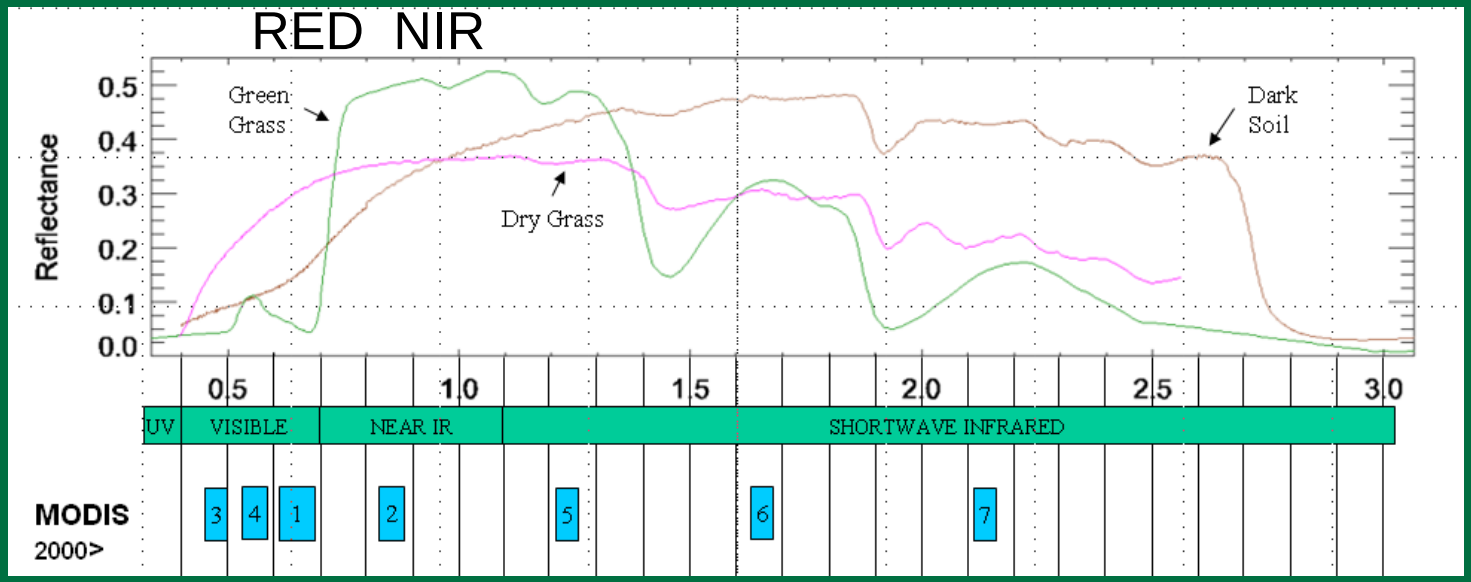
A proxy for rangeland productivity

- **Remotely sensed Normalized Difference Vegetation Index has been correlated to biomass, GPP, photosynthetic potential, and Leaf Area Index**



$$NDVI = \frac{NIR - RED}{NIR + RED}$$

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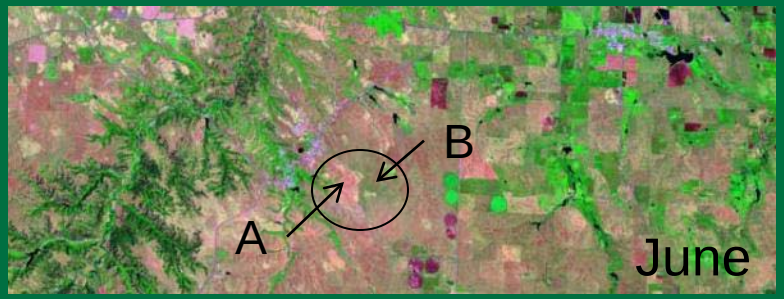
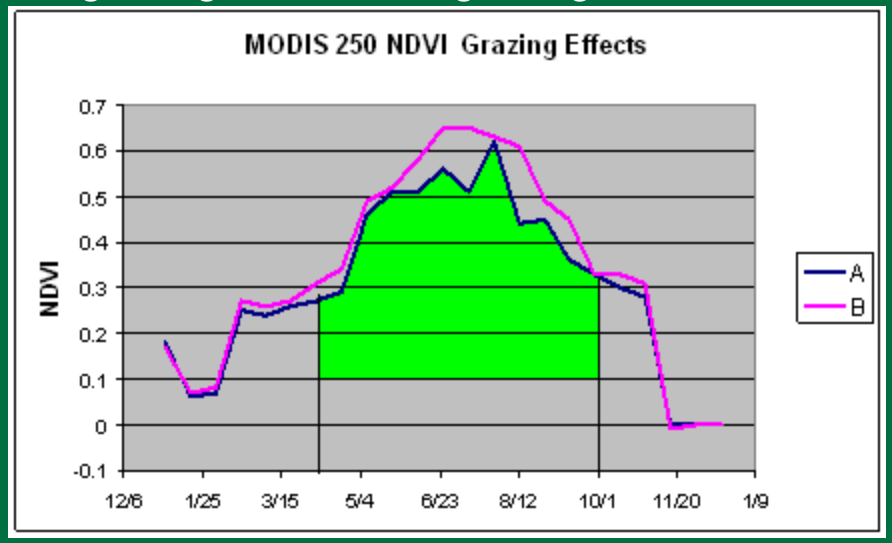
Proxy for range productivity Growing Season NDVI (GSN)



A: grazing B: non-grazing



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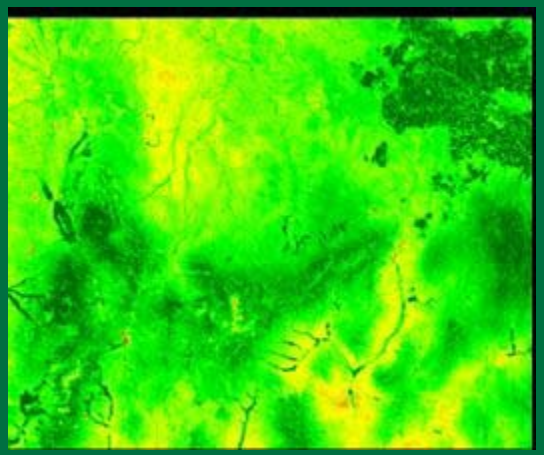
Predict GSN from weather (Expected ecosystem performance – EEP)

EEP = ***f*** (site potential , weather)

2007 MODIS Growing Season NDVI (250 m)



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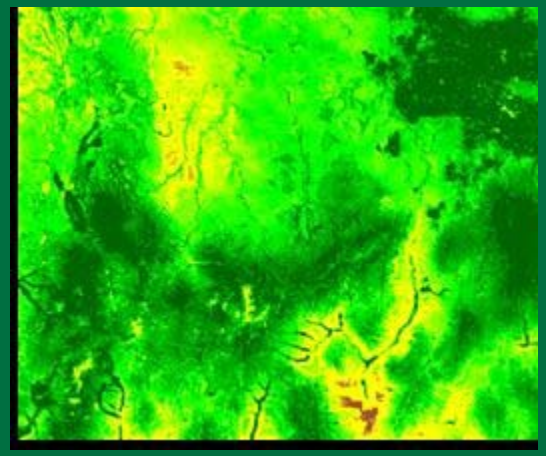
Soil Survey Geographic Database Productivity Index or long-term GSN



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Precipitation, maximum and minimum temperature for 3 seasons

- **Winter: Nov. – Feb.**
- **Spring: March – May**
- **Summer: June – July**

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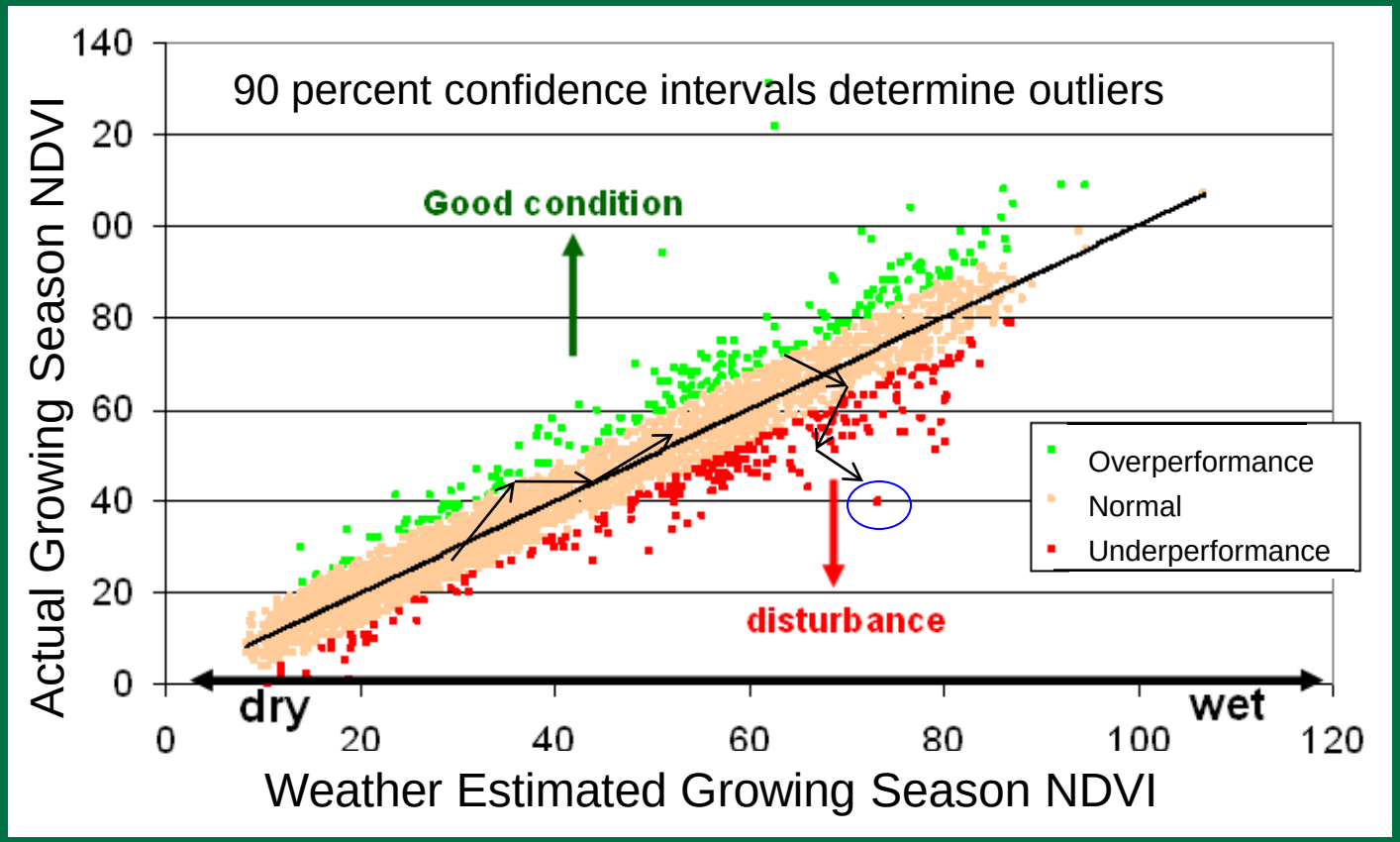
Piecewise regression model to estimate rangeland performance based on weather conditions



The models are developed from more than 10,000 random locations across multiple years

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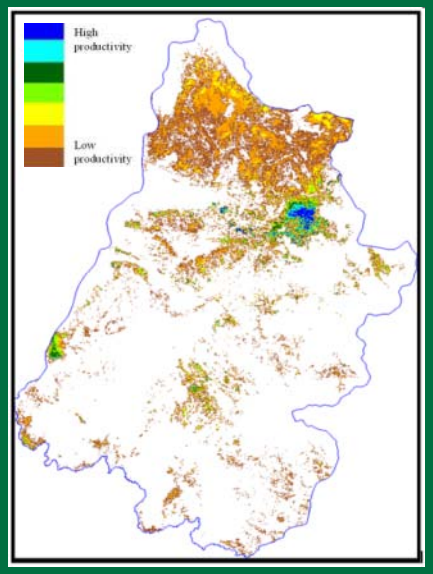
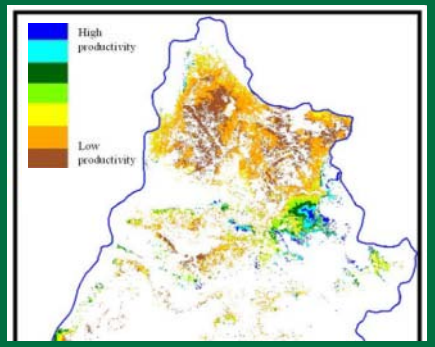
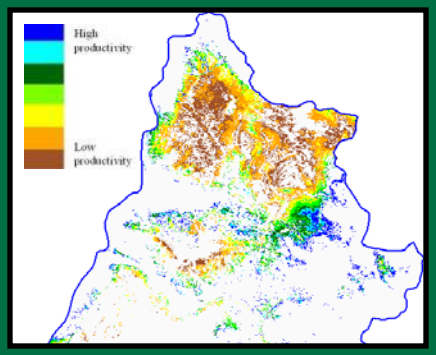
Example Ecosystem Performance for Big Sagebrush in the Upper Colorado River Basin (2006)



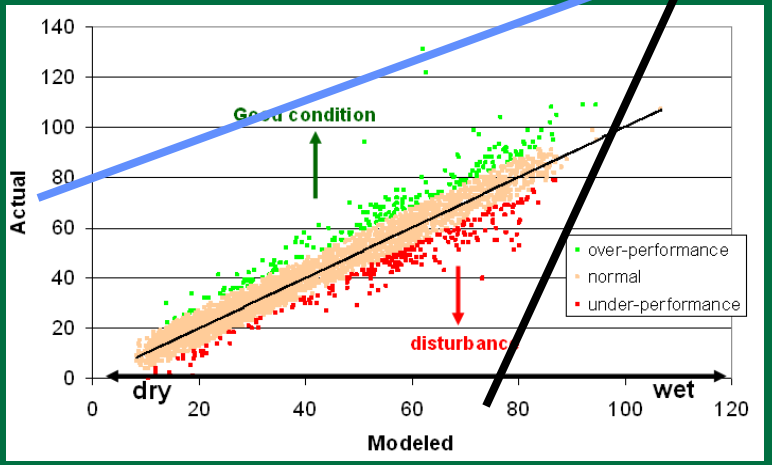
Site potential

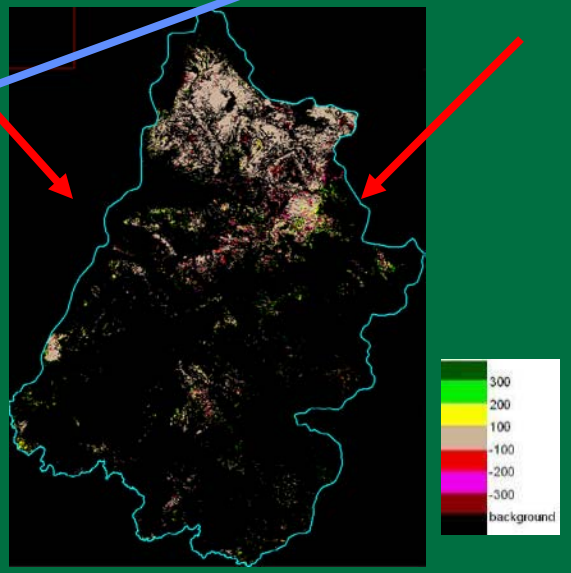


Expected ecosystem performance



Real ecosystem performance





Ecosystem performance anomalies

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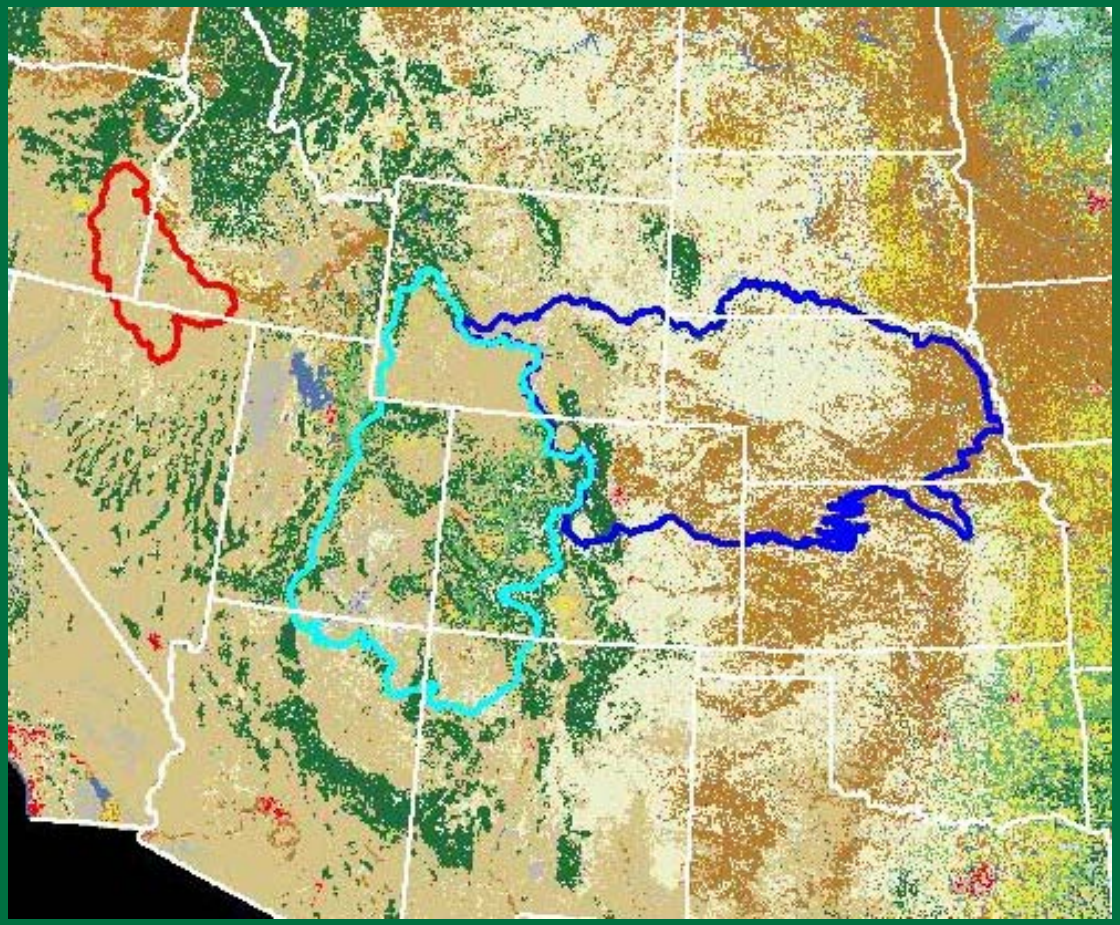
Ecosystem performance anomaly applications: Owyhee Uplands, Upper Colorado River Basin, and Platte River Basin



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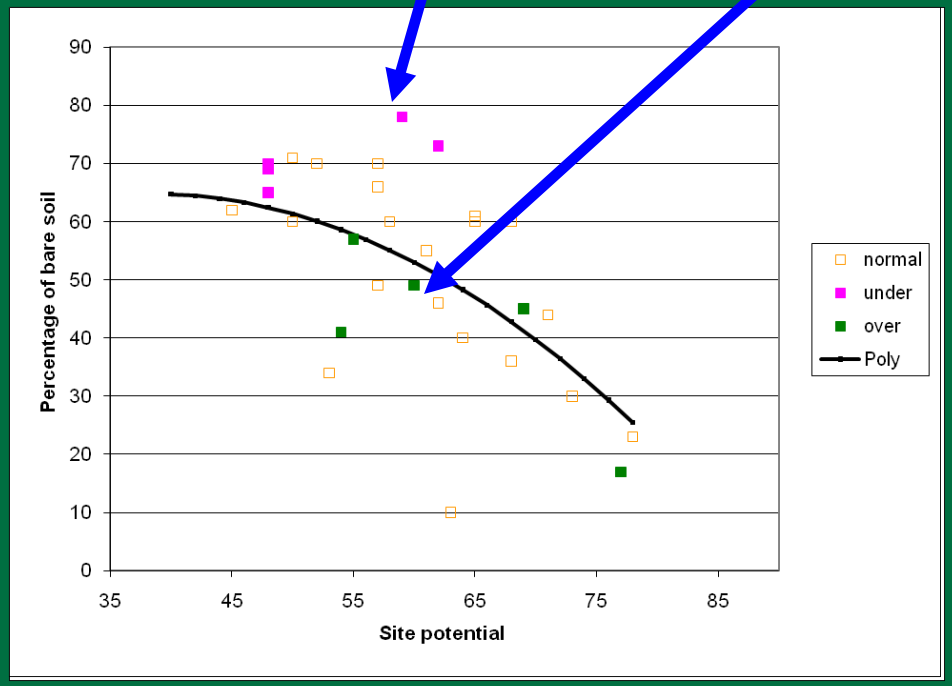
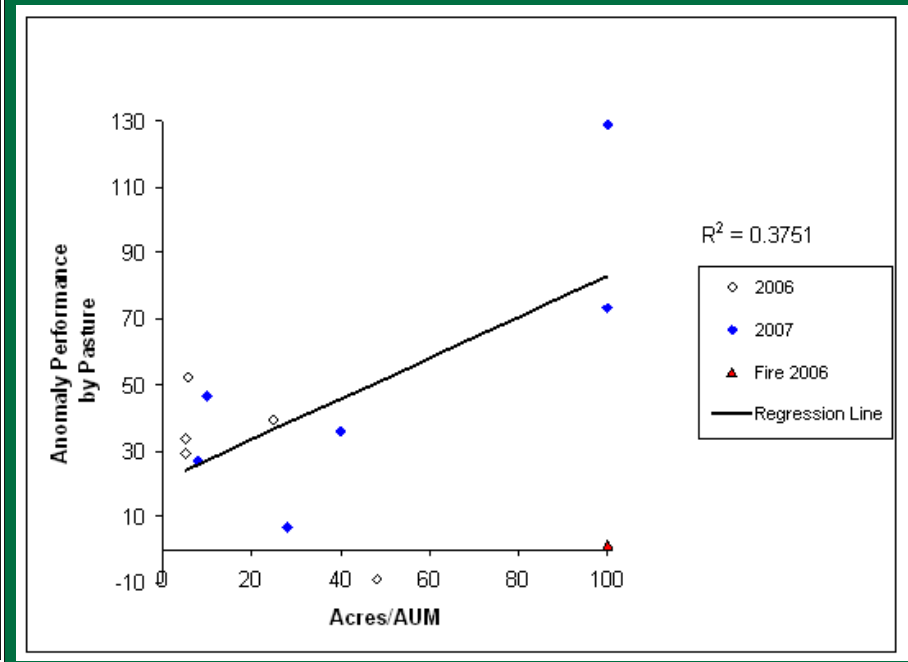
Performance anomaly validation with percent bare ground and stocking rates (acres/animal unit month)

Regions identified as persistently underperforming tended to have a higher percentage of bare soil

Regions identified as persistently overperforming tended to have a lower percentage of bare soil





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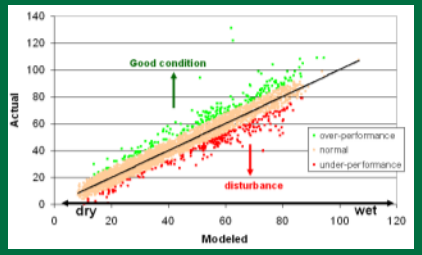
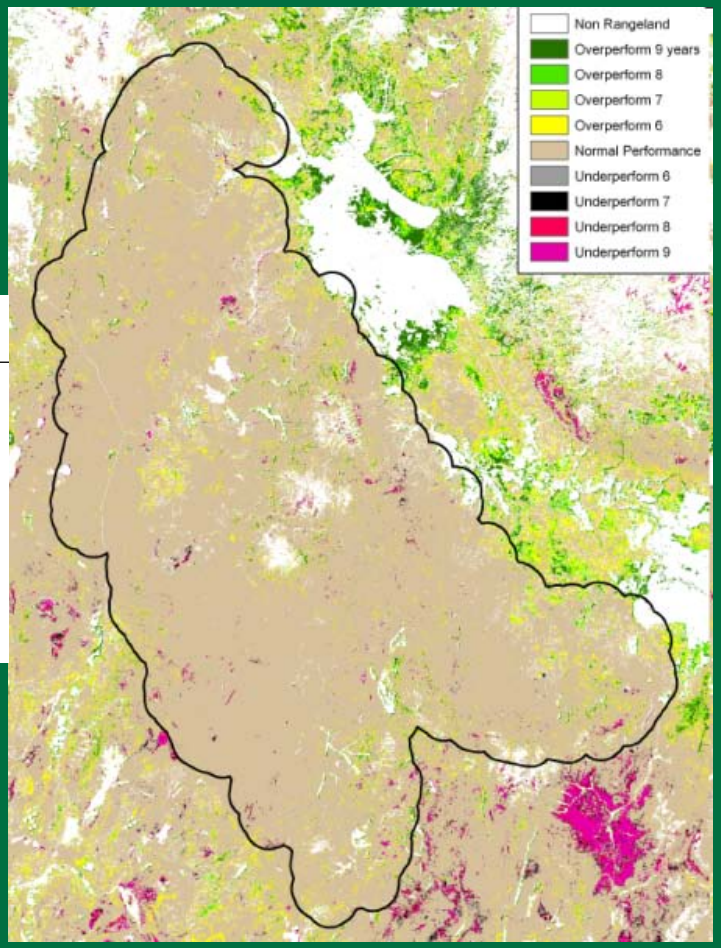
Owyhee rangeland condition and trends

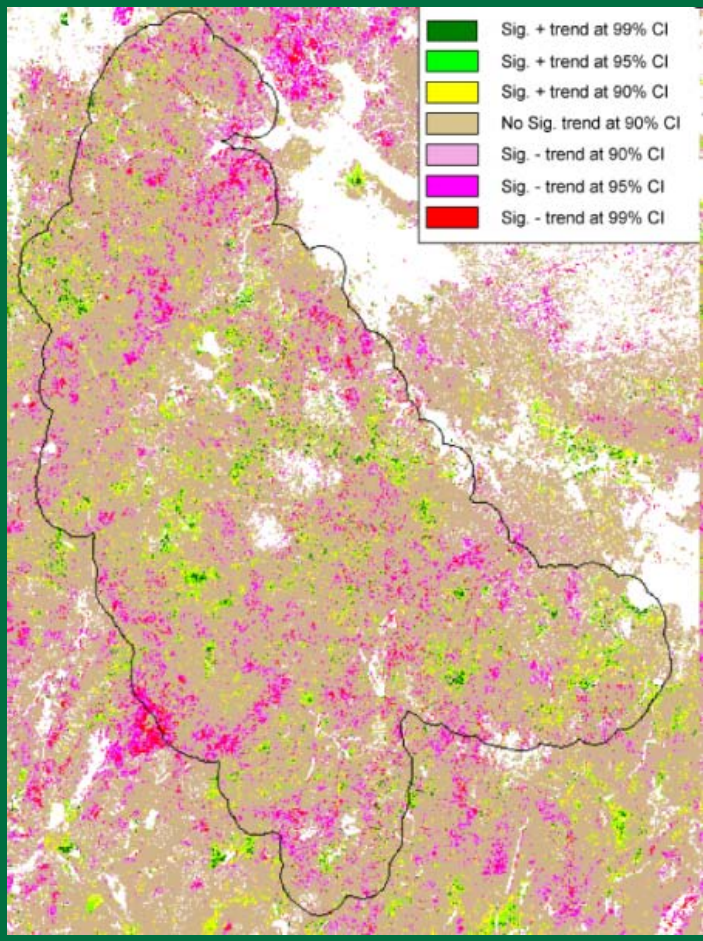


Land Cover	R^2
Big Sage	0.83
Grass	0.90
Low Sage	0.81
Other Veg	0.71
Purshia	0.79

Ecosystem performance anomaly map for 2000-2008



Trend map displays the trend at different levels of significance



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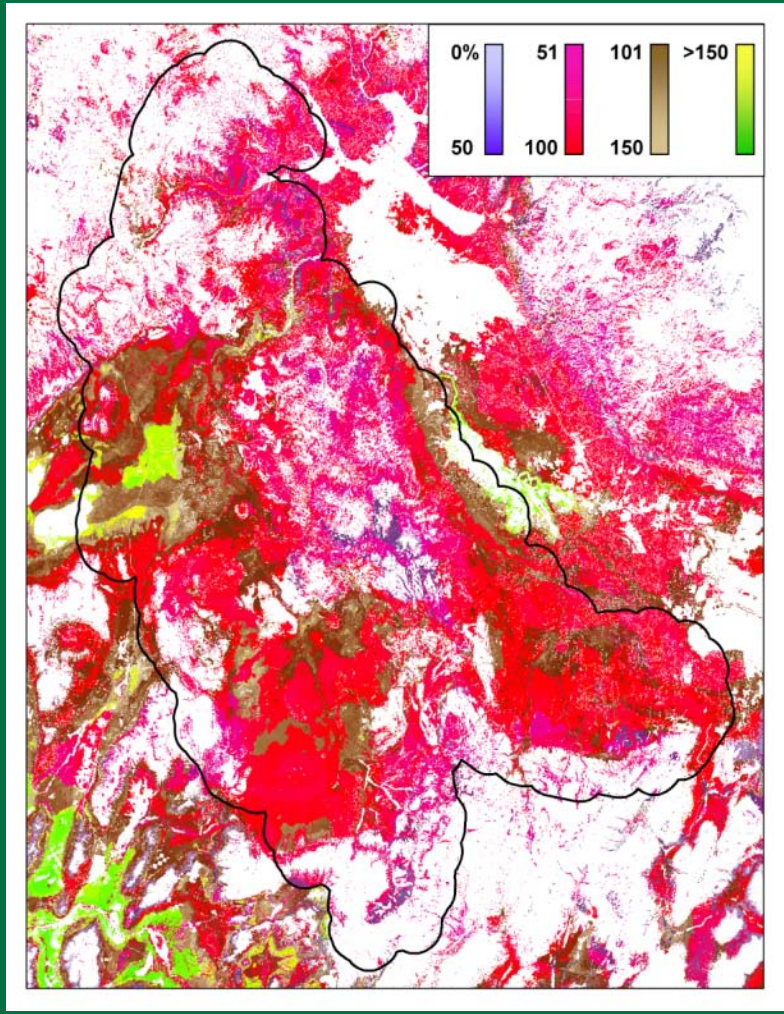
Owyhee 2040 Big Sage productivity estimates (percent of current productivity)

- Big Sage model applied to a near-term future climate projection
- Data from National Center for Atmospheric Research (model CCSM3, moderate emission scenario-A1b)



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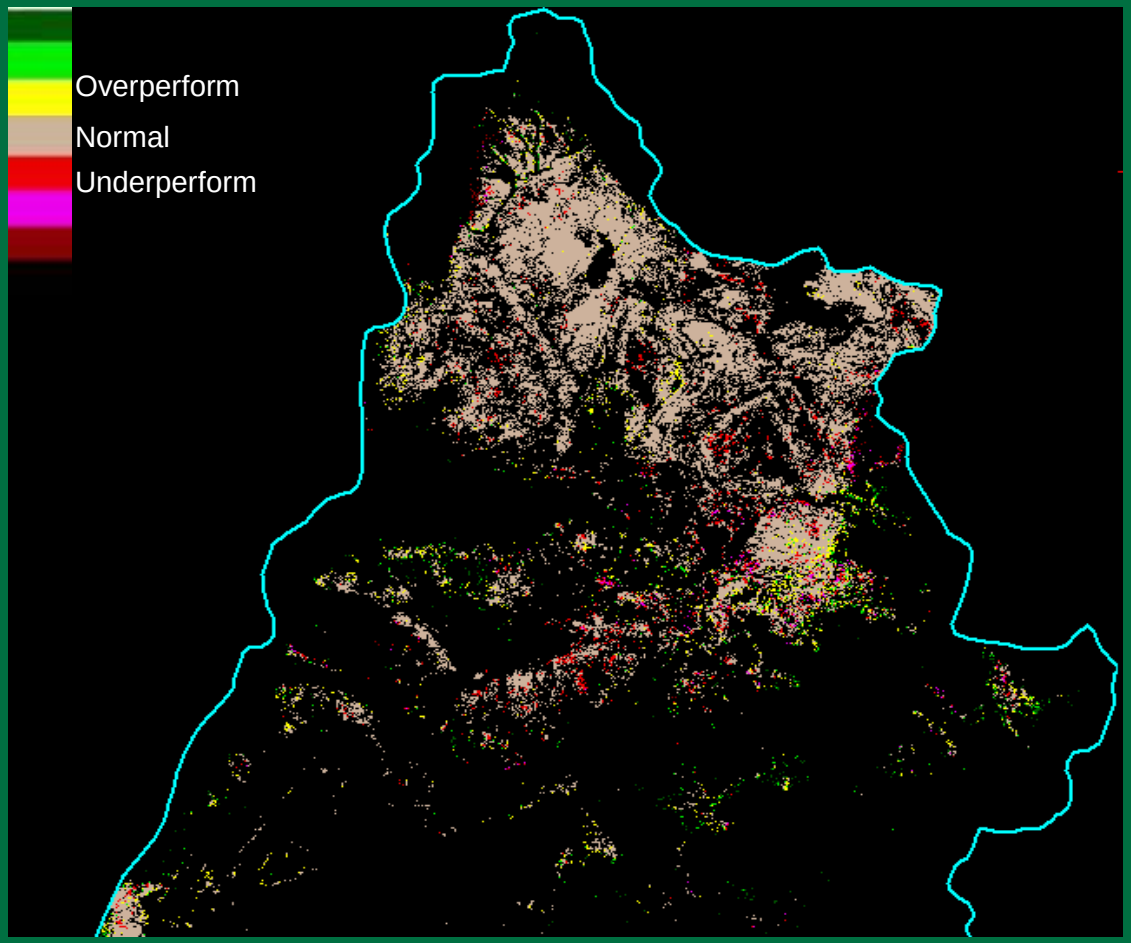
Sagebrush 2006 performance anomalies for the northern part of the Upper Colorado River Basin



Four rangeland types were modeled and mapped but only the Big Sage is shown

Land Cover	R^2
Grass	0.97
Big Sage	0.94
Pinion Juniper	0.94
Salt Scrub	0.89

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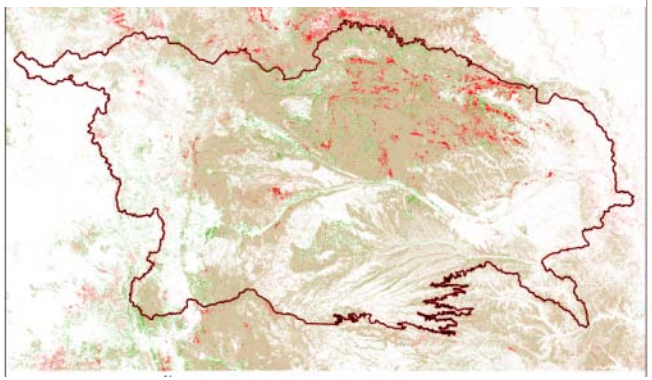
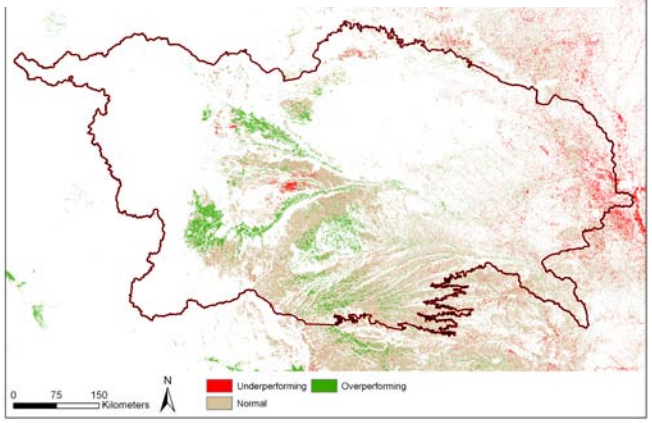
Platte Basin grass anomalies: implications for Switchgrass biofuel expansion

Applied to grass areas



Applied to crop areas



Productive, good condition grasslands

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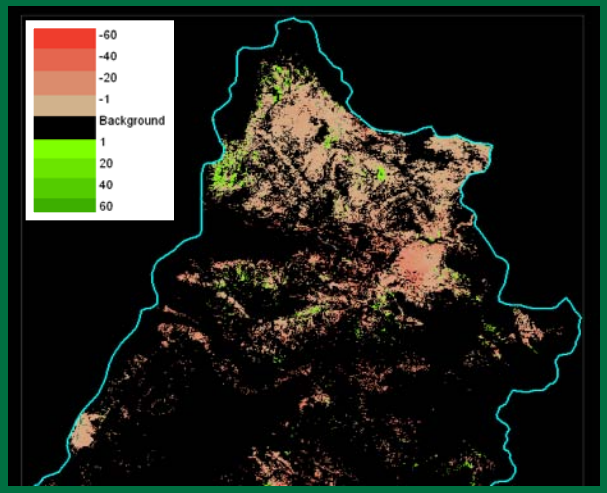
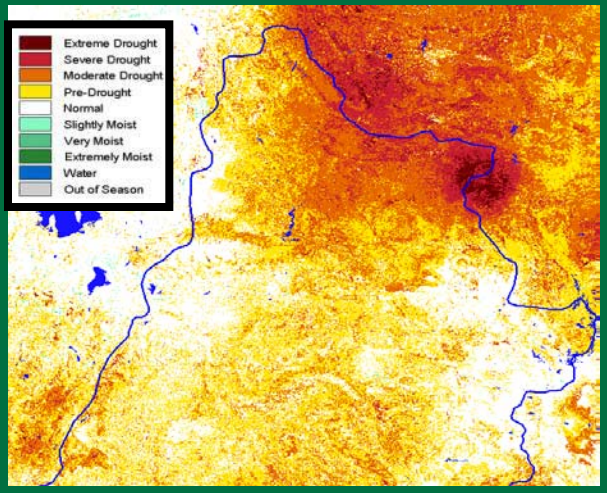
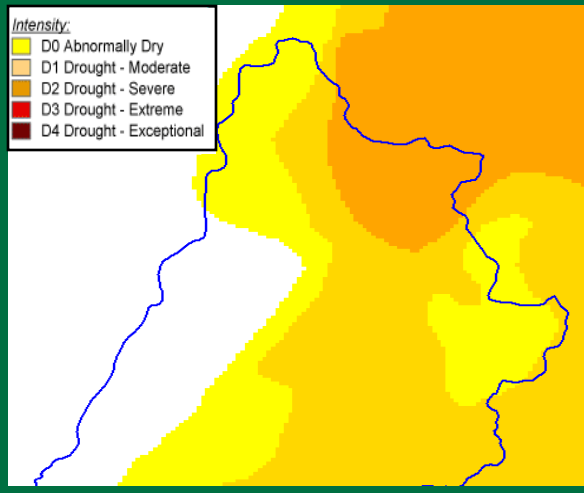
Investigating variations in the weather axis



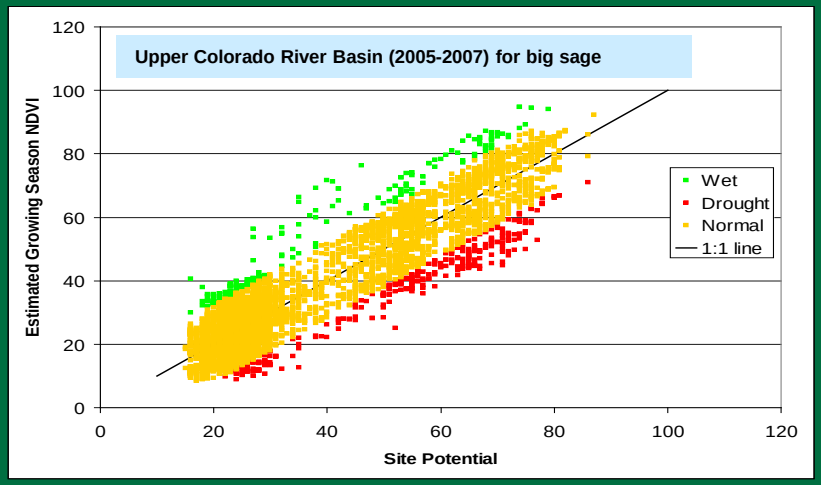
Difference between the weather-based (predict) GSN and the GSN site potential map for Big Sagebrush (2006)



USGS VegDRI map (June to September)



U.S. drought monitoring map (average conditions between June and September, 2006)



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Summary

- This study accounts for interannual weather effects on vegetation so that trend and persistence analysis are consistent
- It provides land managers rangeland histories and trends
- Such studies help optimize field visits and range restoration
- They help put current studies into longer perspectives (historical and future)

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