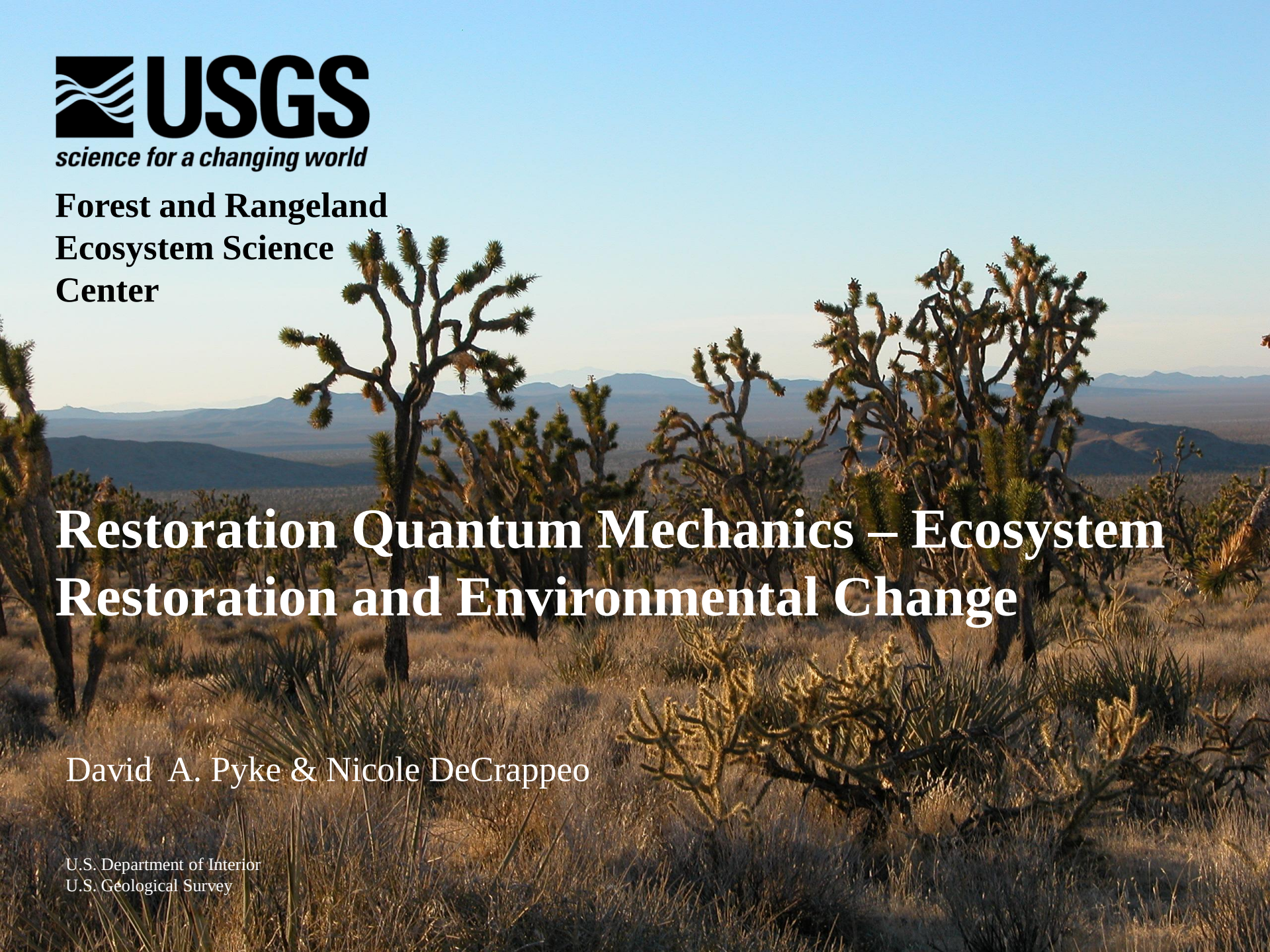
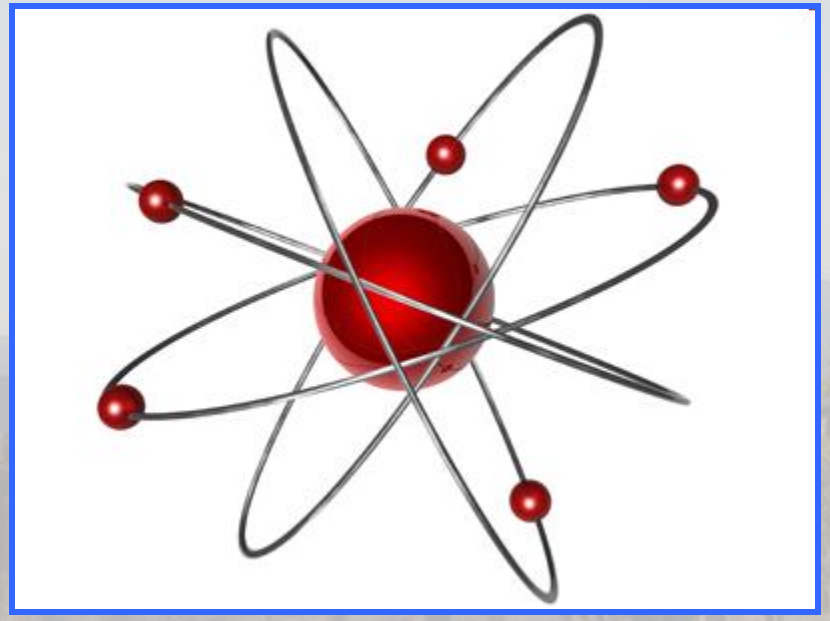


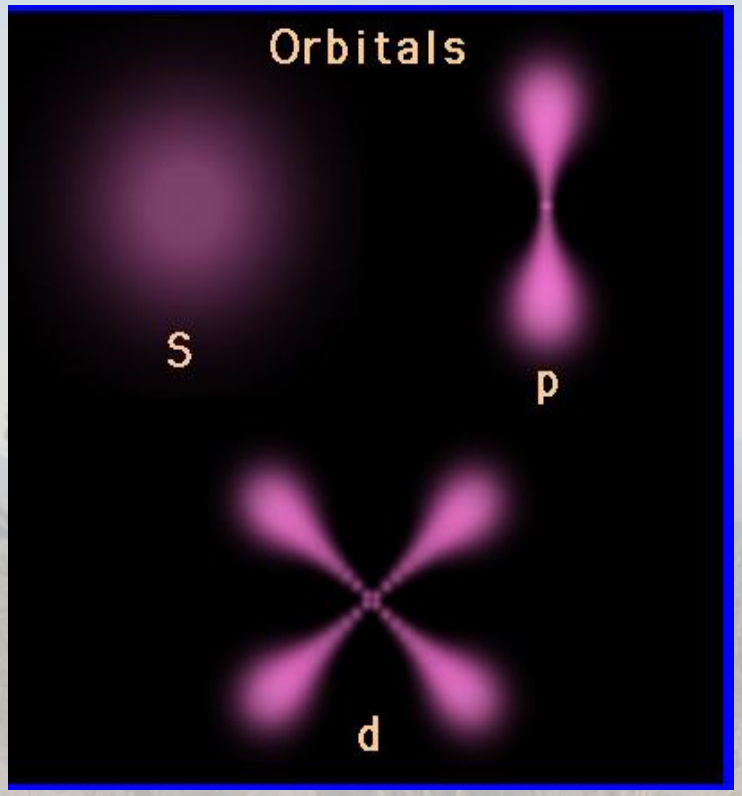
Forest and Rangeland Ecosystem Science Center

Restoration Quantum Mechanics – Ecosystem Restoration and Environmental Change

David A. Pyke & Nicole DeCrappeo

U.S. Department of Interior
U.S. Geological Survey





- Uncertainty and Probability of Outcomes

USGS

Pathway to Successful Objectives

1. Understanding the probability of ecosystem impacts
2. To which goal do we shoot?
3. Ecosystem status & probability of success dictate restoration choices
4. Potential options to consider

USGS

Understanding the Probability of Ecosystem Impacts

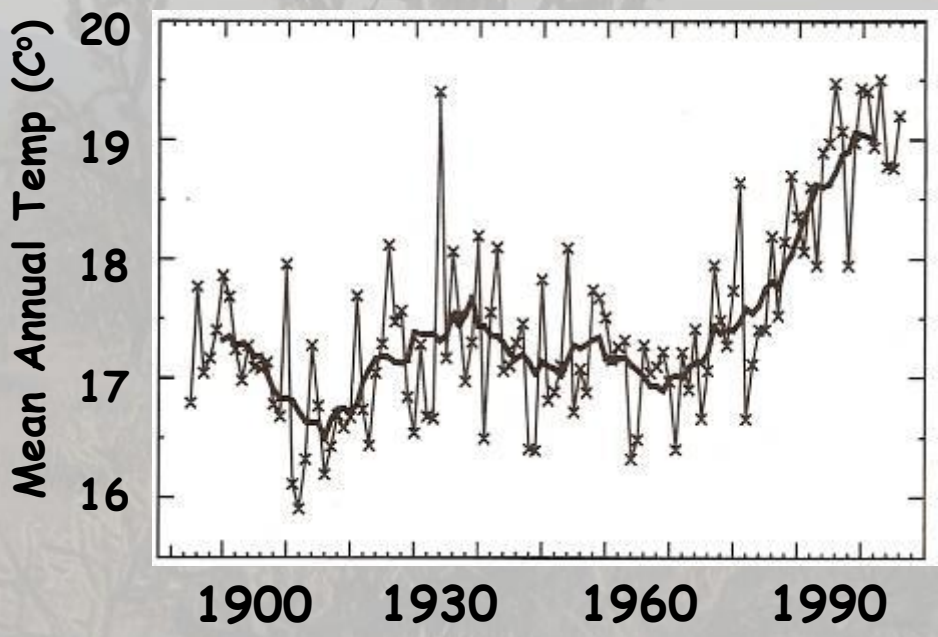
- **Atmospheric Gases**
  - CO_2
    - Spatially – Equal
    - Temporally – Now
    - Probability of Occurrence – 100%
    - Favors cool-season plants
  - N-Deposition
    - Spatially – Higher closer to large cities
    - Temporally – Now
    - Probability of Occurrence – 100%
    - Favors fast growing plants; Reduce N-fixing organisms

USGS

Understanding the Probability of Ecosystem Impacts

Temperature Rise

- Spatially – relatively equal
- Temporally – high probability of continued rise
- Probability of occurrence – High
- Biggest Impacts – Water loss (evap); Frost free zone moving north; Earlier snowmelt; Changes in phenology
- Favors phenotypically plastic or adaptive plants



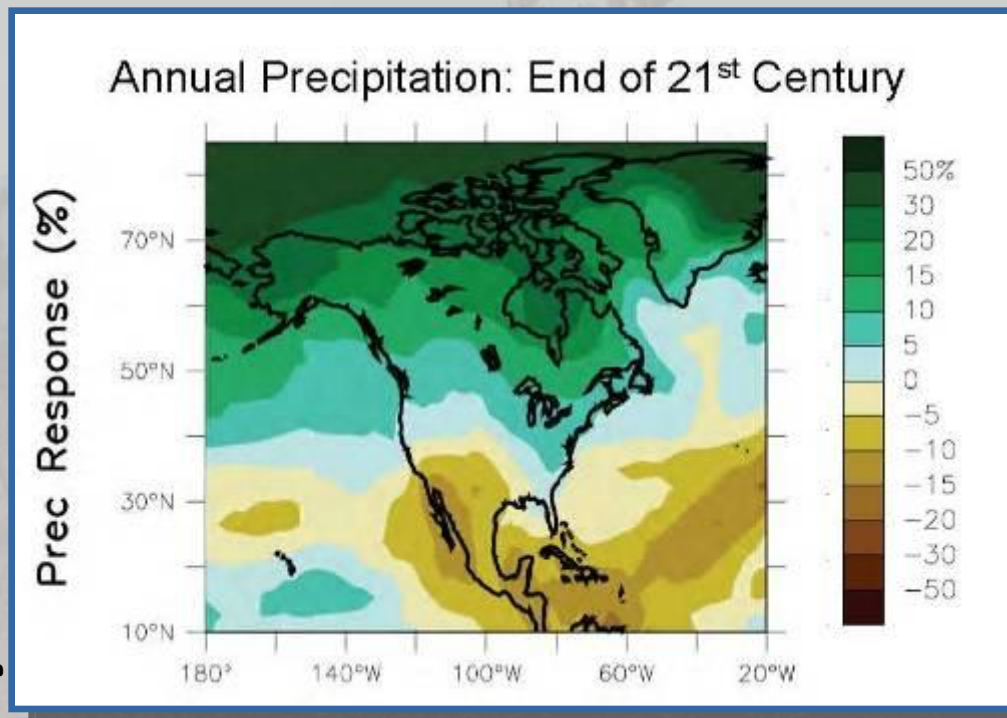
From Redmond 2009

USGS

Understanding the Probability of Ecosystem Impacts

Precipitation ?

- Spatially – Unpredictable; Change in summer monsoon?
- Temporally – Unpredictable
- Probability of occurrence – Less certain
- Biggest Impacts – Severe droughts;
- Hard to predict plant impacts;
  - Droughts impact plants susceptible to cavitations or drought stress disease;
  - change in summer monsoon impacts warm season plants



IPCC 4th Assessment: Working Group 1, Chapter 11, Regional Projections

USGS

To which goal do we shoot?

Shift with additional climate and monitoring information

- Historic Community
  - May no longer provide former goods and services
    - Species richness and composition may remain
    - Lower production = lower carrying capacity
- Maintain potential ecosystem function and processes
  - Retain soils
  - Maintain hydrologic function
  - Match diverse structure and function of biologic system to soils and climate

USGS

To which goal do we shoot?

- Monitor annual weather
  - Temperature & Precipitation
    - Frost-free period;
    - Temperature extremes;
    - Growing season available water

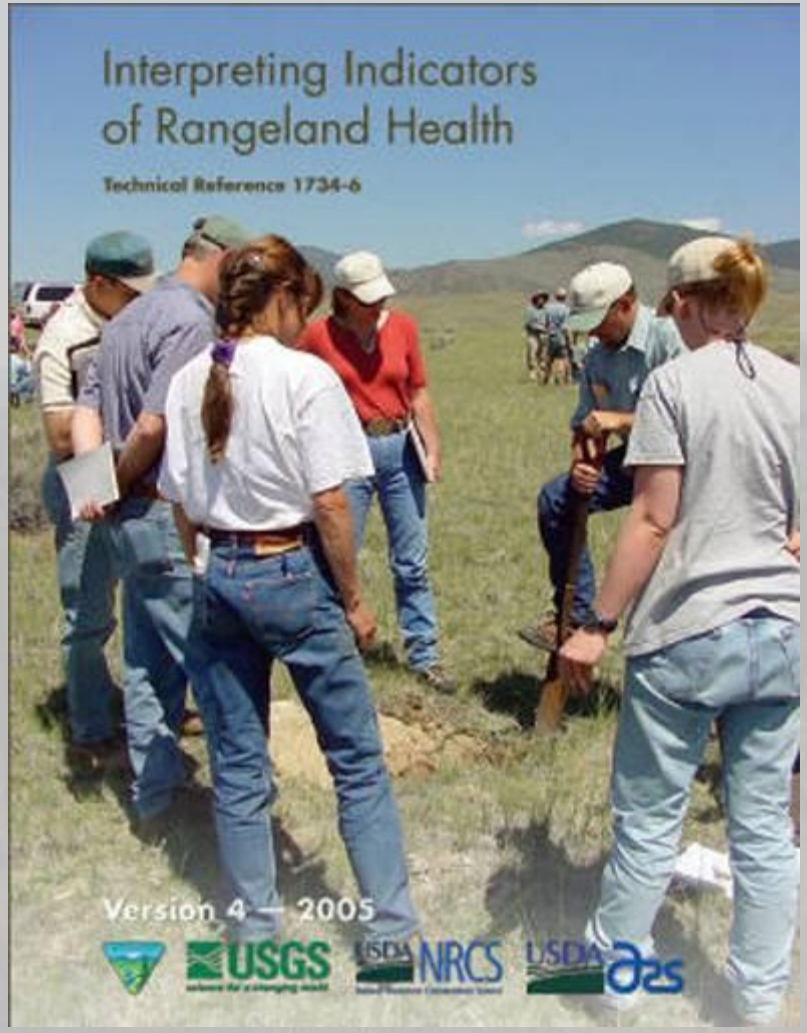
USGS

Historic community *vs.* ecosystem function/process?

- Monitor Ecosystems
  - Species composition based on both cover and biomass
  - Plant phenology
    - Pollination or pollinators set by photoperiod
  - Seed yield – not just flowering
  - Soil
    - exposure to rain and wind
    - Organic Matter
    - Organisms
  - Water runoff – water lost from the site

USGS

Ecosystem status & probability of success dictate restoration choices



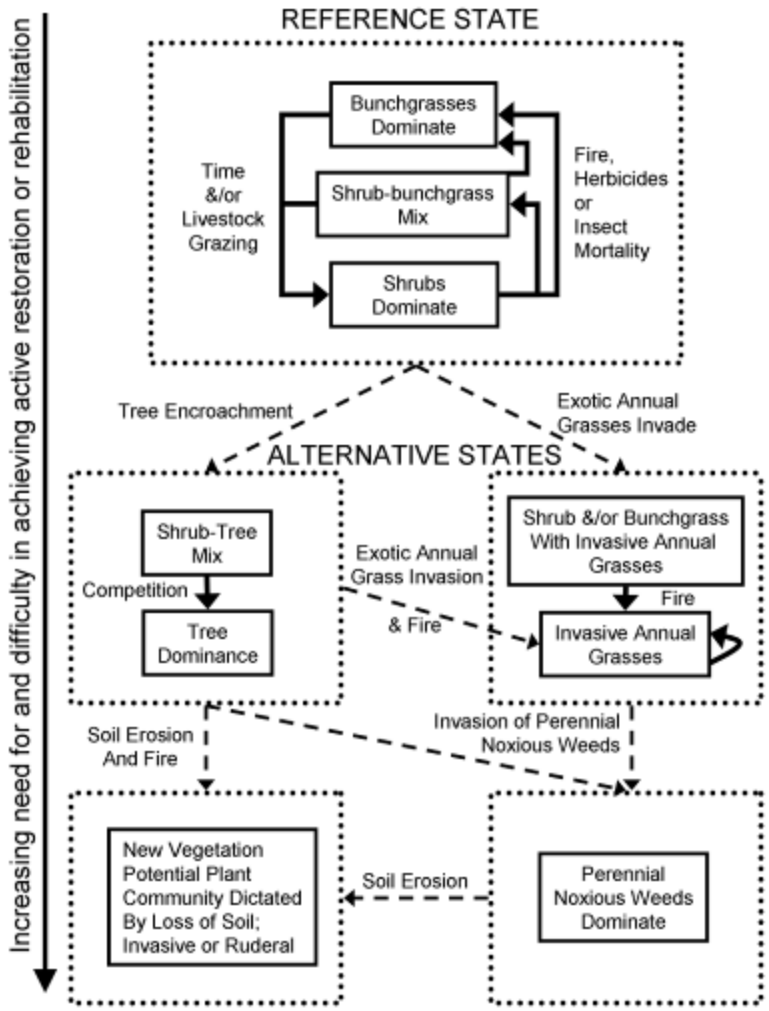
Pellant et al. 2005
Based on Pyke et al. 2002

- Interpreting Indicators of Rangeland Health
  - Assesses status relative to 17 indicators & 3 attributes of Rangeland Health
  - Qualitative and Quantitative estimates of biological, hydrological and soil stability status
  - Judge relative to the range in variation of the indicators in the reference state

USGS

What is the Reference?

- Assess & compare land status to potential
  - Potential = Ecological Site Description
- Determine appropriate intervention given the status



USGS

Intervention Grid

		Status: Departure from reference		
		None to Slight	Moderate	State Change
Probability of Recovery	High	No Action	Passive 1st; Active	Active
	Med	No Action	Passive 1st; Active	Active; ↓ priority
	Low	No Action	No Action or Passive	Adjust Mgmt to fit site

From Pyke In Press SAB

USGS

Intervention Actions

Passive

Active

USGS

Probability of Recovery

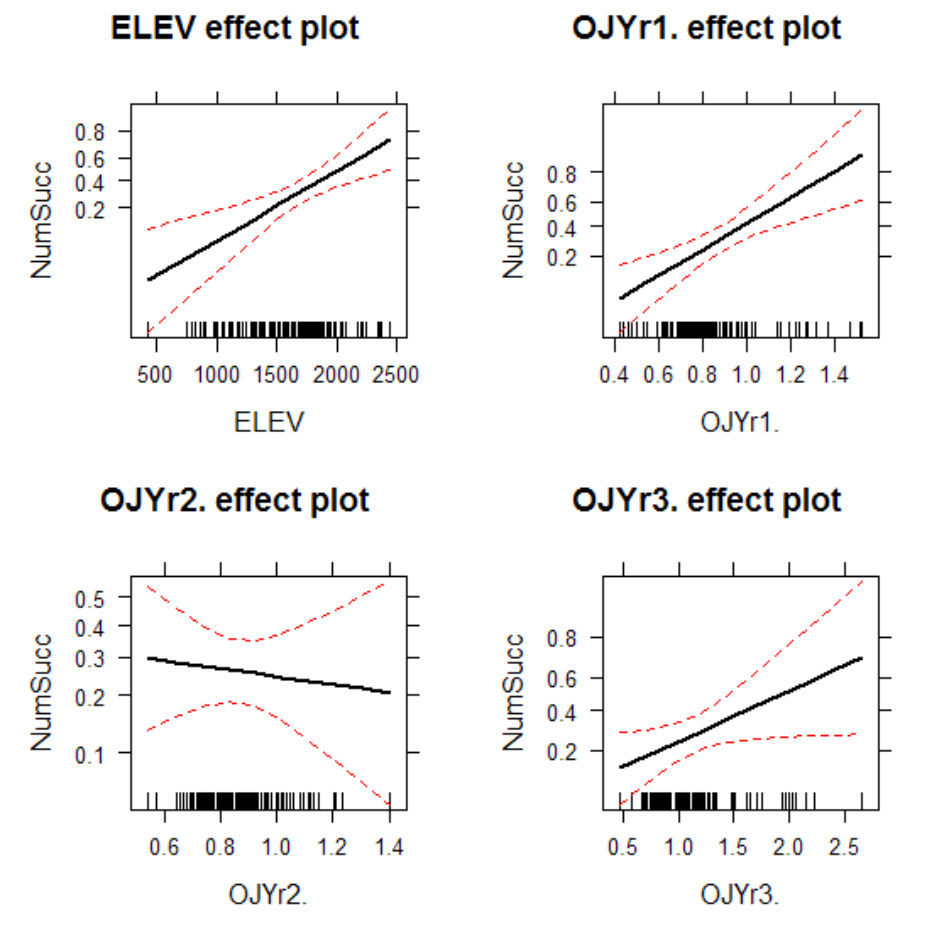
Aerial Seed Success = Int + Elev + OJPptYr1 + OJPptYr2 + OJPptYr3

Success Increases with:

- Precipitation
- Elevation

- Soil Depth
- Loamy Soils

- Seed Availability
- Fewer Weedy Competitors



Wirth & Pyke Prelim Results

USGS

Probability of Recovery

Difficulty in Recovery

- Abiotic Factors
  - Soil loss
    - Impacts structure and ecological processes
    - Must rebuild to return to past ecosystem
  - Water Table Lower
    - Change in riparian systems
    - Seeps and streams may dry up or become ephemeral

USGS

Potential options to consider

- Research Needed to aid ID of Ecosystem Objectives
  - Regional studies crossing Mojave/GB boundary on similar soils.
    - Plants
    - Soils & Soil Organisms
  - Re-evaluate forage production and stocking rates
    - Potential impacts on livestock and wildlife
- Refine/improve restoration expert systems - VegSpec

USGS

USGS