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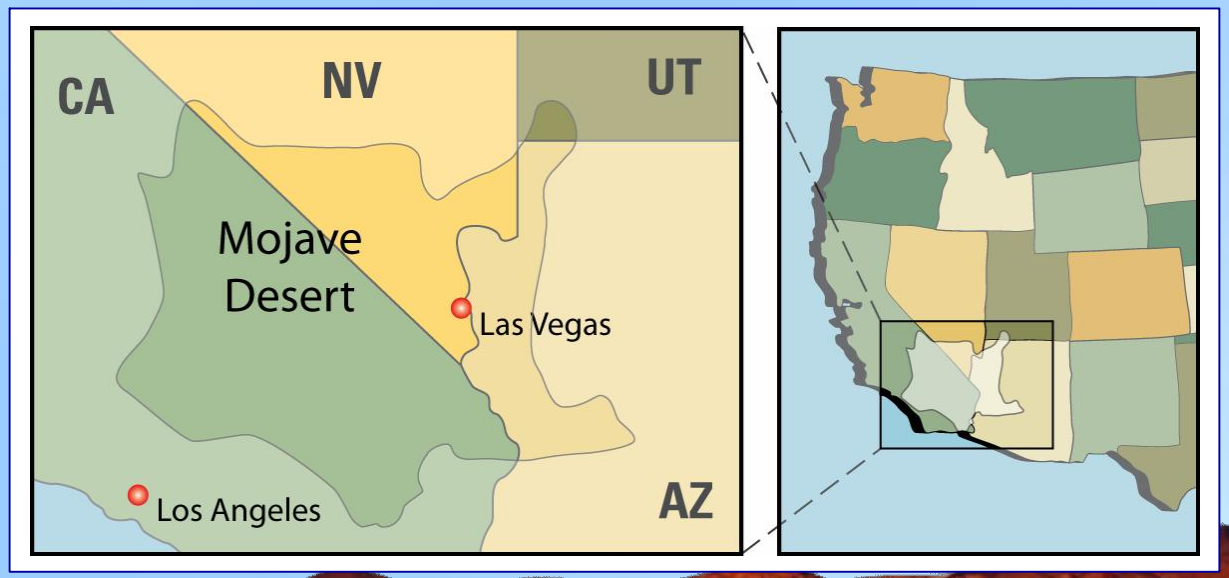
Recoverability and Vulnerability of Desert Ecosystems

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

Photos by David Miller

Mojave Desert land management issues

- Near fast-growing population centers (e.g., Las Vegas, Los Angeles) and within a day's drive of 40 million people
- Multiple jurisdictions: 4 National Park units and 6 military bases within a mosaic of BLM land



Mojave Desert land uses

- Military
- Recreation
- Mining
- Grazing
- Climate change
- Nitrogen deposition

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Mojave Desert land-use impacts

Land use can lead to:

- Disturbance or removal of vegetation
- Soil compaction
- Disturbance of soil stabilizers

Disturbance can lead to:

Loss of soil stability

- Increased water erosion = gullying, aquatic impacts, soil loss
- Increased wind erosion = dust (human health), nutrient and WHC loss

Greater soil compaction

- Increased water runoff = less infiltration
- Loss of soil structure = lower nutrient availability

Disturbance can lead to:

Plant loss

- Increased loss of soil and water
- Less soil structure and fertility
- Habitat loss
- Altered community structure (including invasives)

Animals

- Directly squished
- Habitat loss

Restoration

- Soils
  - Texture
  - Chemistry
  - Structure
- Plant cover
- Temperature
- Moisture regimes

In deserts, these responses are determined by abiotic factors, especially geomorphology (soils, landscape position) and climate….

….and mediated by biological processes

USGS RVDE project

- Began in 1998
- Primary hypotheses:
  - Recovery from disturbance varies across the landscape
  - Vulnerability to and recovery from disturbance is a function of landscape variables (e.g., geomorphology, climate)
  - These variations can be spatially modeled

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Who are RVDE's partners/collaborators?

- All DOI sister agencies in the Mojave, including BLM, FWS, and NPS
- U.S. Department of Energy
- U.S. Department of Defense

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How were RVDE's priorities established?

- The USGS interest in land management in the Mojave Desert extends back to the California Desert Area Plan in the 1970s.
- In the last 35 years, we've had extensive contact with land managers in the Mojave, who helped, and continue to help, set our priorities.

What are the USGS goals/objectives in RVDE?

- Conduct research on ecological processes in the Mojave Desert
- Demonstrate the importance of climate, soil moisture, and geomorphic surfaces on ecosystem function, resilience, and recovery
- Create spatial models of vulnerability and recoverability
- Develop protocols for monitoring long-term ecosystem change

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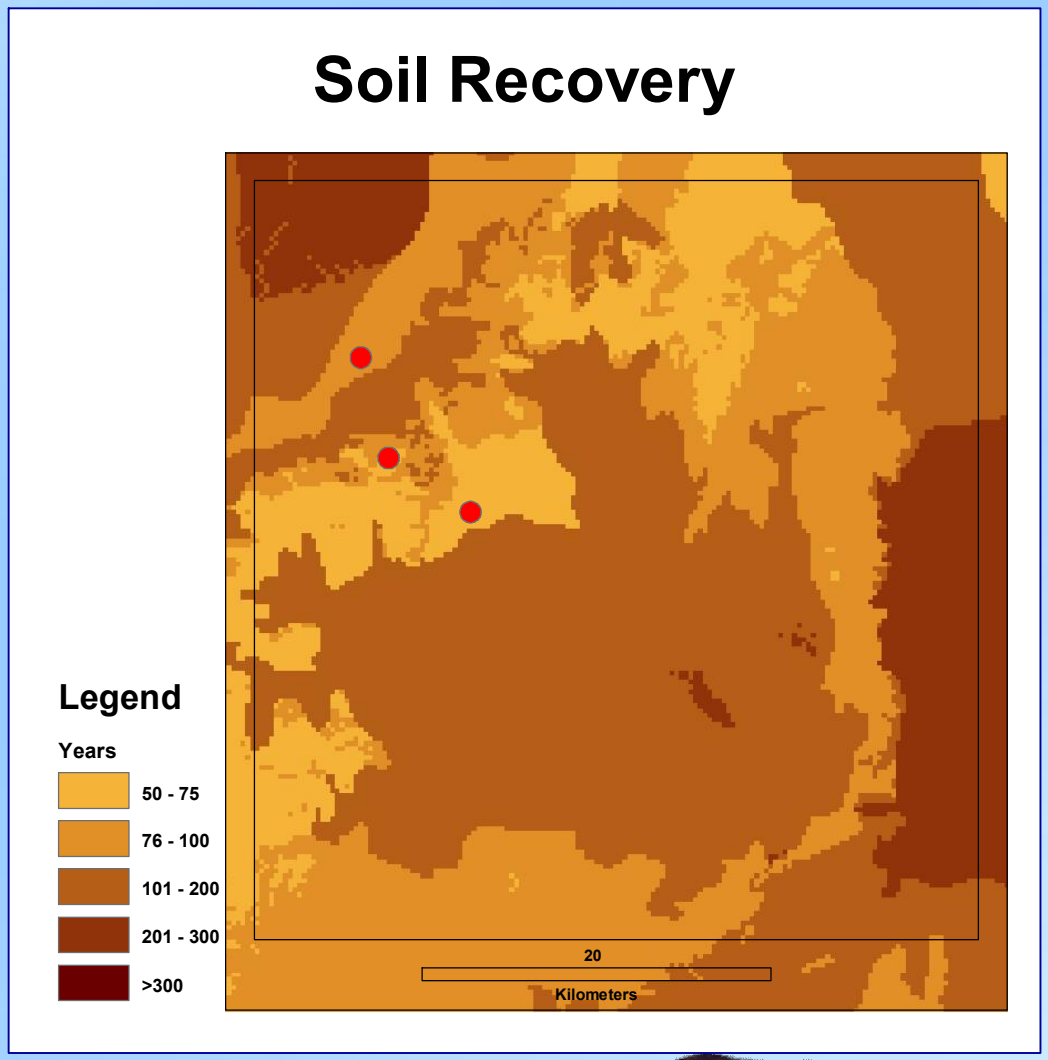
RVDE goal

Synthesize geospatial information on landscape variables with scientific understanding of ecosystem processes into maps and models of vulnerability and recovery that are useful for land management



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RVDE project approach

- Integrated, multidisciplinary approach
- Study the processes resulting from disturbance and how landscape recovers
- Model/predict vulnerability and recoverability

RVDE structure

Map/model current physical and biological properties

- Topography
- Surficial geology
- Soil texture
- Soil moisture
- Biological soil crust
- Vegetation
- Fire fuels & regimes

Study historical conditions and disturbance properties

- Vegetation change history
- Climate history
- Land use history

Study and model physical and biological processes as influenced by geology (water, nutrients)

- Soil erosion
- Soil compaction
- Crust processes
- Non-native species
- Rodents, ants
- Hydrology
- Nutrient cycles
- Vegetation dynamics

Models to predict vulnerability/recoverability

- Soil compaction
- Erosion occurrence/recovery
- Biological soil crust
- Fire risk
- Nutrient cycles
- Vegetation recovery
- Tortoise habitat

Predictive and monitoring tools for land managers

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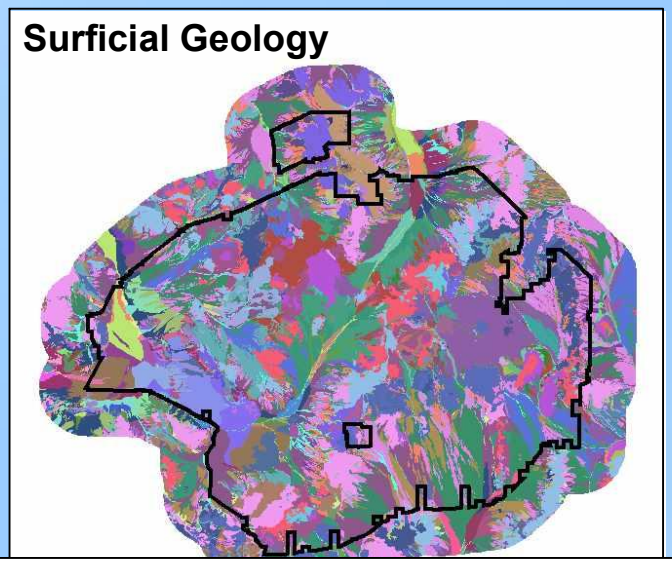
RVDE project elements

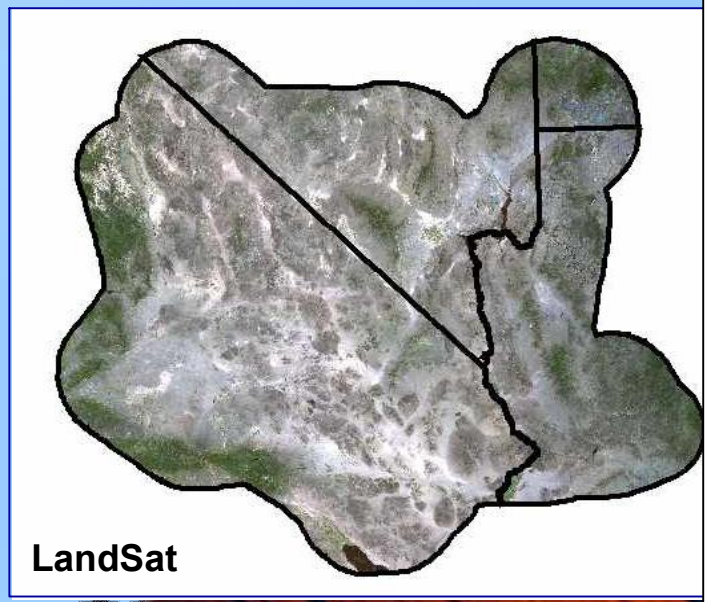
Mapping and modeling existing conditions

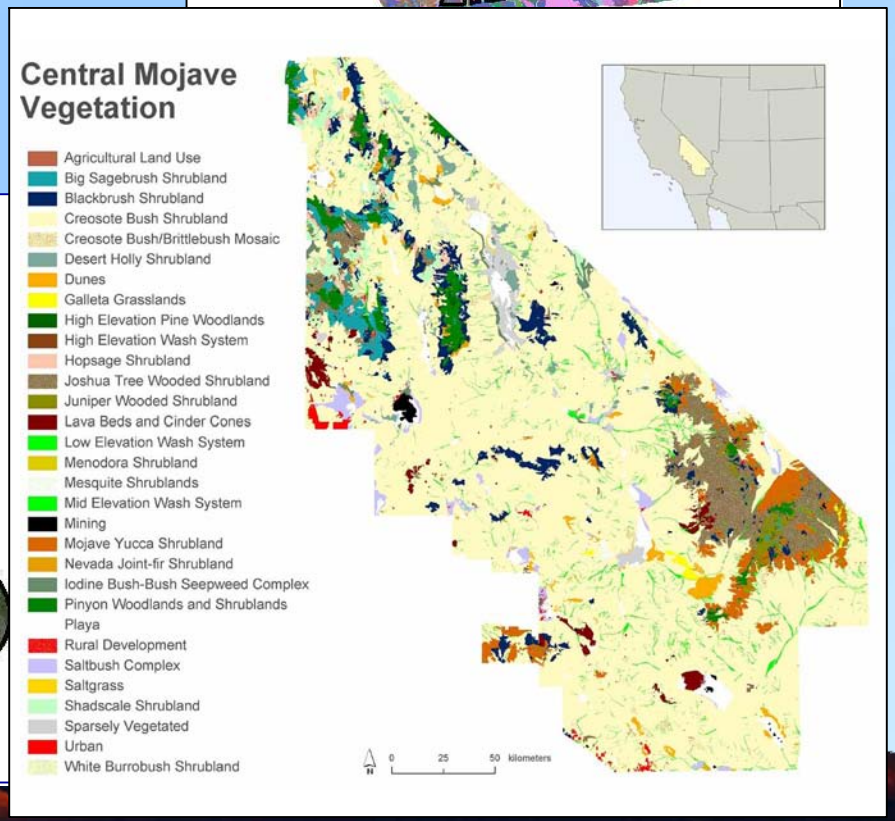
- Base data
- Surficial geology
- Soil texture
- Soil moisture
- Fire fuels and regimes

Base data

- MDEP CD set used as starting point
- MDEP Vegetation map
- Other datasets added as developed







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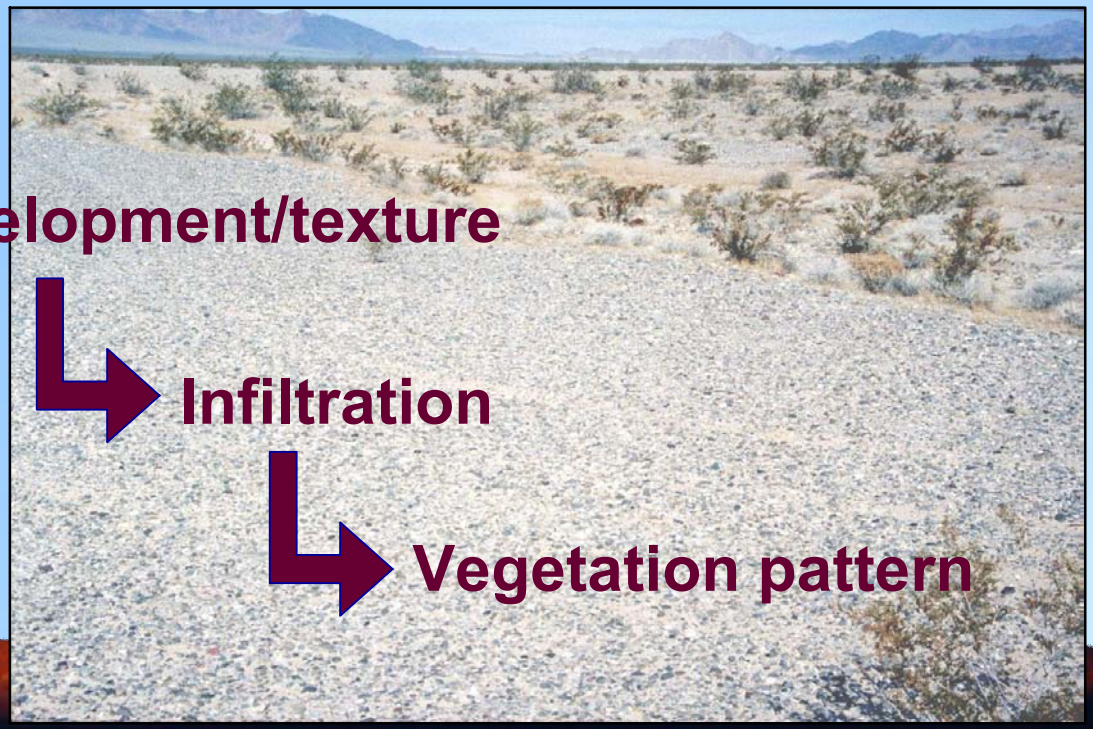
Surficial geology mapping

- Surficial geology (geomorphic surface) is related to:
  - Soil hydrology
  - Vegetation patterns
  - Recovery rates from disturbance

Age/type of surface



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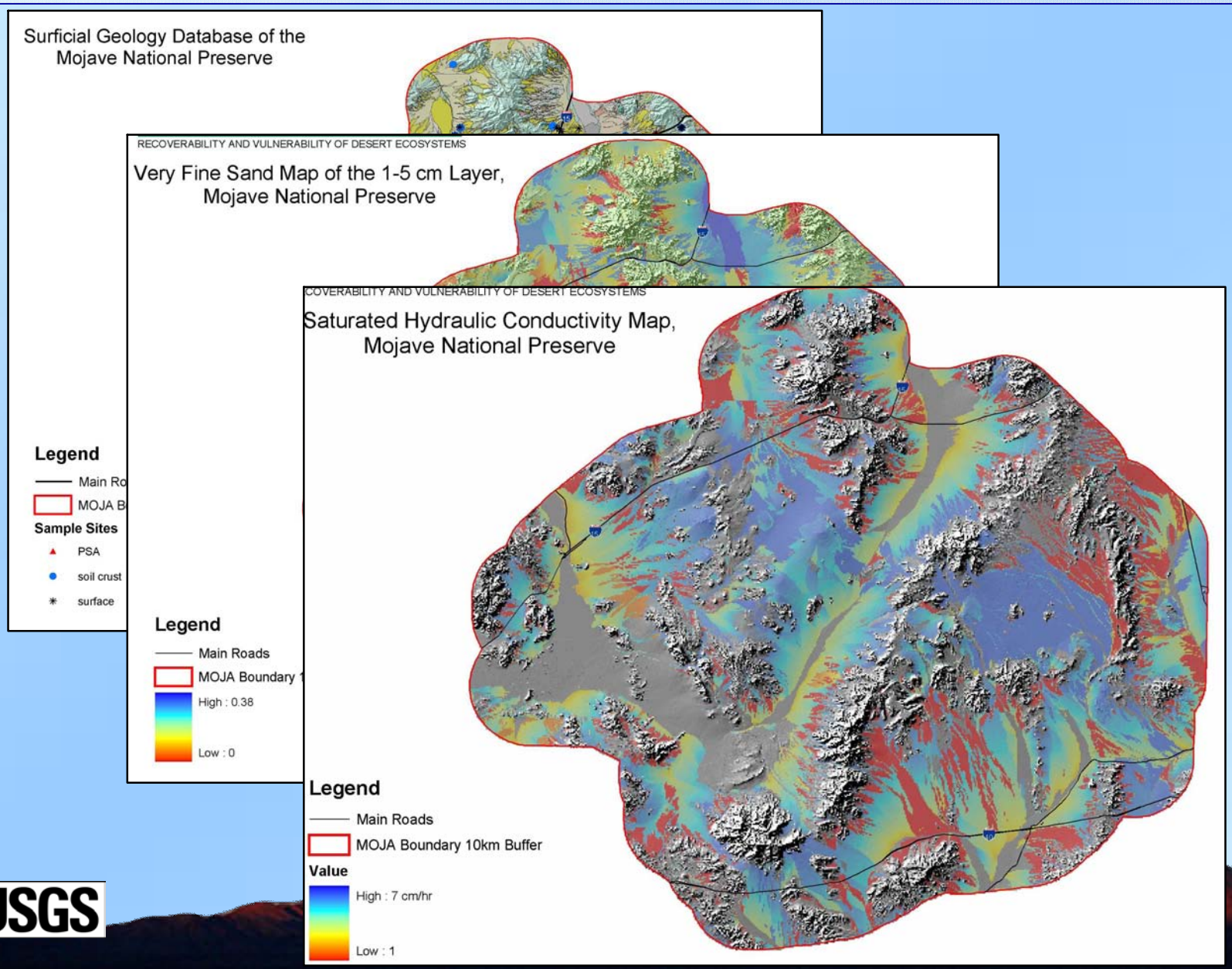
Soil texture modeling



Application to land management

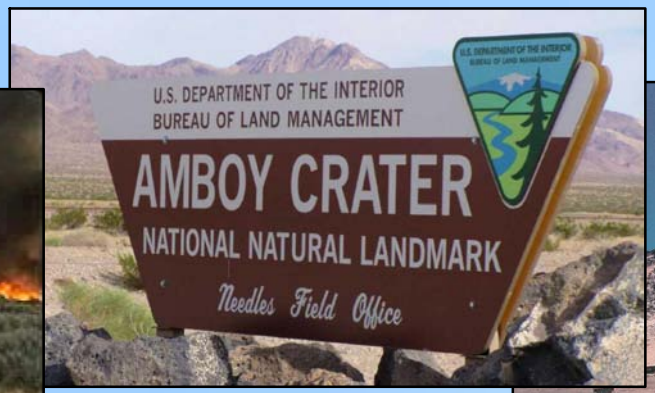
- Select location or time activities to:
  - Minimize disturbance
  - Minimize recovery times once disturbed
- Support decisions on active vs. passive restoration

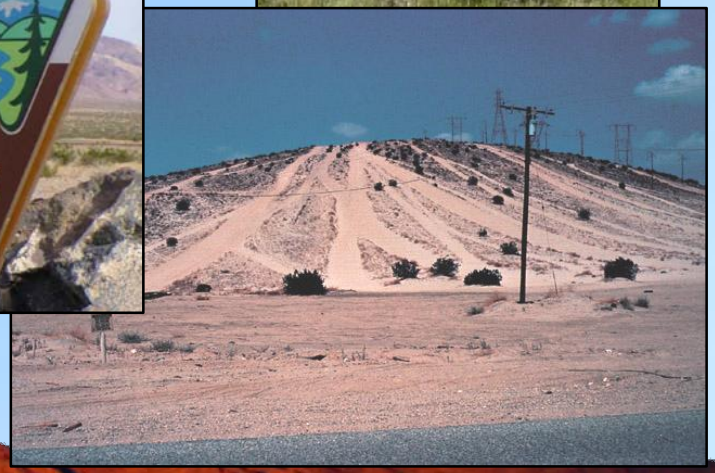
Photos courtesy of the National Park Service

Application to land management

Needs for modeling tools:

- Can address a range of land management issues
- Can be used at various scales
- Allow user to vary input data, conditions, weighting





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Important Mojave Desert attributes and processes:

- Disturbance history
- Visual aesthetics
- Soil structure
- Soil compaction
- Biological soil crusts
- Rodents
- Reptiles
- Large mammals
- Desert annuals
- Riparian ecosystems
- Invasive species
- Total plant cover
- Species composition
- Wind erodibility
- Water erodibility
- Threatened and endangered species
- Overland flow hydrology
- Habitat fragmentation