

Estancia Basin Watershed and Forest Health Experimental Monitoring Project

by

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Background

Southwest forest management over the past decade

- **forest thinning and restoration**

New forest management practices aimed to reduce potential for catastrophic wildfire and associated negative environmental / economic impacts; thinning and prescribed burns.

National plans and initiatives:

- US National Fire Plan (2000).
- **US Healthy Forests Initiative (2002).**
- Western Governors 10-year Plan (2002).
- Healthy Forests and Rangelands (2007).

New Mexico specific:

- **New Mexico Forest and Watershed Health Plan (2004).**

Background

Forest thinning and forest and watershed health

- Key goals of forest restoration:
 - Sustainable **landscape productivity**.
 - **Reduced** potential for catastrophic **wildfire**.
 - **Resistance and resilience** to environmental disturbance (drought, insects, disease, wildfire).
 - Long-term provision of **wildlife habitat**.
 - Long-term **ecosystem services** to people.
 - Sustainable **natural hydrologic processes**.
 - surface flow, infiltration, recharge.
 - **water quality**.

Background

Potential Environmental Impacts of Forest Thinning;
Positive or Negative from a resource management perspective

Soils

- compaction, infiltration, erosion.
- leaching of soil minerals and organic matter.

Hydrology

- surface runoff.
- ground-water recharge.
- water quality.

Vegetation

- productivity (cover), diversity (species, growth form, physical structure).
- invasive species.

Animals

- productivity (relative abundance), diversity (species & trophic structure)

Temporal stability for all of the above.

Purpose of Experimental Monitoring Project

Forest Thinning in the Estancia Basin Watershed,

Manzano Mountains: forest management for watershed health.

- Ponderosa pine forest and pinyon/juniper woodlands.

To determine the effects of Estancia Basin forest thinning practices on:

- hydrology,
- soils,
- vegetation,
- native animals,

over time, following forest thinning treatments.

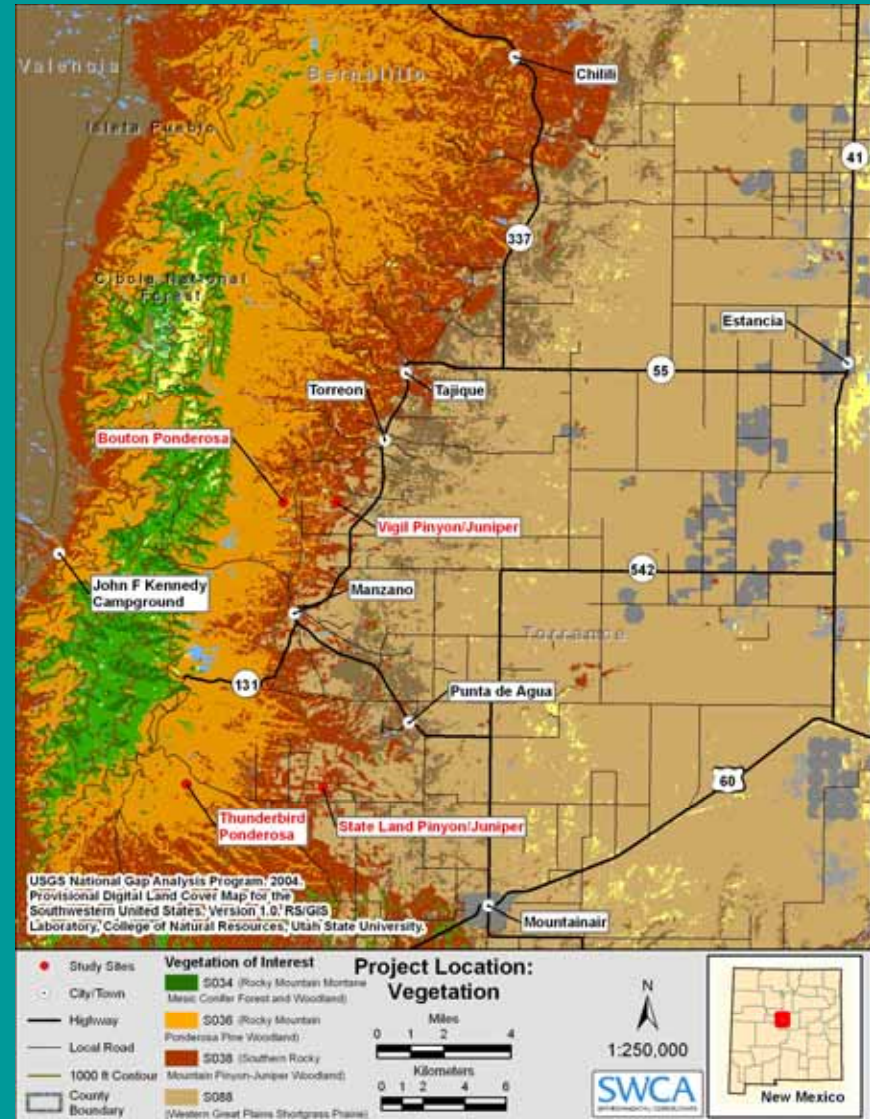
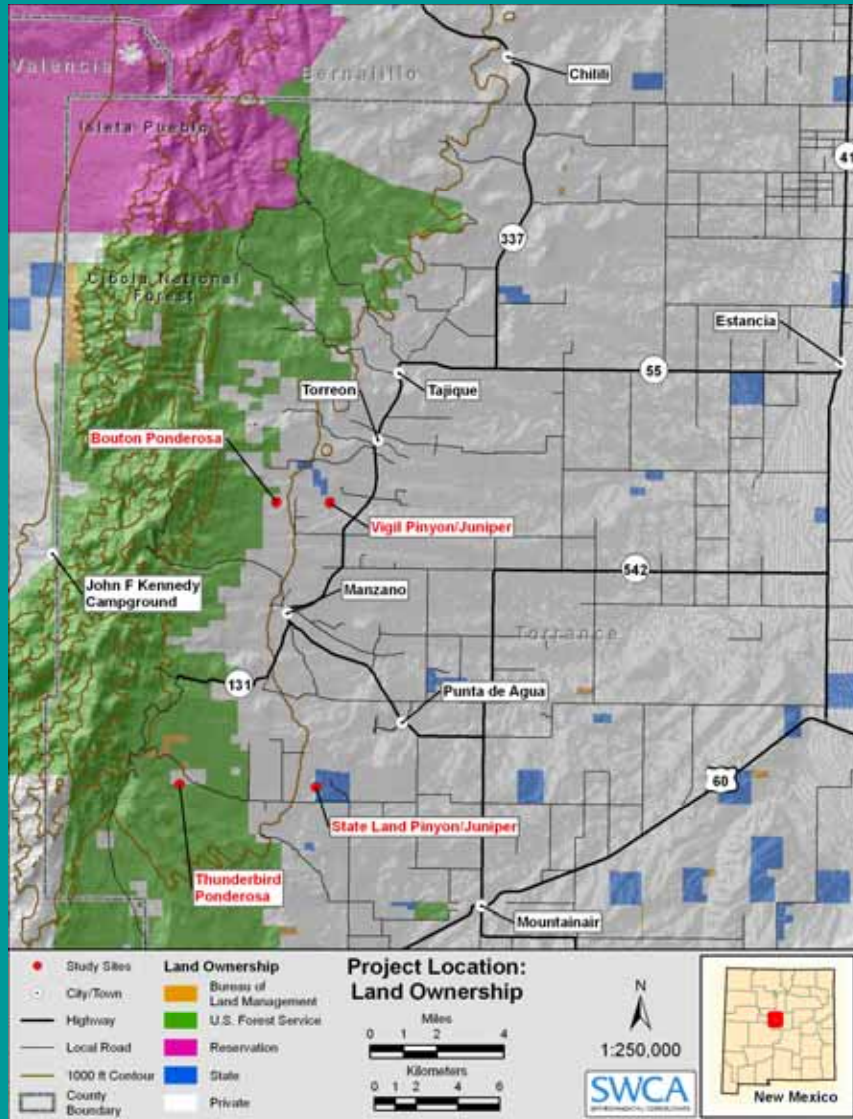
Experimental Approach

Implement current forest thinning treatments on specific study plots. Measure responses of soils, hydrology, vegetation, and animals over time.

- assess both **ponderosa pine and pinyon/juniper** woodlands.
- **stratify landscape** by topography, soils, vegetation.
- **replicate** in different sub-watersheds.
- **paired treatment and control** study plots.
- determine **pre-treatment conditions** for soils, hydrology, vegetation and animals.
- **impose forest thinning treatments (*prescriptions for the watershed*)**.
- **monitor responses** of soils, hydrology, vegetation and animals over time.

Current status at the planning stage, site installation begins in September.

Experimental Design



Experimental Design

Thunderbird Ponderosa



Bouton Ponderosa



State Land Pinyon/juniper

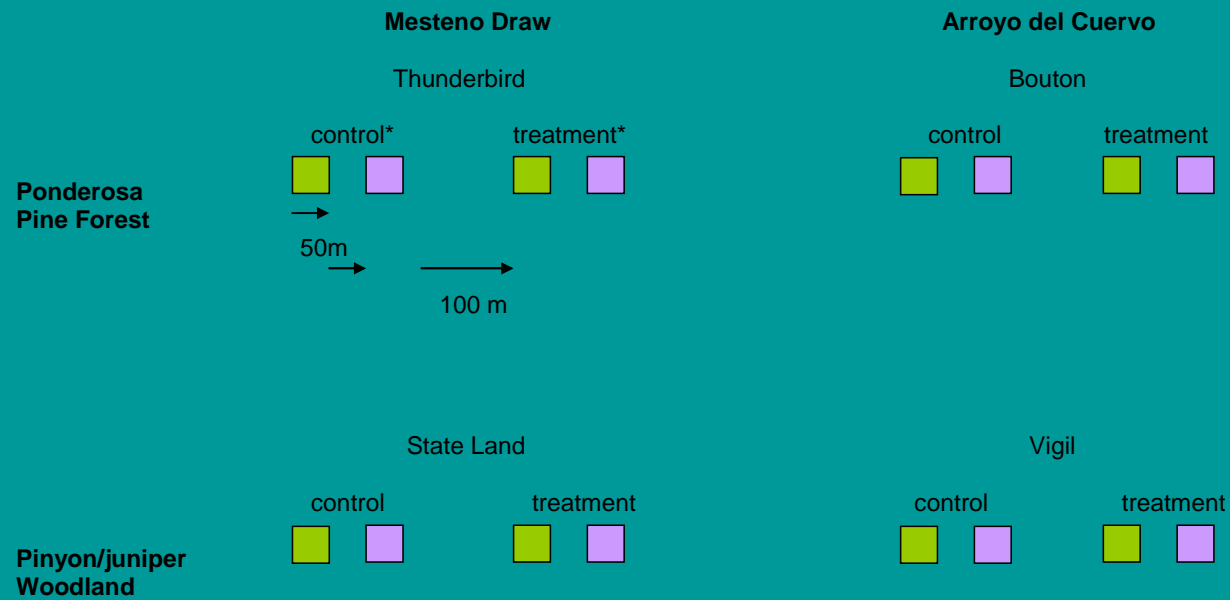


Vigil Pinyon/juniper





Experimental Design

Estancia Basin Monitoring Study Experimental Design



* actual thinning treatments will be randomly assigned to one of each subplot pair.

-  Vegetation / soils study subplot
-  Animal study subplot

Experimental Design: Study Site Selection

Criteria

Representative of on-going Estancia Basin forest thinning projects.

- Two woodland types; 1) ponderosa pine, 2) pinyon/juniper.
- Ponderosa and PJ sites within the same subwatersheds.
- Within region of current forest thinning activities.
- On private land of landowner involved with thinning program, and cooperation of landowner.
- Appropriate sized area (~10 acres).
- Homogenous landscape for paired treatment :
 - elevation, topography, aspect, slope, soils, hydrology, vegetation (including tree species, density and structure).

Process

Assessed 30 potential sites along Manzano Mountains east slope.

- Eliminated about half based on size (too small) or isolation.
- Visited 13 sites for field evaluation.
- Selected final four from 7 with potential (chose within subwatersheds).

Experimental Design

Landscape / forest type stratification

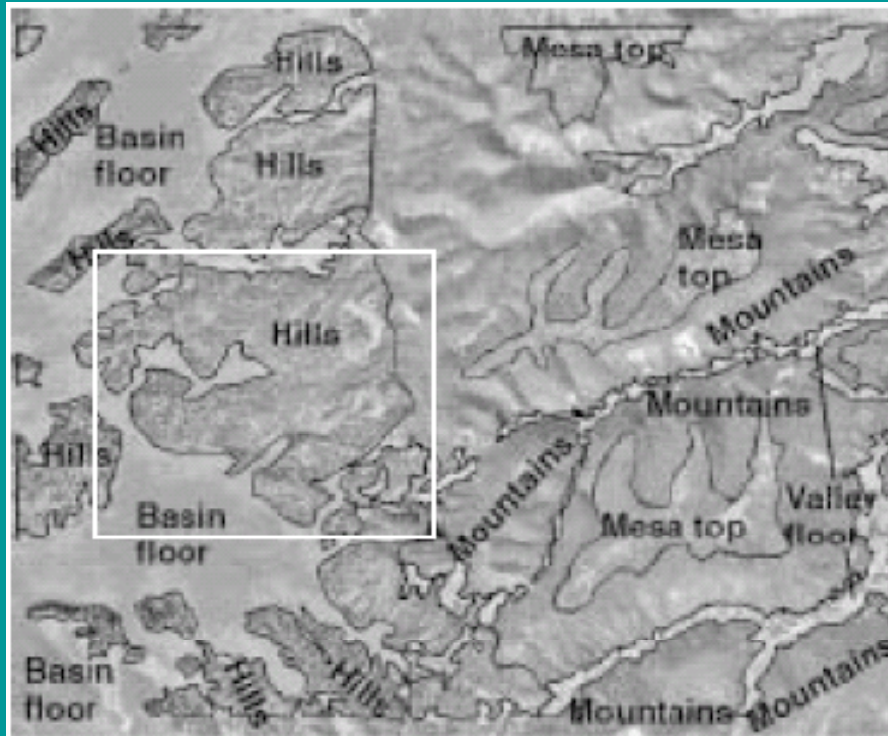
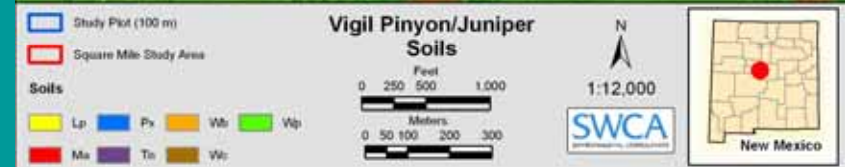
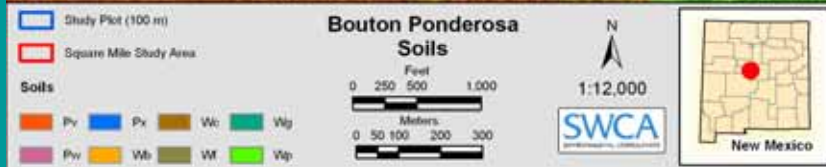


Figure 2.2. Example of landscape unit stratification. This type of stratification can only be done with aerial photos. Subdivision into soil-landscape units was not possible due to lack of soil survey information. The use of Soil Survey Maps can make this process easier and more accurate.

Source: USDA-ARS
Monitoring Manual, 2005.

Experimental Design

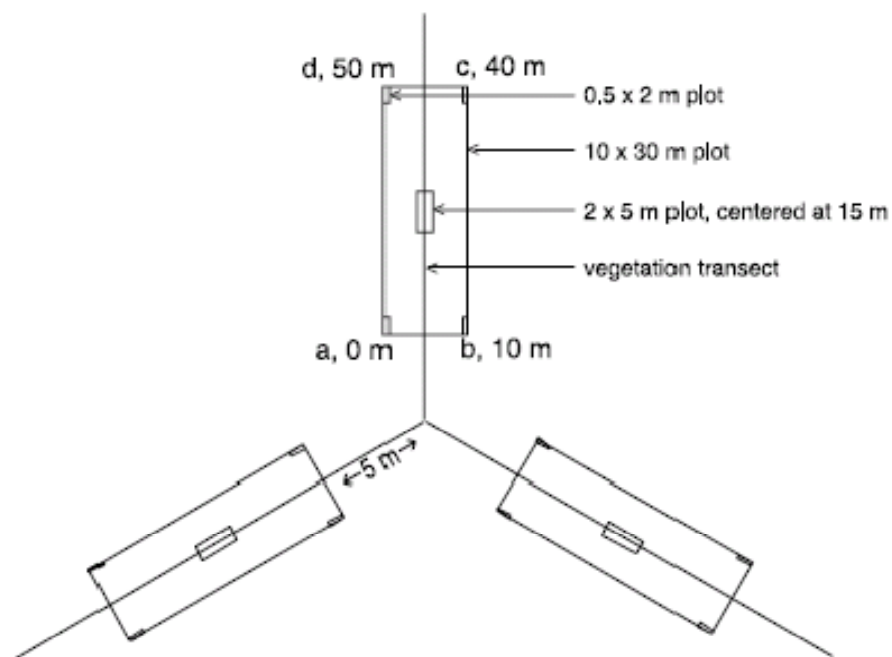
Arroyo del Cuervo subwatershed (soils / aerial overlays)



Study Subplots

Vegetation/soils subplot diagram

- soils and vegetation measures



Tree density subplots (overlaid on soils and veg subplot lines)

Subplot:

7.3 m (24.0 ft) radius

Azimuth 1-2 = 360°

Azimuth 1-3 = 120°

Azimuth 1-4 = 240°

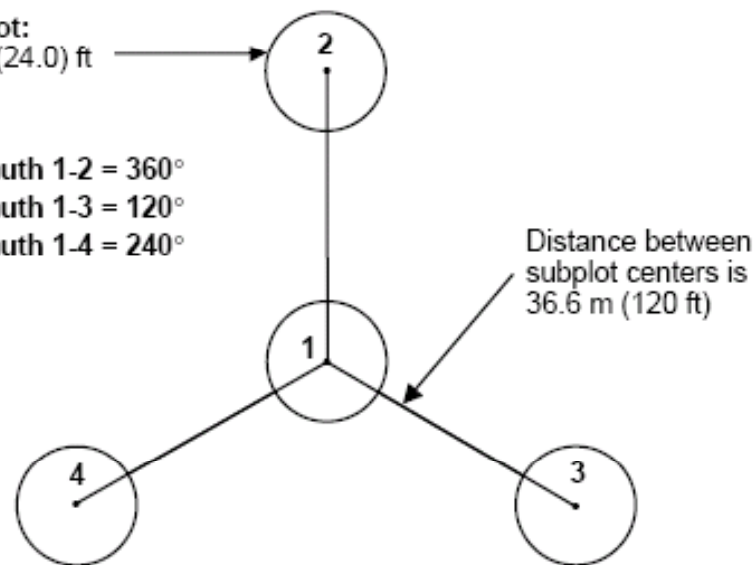


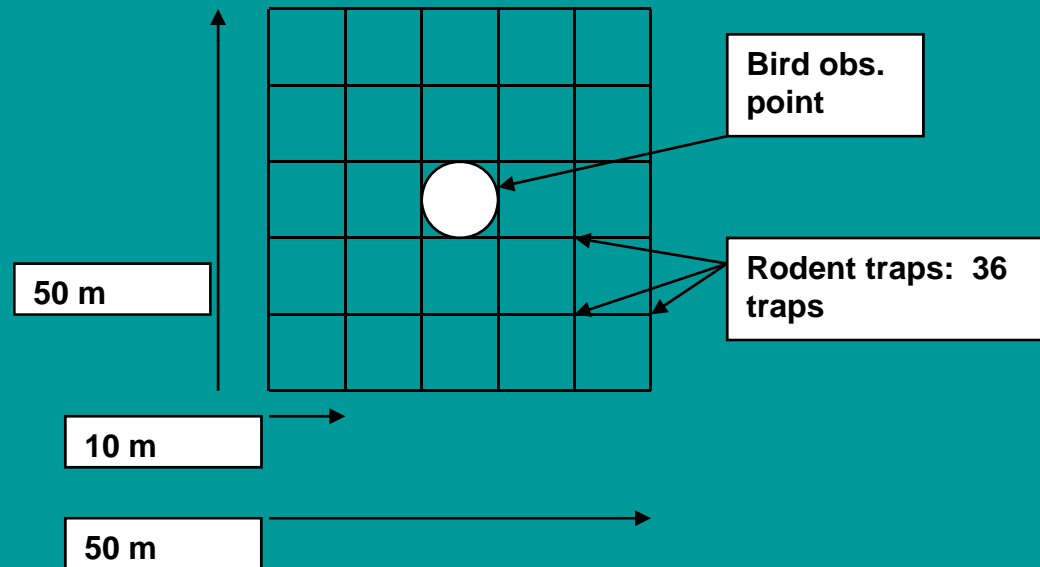
Figure 12.1. USFS Forest Inventory and Analysis plot diagram (modified from USDA Forest Service 2003).

Source: USDA-ARS Monitoring Manual, 2005.

Study Subplots

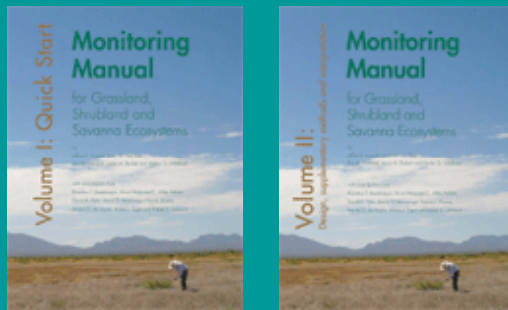
Animal subplot diagram

- bird point counts
- rodent trapping grid



Monitoring Methods and Protocols

1. USDA-ARS rangeland monitoring protocols; soils, vegetation. Integrates various soils, hydrology and vegetation measures with monitoring.



http://usda-ars.nmsu.edu/JER/Monit_Assess/monitoring.php

2. USDA Forest Service Inventory and Analysis (version 3) protocols; tree density and canopy structure (*in above too*).

<http://www.fia.fs.fed.us/library/field-guides-methods-proc/>



3. Specific literature sources; hydrology, animals, and some aspects of soils.

Weather

Automated meteorological stations at **each study plot**;
data recorded hourly on data loggers year-round.



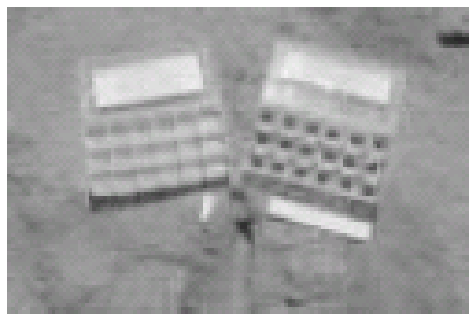
Spectrum Technologies®

weather data recorded:

- precipitation
- soil moisture (-2 cm, -5 cm)
- ambient temperature
- soil temperature (-2 cm)



Soils



Soil stability test



Infiltration test (Ch. 8)

All measurements made in May of each year

Soil type and structure

- soil pits (*profile, texture; standard*)

Soil chemistry

- soil cores and analysis (*nitrogen:total N, phosphorus, carbon:organic matter; standard*)

Soil surface stability

- surface stability test (*crust development, resilience; USDA-ARS*)

Soil water infiltration

- surface infiltration test (*water infiltration rate; USDA-ARS*)

Soil surface erosion

- soil erosion bridge (*drop-pin measures; Carl White, UNM*)

Hydrology

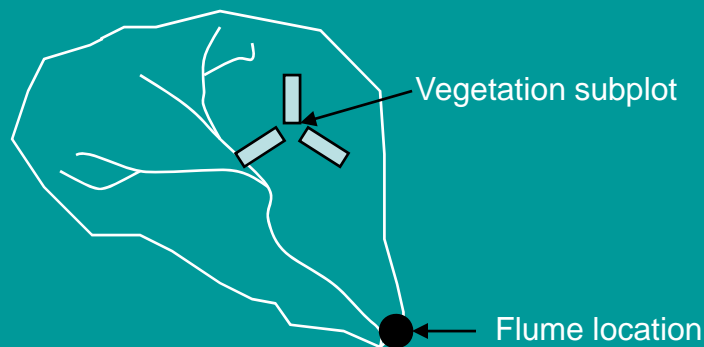
Thinning treatments can affect various aspects of the hydrologic response on the watershed:

- Amount of runoff
- Seasonal timing of runoff
- Rapidity of runoff (flashiness)

The surface outflow from the subwatershed associated with each subplot will be monitored using pre-fab Parshall flumes:

Water levels in the flumes will be automatically measured using a pressure transducer/datalogger:

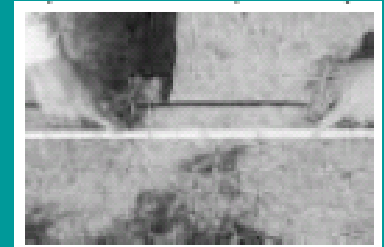
- Measurements collected every 5 minutes
- Datalogger maintenance every 6 months



Vegetation



Line-point intercept



Gap intercept

All measurements made in September of each year.

1. Non-trees, and trees less than one-inch dbh:

species composition (*diversity*)

- modified Whittaker plots.

foliage canopy cover (*productivity*)

- line-intercept.

foliage canopy height (*productivity*)

- point-line-intercept, veg. structure.

2. Trees (greater than one-inch dbh):

species composition (*diversity*)

- whole subplot tree inventory, maps.

tree canopy structure (*productivity*)

- canopy structure measures.

tree growth (*productivity*)

- dbh, dendrometer bands.
- density.

3. Repeat photo points: (*stability over time + all above*)

- visual representation of overall plot vegetation over time.

Animals

Measurements made in May and September each year

Birds

- 20 minute dawn point counts centered on each animal study plot.
- species composition, relative abundance.
(*diversity, productivity, temporal stability*)
- breeding season, fall migration.

Small Mammals

- repeat mark/release live trapping on each animal plot, 6 by 6 trap array, 36 traps/plot.
- 3 consecutive nights.
- species composition, relative abundance.
(*diversity, productivity, temporal stability*)
- pre- and post-breeding season each year.

Large Mammals

- track and scat counts (by species) on vegetation line-intercepts.
(*diversity, productivity, temporal stability*)

Data Management

- Weather and hydrology data will be offloaded and stored as ASCII files
- Field data from soils, vegetation, and animals will be entered as Excel files and stored as both Excel and ASCII files.
- Metadata for each data set, including data history records.
- Data error checking by summary analyses and visual inspection.
- All clean data files and metadata will be available on-line at secure ftp site.
- Data will be available on-line within one year of collection.

Data Analysis and Interpretation

- Summary graphics and charts.
- Statistical tests for **comparing treatment to control plots** within subwatersheds for measurement variables (*paired t-tests and ANOVA; SAS software*).
- Repeated measures ANOVA and/or mixed-model approaches for testing **treatment differences over time and interactions** (*SAS software*).
- Ecological community analysis approaches for comparing **species composition and diversity** (*similarity/dissimilarity approaches; PC-ORD software*).
- Correlation/regression **co-variance analysis** across variables (*SAS software*).
- Separate analyses for **ponderosa and pinyon/juniper** environments.

Integration of Findings and Assessment of Forest and Watershed Health

Integrated ecosystem approach – assess the entire **interactive system**

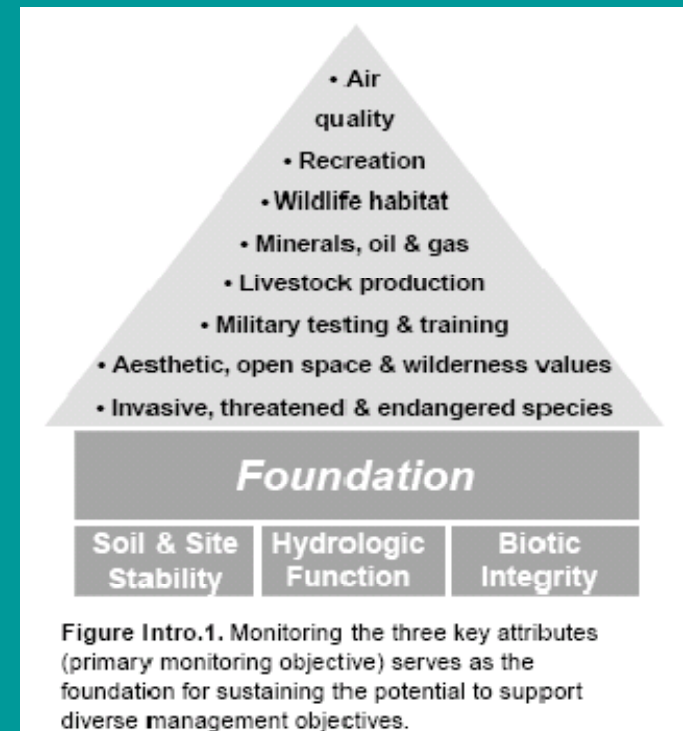
Ecosystem function and productivity

- comparatively assess responses of all measured variables to treatments in an integrated way (e.g., weather/soils/hydrology/plants/animals X treatments vs. controls).
- determine if responses are positive or negative (relative to management goals).

Ecosystem resilience and stability

- comparatively assess ecosystem function.
- and productivity over time.

Source: USDA-ARS
Monitoring Manual, 2005.



Integration of Findings and Assessment of Forest and Watershed Health

Resistance and resilience of ponderosa pine forests and pinyon/juniper woodlands to forest thinning in the Estancia Basin.

- **Soil stability, hydrologic function, biological integrity.**

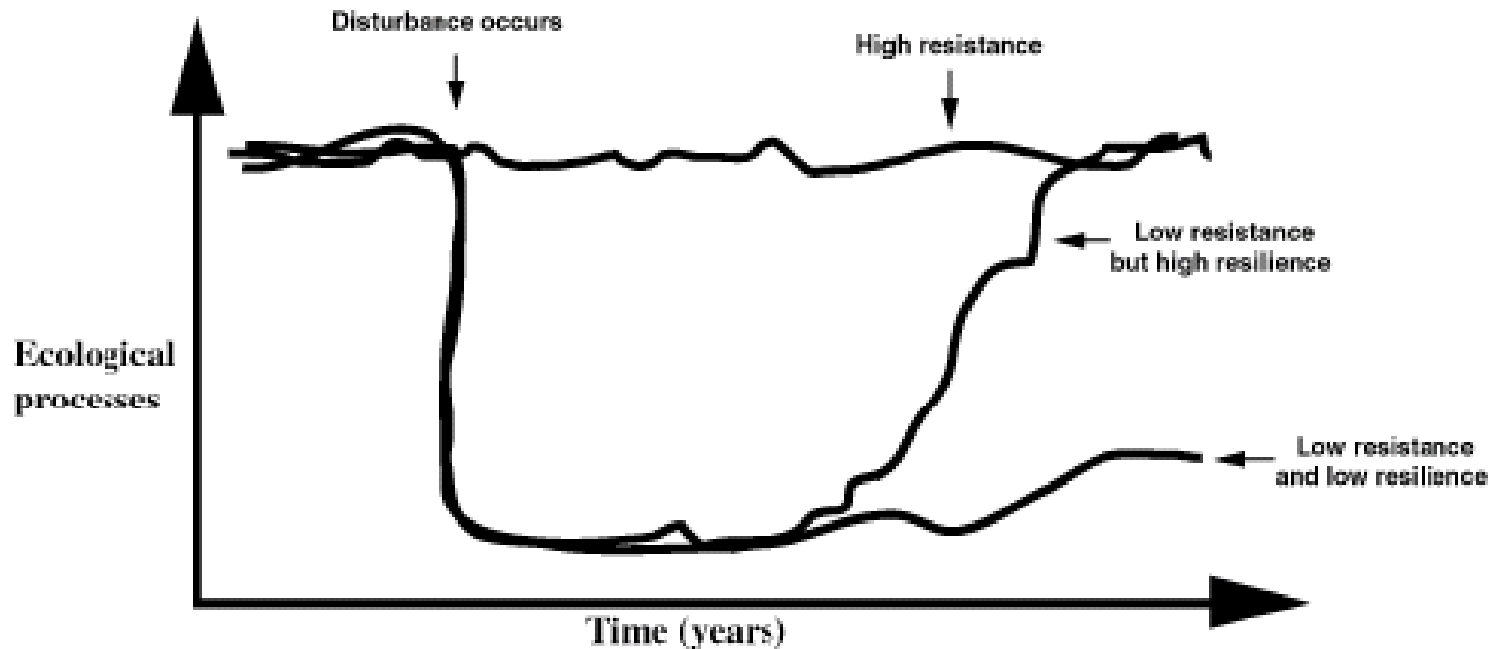
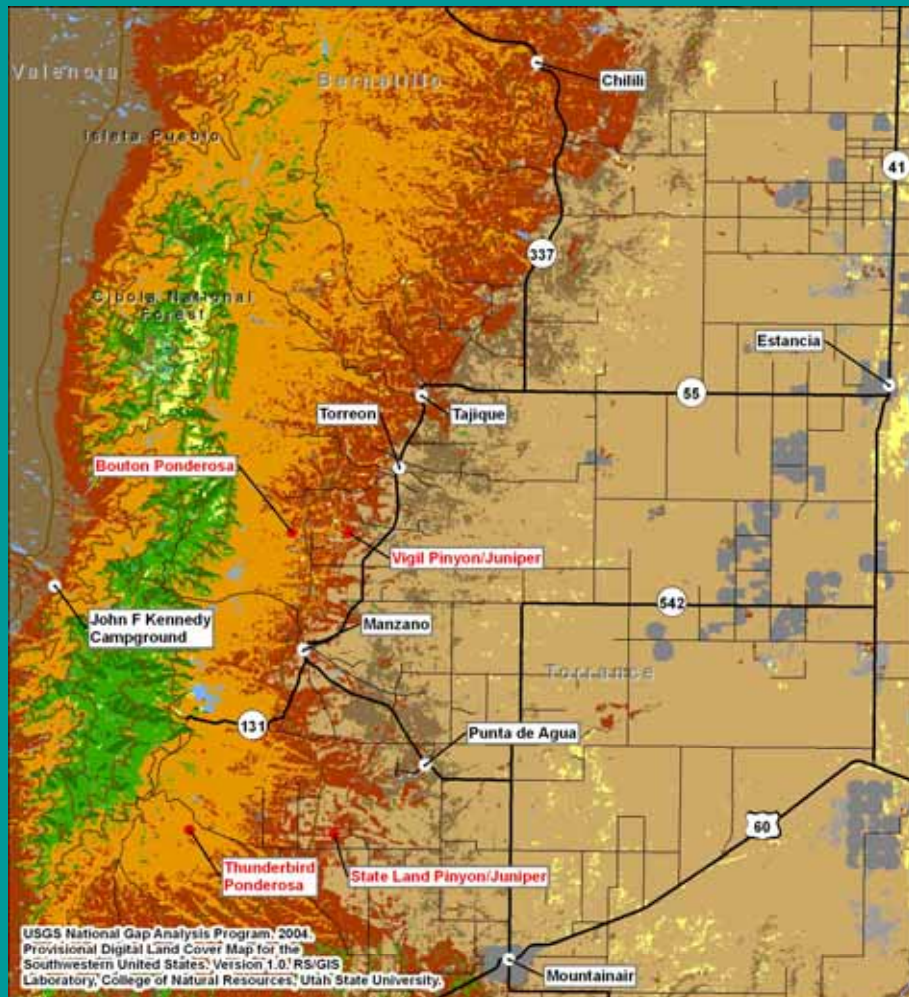


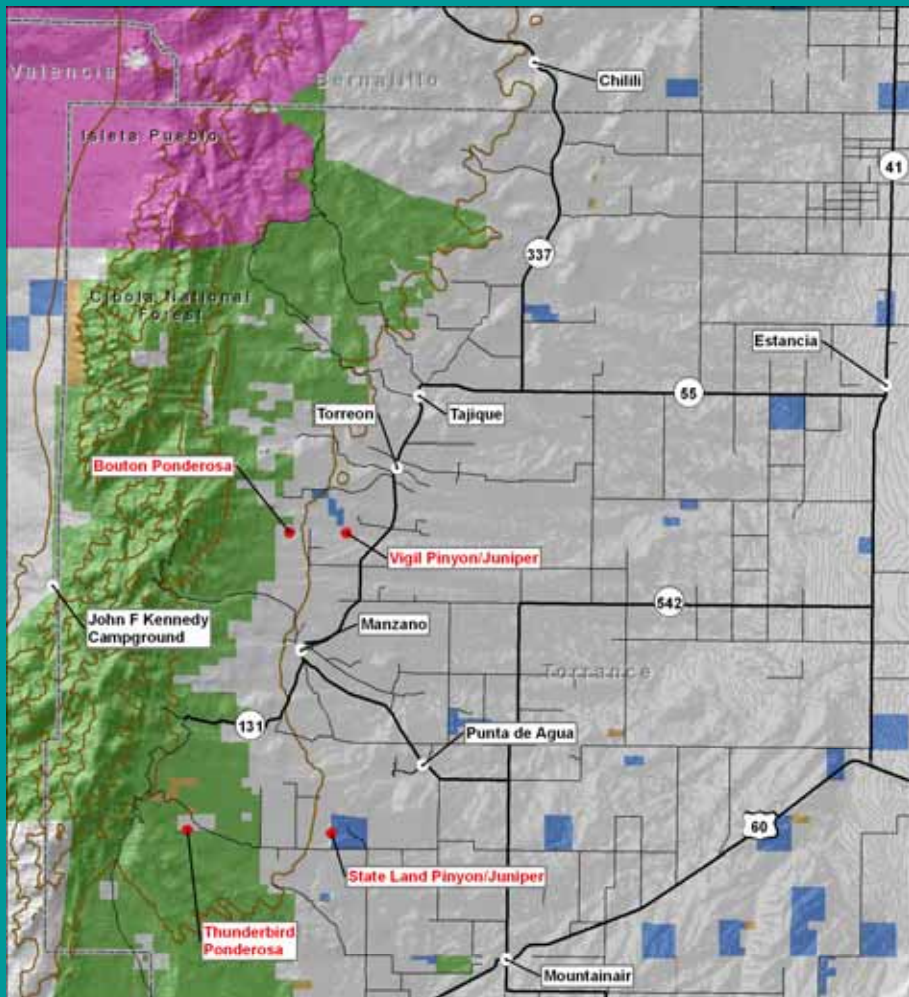
Figure 17.10. Resistance is the ability of a system to resist a disturbance over time. Resilience is the ability of a system to rebound after a disturbance (adapted from Seybold et al. 1999).

Source: USDA-ARS Monitoring Manual, 2005.



USGS National Gap Analysis Program, 2004
 Provisional Digital Land Cover Map for the
 Southwestern United States, Version 1.0! RS/GIS
 Laboratory, College of Natural Resources, Utah State University.

<ul style="list-style-type: none"> ● Study Sites ○ City/Town — Highway — Local Road — 1000 ft Contour □ County Boundary 	<p>Vegetation of Interest</p> <ul style="list-style-type: none"> ■ S034 (Rocky Mountain Montane Mesa, Conifer Forest and Woodland) ■ S036 (Rocky Mountain Ponderosa Pine Woodland) ■ S038 (Southern Rocky Mountain Pinyon-Juniper Woodland) ■ S088 (Western Great Plains Shortgrass Prairie) 	<p>Project Location: Vegetation</p> <p>Miles: 0 1 2 4 Kilometers: 0 1 2 4 6</p> <p>1:250,000</p> <p>SWCA <small>SWCA is a subsidiary of URS NRS</small></p> <p>New Mexico</p>
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