

# Monitoring of Forest Thinning Treatments and Wildfire Effects on Forest and Watershed Health in the Manzano Mountains, New Mexico

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**Funded principally by the New Mexico State Water Trust Board  
to the  
Estancia Basin Watershed Health, Restoration,  
and Monitoring Steering Committee**

# Restoration important part of Southwest forest management

- including forest thinning and prescribed burns to alleviate overgrowth of trees and fuels from decades of fire suppression.
- US National Fire Plan (2000).
- US Healthy Forests Initiative (2002).
- Western Governors 10-year Plan (2002).
- Healthy Forests and Rangelands (2007).
- New Mexico Forest and Watershed Health Plan (2004).

For example, the Manzano Mountains



Pre-Trigo Fire 2007



Post Trigo Fire 2008



Runoff below Trigo 2009

# Some key goals of forest restoration:

- Thin trees to reduce potential for catastrophic wildfire, and to reduce competition among trees for water, nutrient and light resources (reduces impacts of drought, insects, disease).
- Sustainable forest productivity and ecosystem services to people and improved wildlife habitat.
- Sustainable natural hydrologic processes: infiltration, recharge, reduced soil erosion, increased water quality.



US Forest Service photo



US Forest Service photo

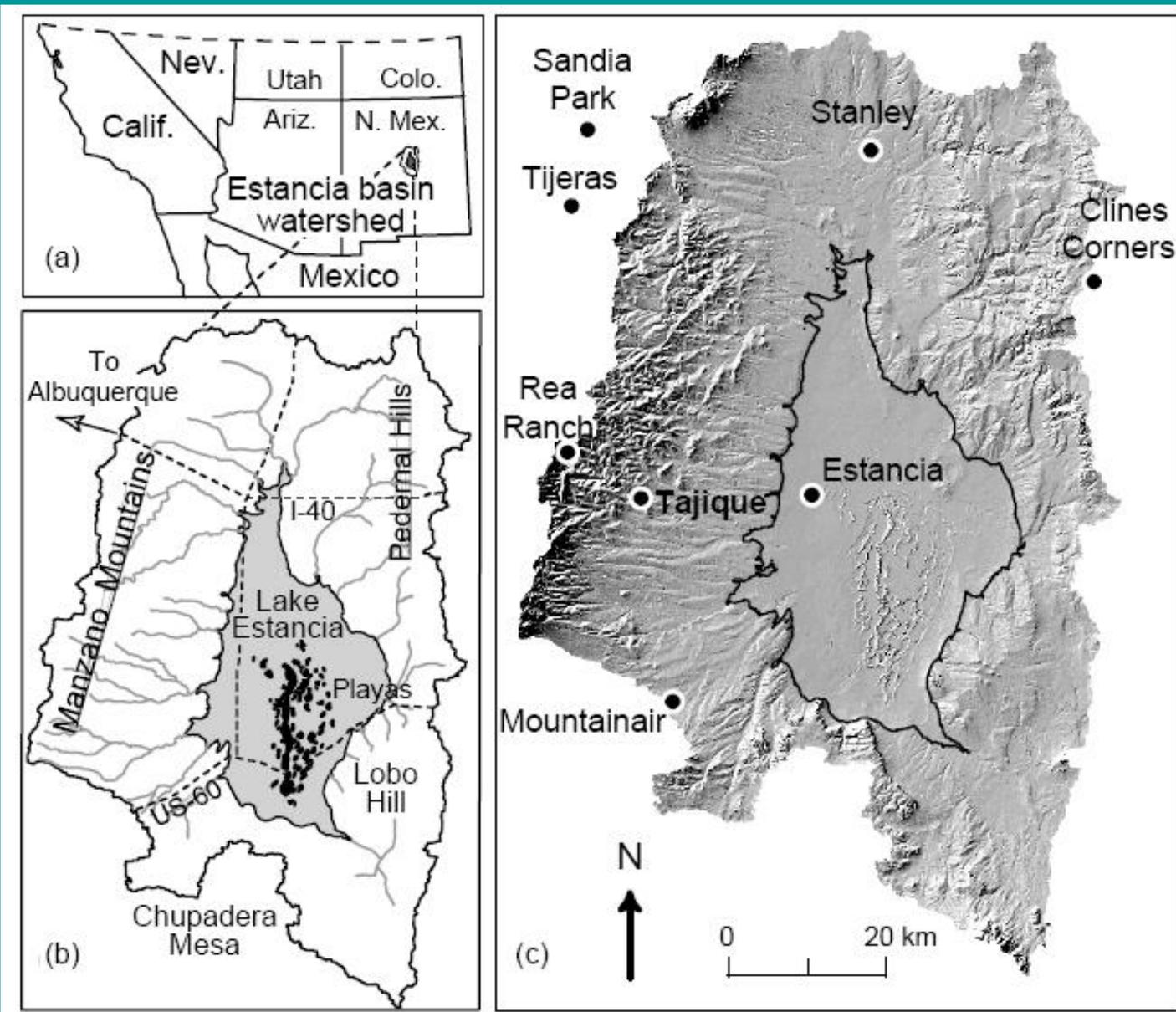
# Estancia Basin Watershed Health Restoration and Monitoring Project

**Program funded primarily by the New Mexico Water Trust Board, overseen by the Estancia Basin Watershed Health Restoration and Monitoring Steering Committee:**

Claunch-Pinto, East Torrance, Edgewood Soil and Water Conservation Districts, New Mexico Forest and Watershed Restoration Institute, New Mexico State Forestry, New Mexico Environment Department.

**Emphasis on forest thinning to improve watershed health.**

**Monitoring designed to determine effects of forest thinning on: hydrology, soils, vegetation, and wildlife.**

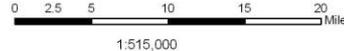
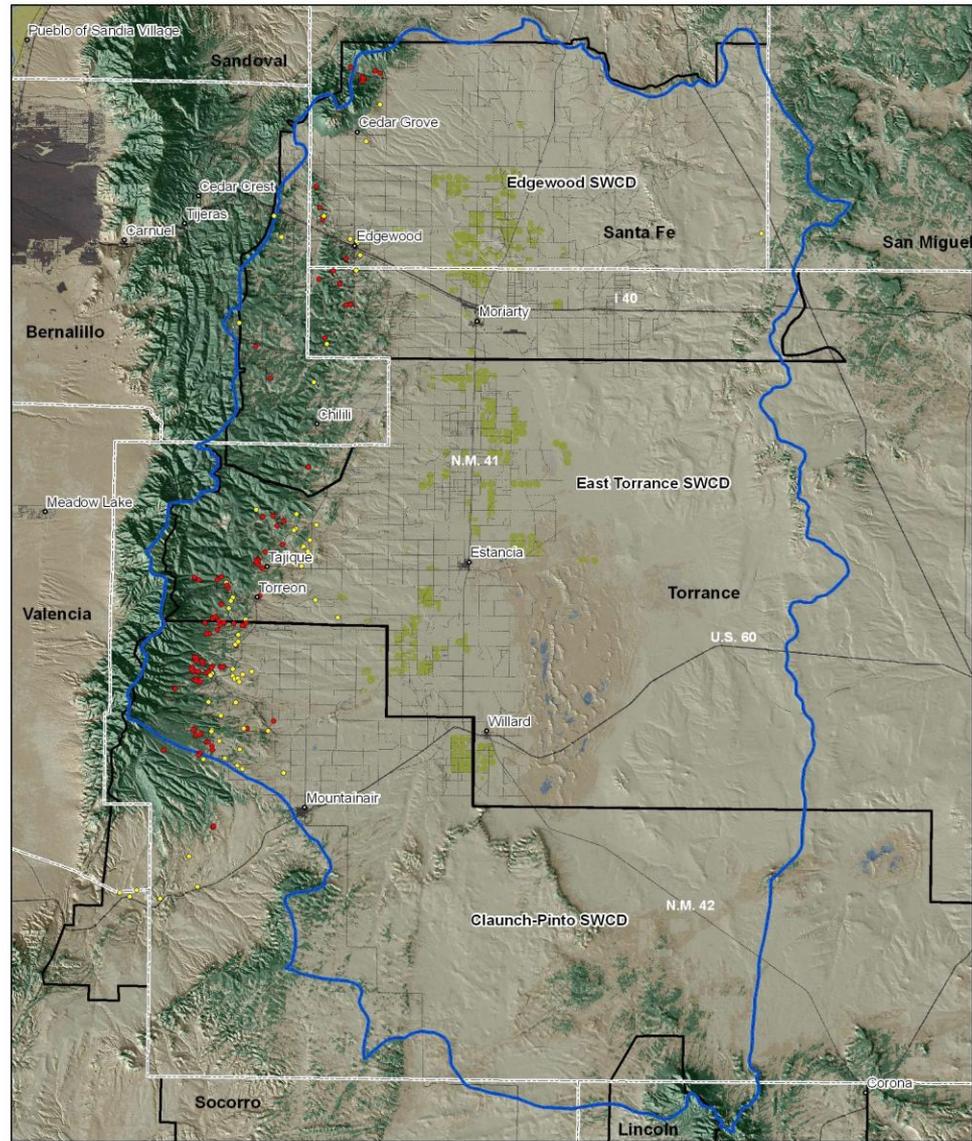


The Estancia Basin; from Menking et al. 2010

# Forest thinning projects on the west side of the Estancia Basin

Sponsored by the Estancia Basin Watershed Health Restoration and Monitoring Steering Committee

## Estancia Basin



# Experimental Approach to Evaluate Forest Thinning Effects

- assess both ponderosa pine and pinyon/juniper woodlands.
- determine baseline pre-treatment conditions for soils, hydrology, vegetation and animals; 2008-2010=3 years baseline data.
- impose forest thinning treatments; 2010  
(*following New Mexico State Forestry prescriptions for the watershed*).
- monitor responses of soils, hydrology, vegetation and wildlife over time.

## Examples near Manzano



Juniper tree removed

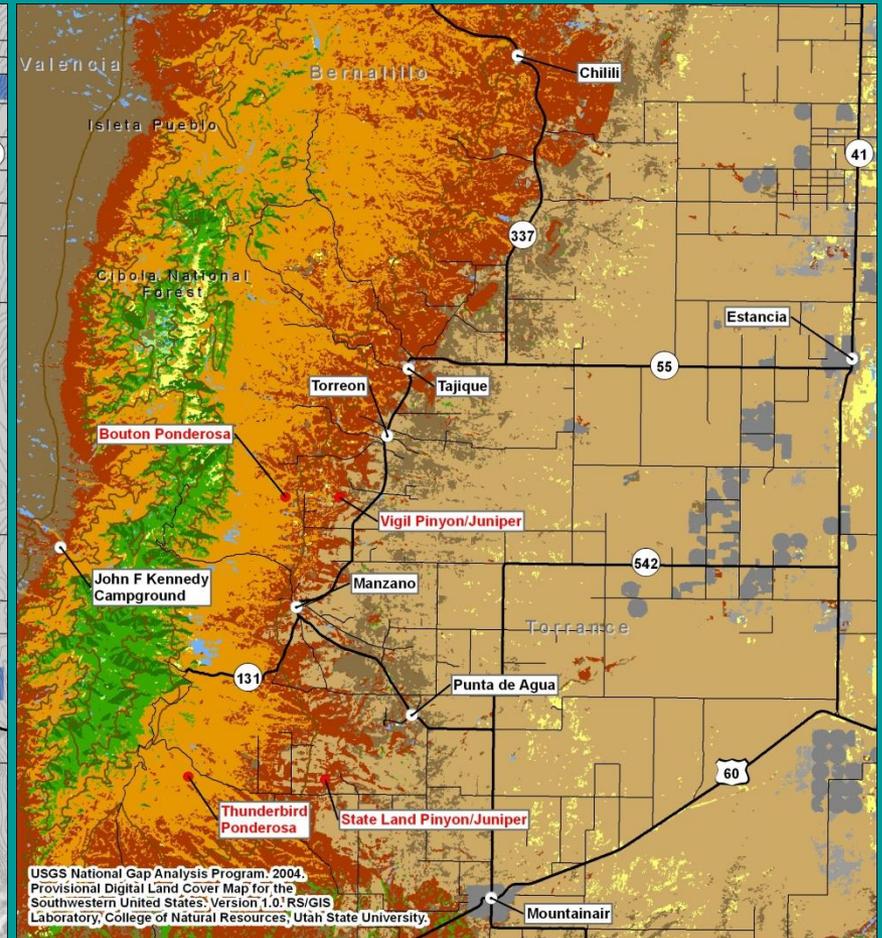
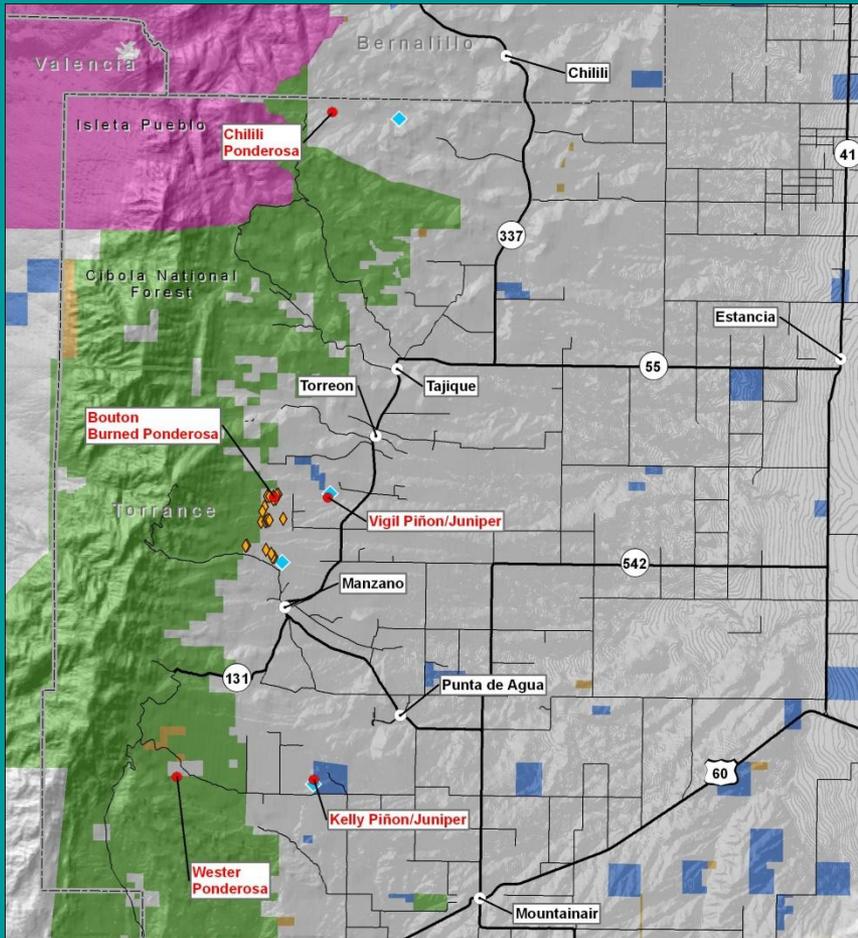


P/J thinning boundary



Ponderosa pine forest thinned

# Study Site Locations



**Project Location Forest Thinning**

- Forest Thinning Site
- ◆ Post-Fire Monitoring Plot
- ◆ Piezometer Site
- City/Town
- Highway
- Local Road
- ▭ County Boundary

**Land Ownership**

- Orange: Bureau of Land Management
- Green: U.S. Forest Service
- Pink: Reservation
- Blue: State
- White: Private

**Scale:** 1:250,000  
 Miles: 0 1 2 4  
 Kilometers: 0 1 2 4 6

**SWCA**  
 ENVIRONMENTAL CONSULTANTS

**New Mexico**

**Project Location: Vegetation**

- Study Sites
- City/Town
- Highway
- Local Road
- 1000 ft Contour
- ▭ County Boundary

**Vegetation of Interest**

- Green: S034 (Rocky Mountain Montane Mesic Conifer Forest and Woodland)
- Yellow: S036 (Rocky Mountain Ponderosa Pine Woodland)
- Orange: S038 (Southern Rocky Mountain Pinyon-Juniper Woodland)
- Brown: S088 (Western Great Plains Shortgrass Prairie)

**Scale:** 1:250,000  
 Miles: 0 1 2 4  
 Kilometers: 0 1 2 4 6

**SWCA**  
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**New Mexico**

Private lands only (funding)

Ponderosa and pinyon/juniper

# Study Sites

**Wester ponderosa**



**Chilili ponderosa**



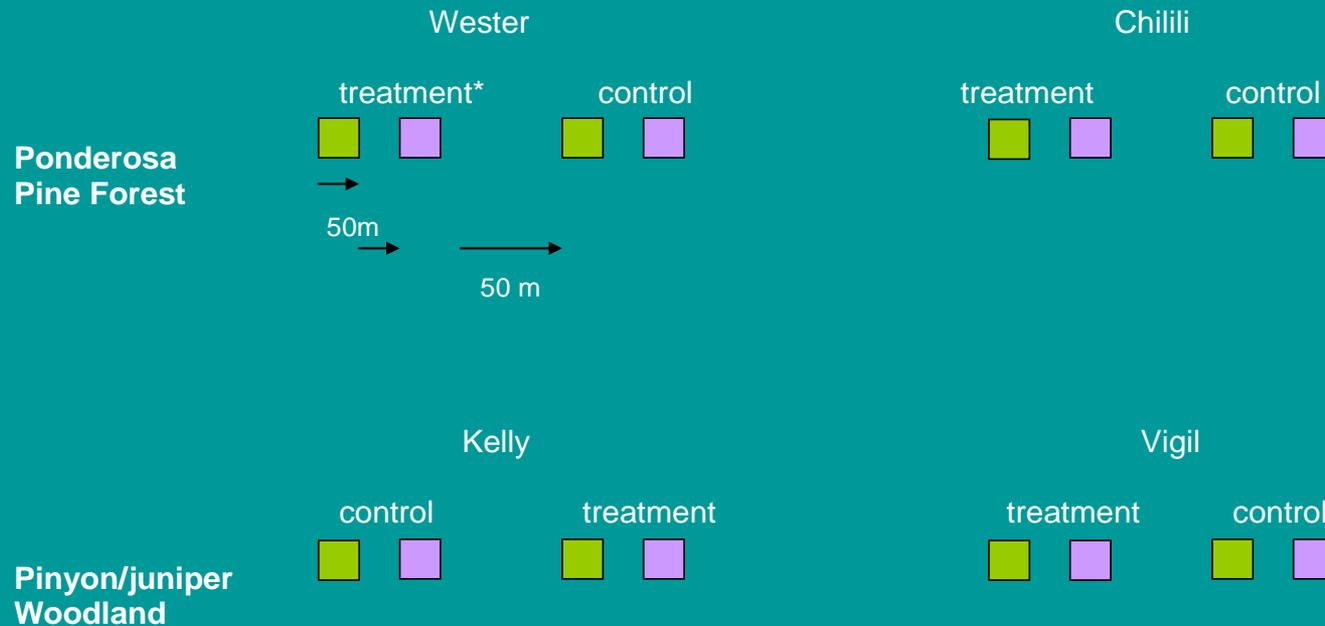
**Kelly pinyon/juniper**



**Vigil pinyon/juniper**



# Experimental Study Design

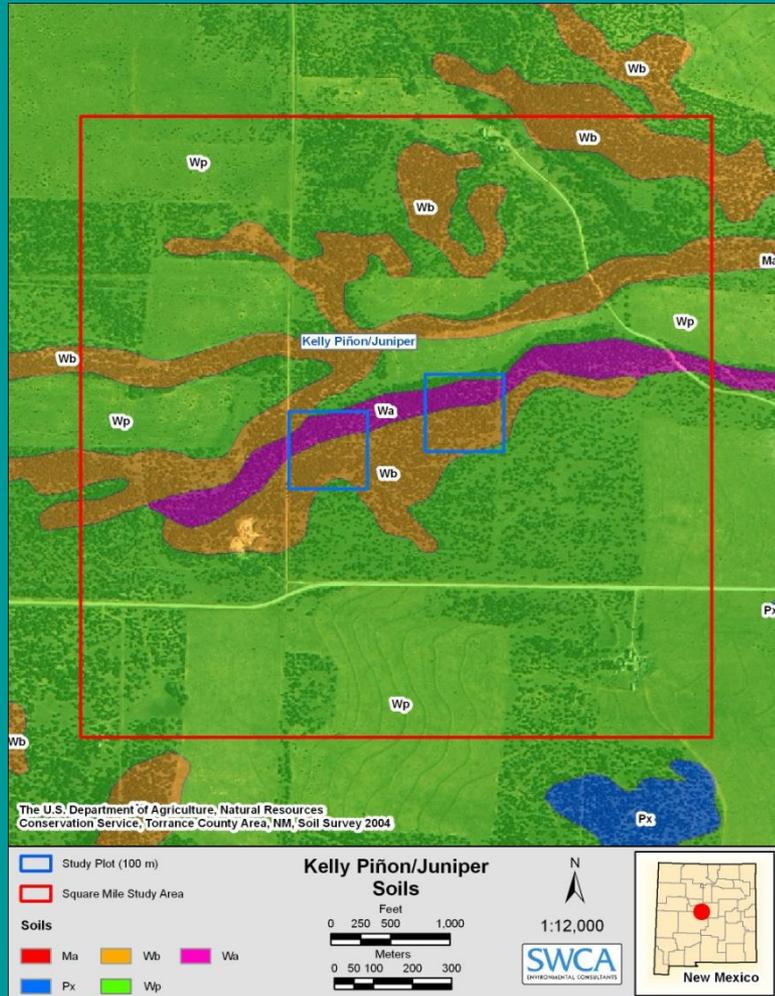


\* actual thinning treatments were randomly assigned to one of each subplot pair, treatments implemented winter/spring 2010

-  Vegetation / soils study subplot
-  Animal study subplot

# Experimental Study Design

## Kelly pinyon/juniper study site



Paired plots, soils, topography



Paired subwatersheds, thinning area

# Monitoring Parameters

## Soils

- moisture
- erosion
- soil minerals and organic matter

## Hydrology

- surface runoff
- ground-water recharge

## Vegetation

- productivity (cover)
- diversity
- fuel loads
- invasive species

## Wildlife

- productivity (relative abundance), diversity (species)



# Monitoring Methods and Protocols

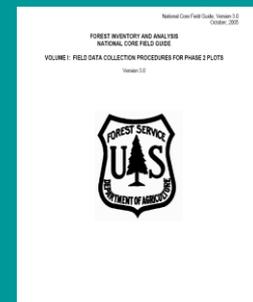
1. USDA-ARS rangeland monitoring protocols and study plot layout (2005); soils, vegetation. **Integrates various soils, hydrology and vegetation measures with monitoring.**



[http://usda-ars.nmsu.edu/JER/Monit\\_Assess/monitoring.php](http://usda-ars.nmsu.edu/JER/Monit_Assess/monitoring.php)

2. USDA Forest Service Inventory and Analysis (version 3, 2003) protocols and plots; **tree density and canopy structure.**

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



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

# Weather

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



Weather data recorded:

- **precipitation**
- **soil moisture (-10 cm)**
- **ambient temperature**
- **soil temperature (-10 cm)**

Spectrum Technologies®

# Soils

All measurements made in May of each year (dry season), moisture and temperature monthly

## Soil moisture and temperature

- TDR probe at 10 cm every month

## Soil chemistry

- soil cores 0-10 cm and analysis (*total N, P, K, S, C*)

## Soil surface stability

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

## Soil surface erosion

- soil erosion bridge (*drop-pin measures*)



# Hydrology

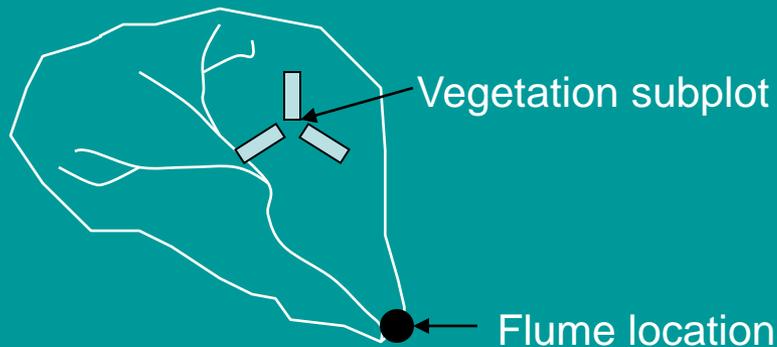
Thinning treatments can affect various aspects of the hydrologic response on the watershed:

- amount of runoff
- seasonal timing of runoff
- rapidity of runoff (flashiness)

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

Water levels in the flumes are automatically measured continuously using a pressure transducer/datalogger:

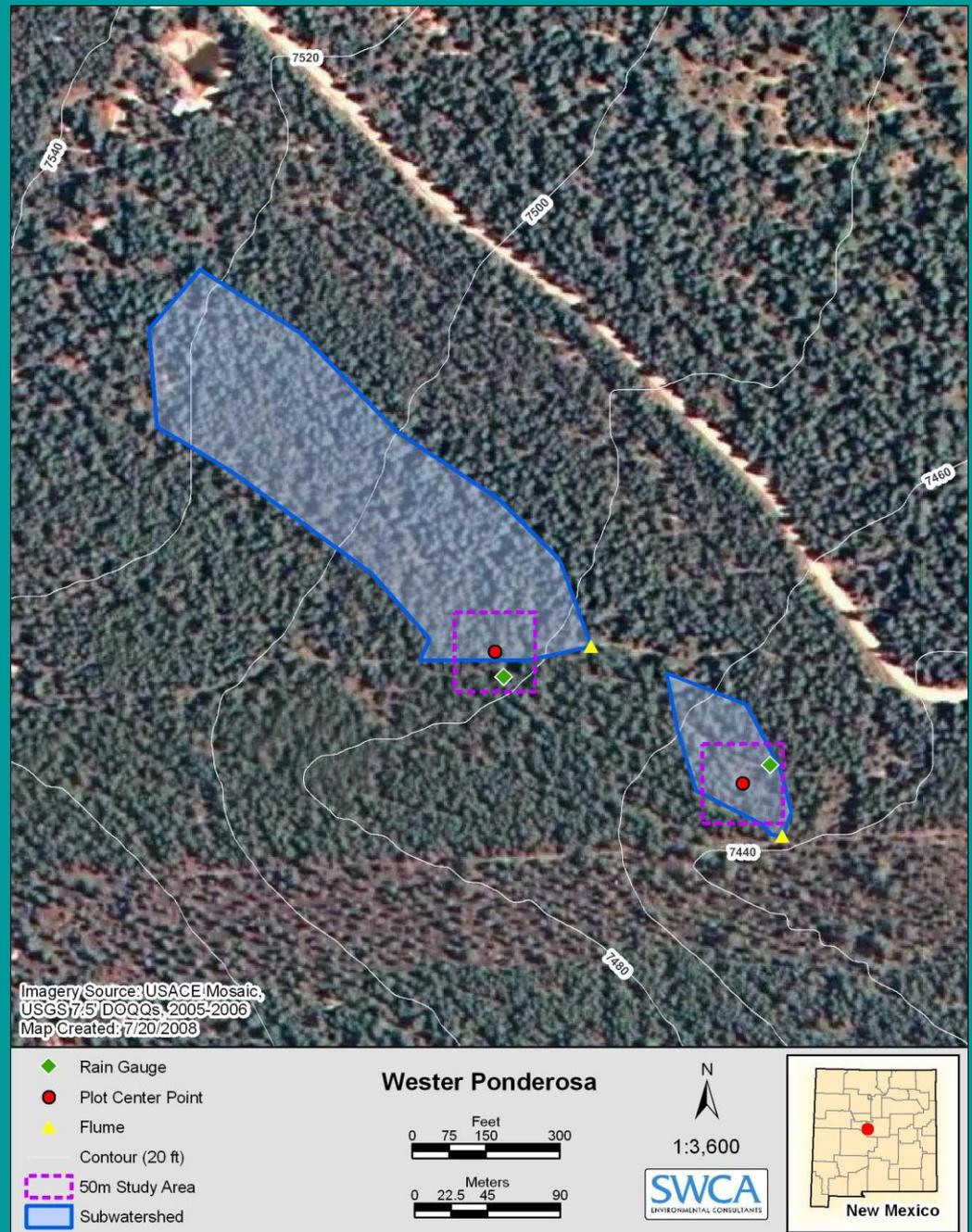
- measurements collected every 5 minutes



# Study Plot Sub-watersheds

## Single storm flow event

Wester 2	9/17/2009
Flow Start*	4:57
Flow Stop**	5:27
Peak Stage	0.149 feet
Peak Flow	0.052 cfs
Flow Duration	30 min
Total Volume of Flow	55.8 ft <sup>3</sup>
Watershed Area	6.76 acres
Volume of Flow per Acre	8.25 ft <sup>3</sup> /acre
Total Rainfall	0.4 inches
Total Volumetric Rainfall	938 ft <sup>3</sup>
<b>Runoff Ratio</b>	<b>0.06</b>



# Vegetation



All measurements made in September of each year.

## 1. Understory:

Species composition (*diversity*)

Foliage canopy cover (*productivity*)

Foliage canopy height (*productivity*)

## 2. Trees

Species composition (*diversity*)

Tree canopy structure (*productivity*)

Tree growth (*productivity*)

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

# Repeat Photo Points

Qualitative change over time

2008



2009



# Herbaceous Vegetation Measurements



# Vertical Foliage Canopy Structure



# Tree Measurements



# Wildlife

Measurements made in May and September each year



## Birds

- 20 minute dawn point counts centered on each animal study plot 3 consecutive mornings.
- 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 (Sherman live-traps, 36 per plot)
- 3 consecutive nights.
- species composition, relative abundance. (*diversity, productivity, temporal stability*)
- pre- and post-breeding season each year.

# Trigo Fire Post-fire Recovery Monitoring

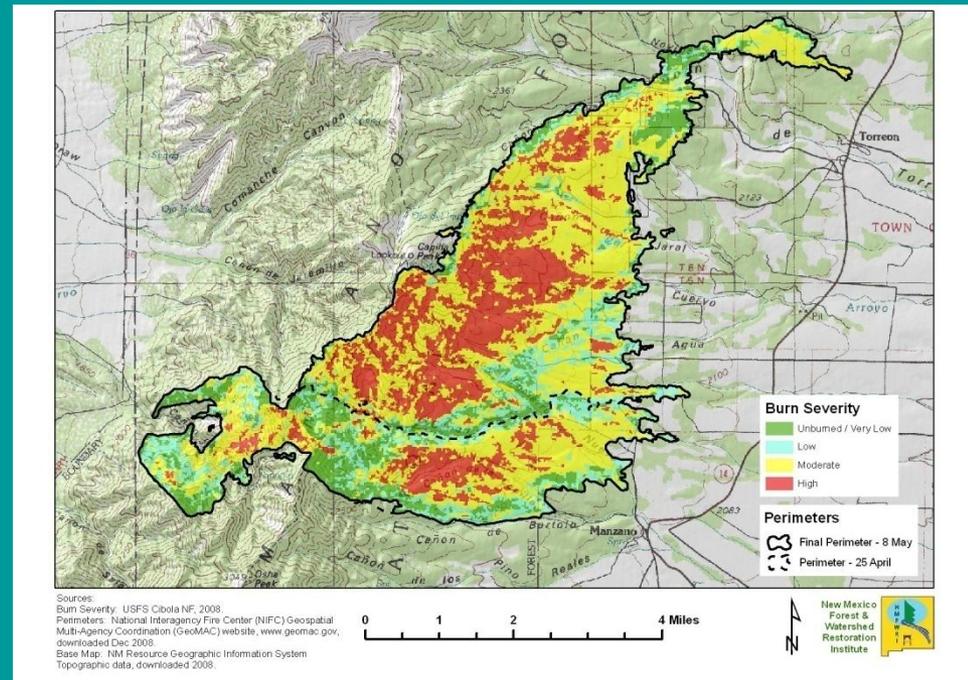
- Trigo Fire occurred in our study area after thinning monitoring commenced.
- Additional funding procured to monitoring recovery.
- Opportunity to examine relationship between tree density and fire severity.

## Trigo Fire, May 2008



photo by D. Tarr,  
Claunch-Pinto Soil & Water Conservation District

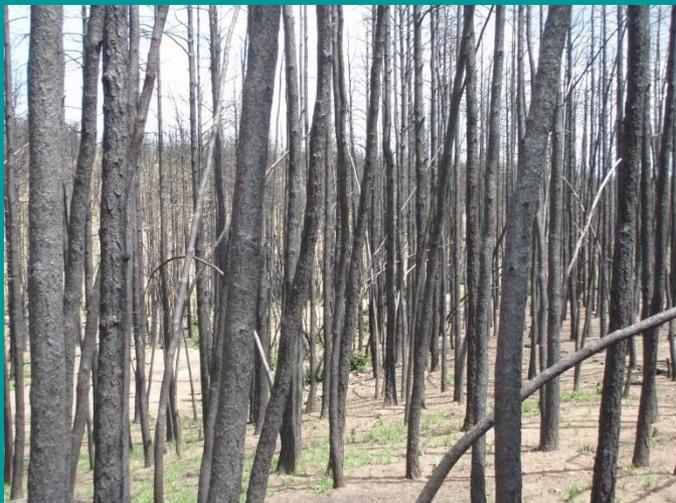
## Post-Trigo Fire Map, BAER assessments



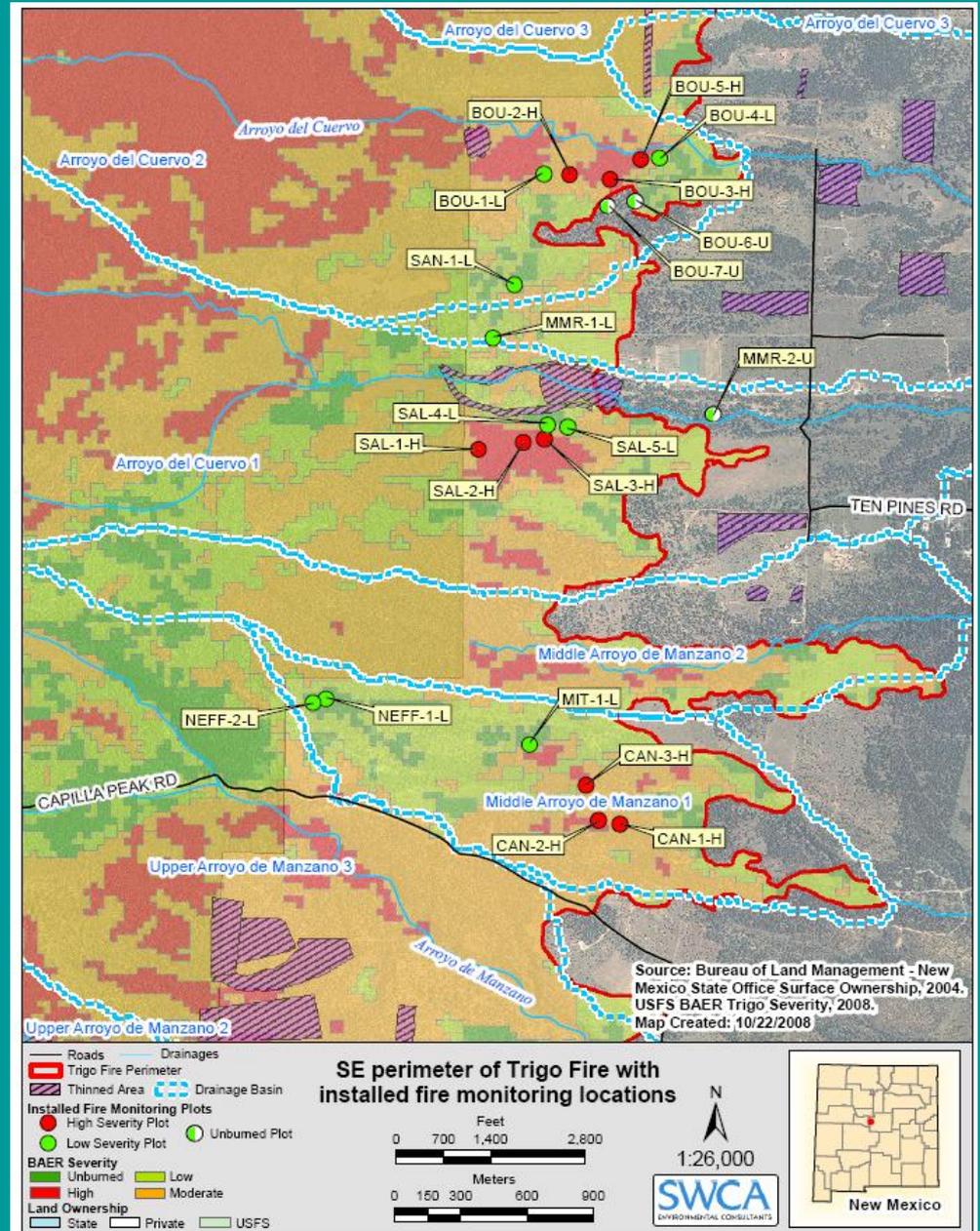
# Trigo Fire Post-burn Monitoring Sites



Low severity burn



High severity burn



# Post-fire Monitoring of Soils, Vegetation, Wildlife



Mini-weather stations



Vegetation transects & quadrats



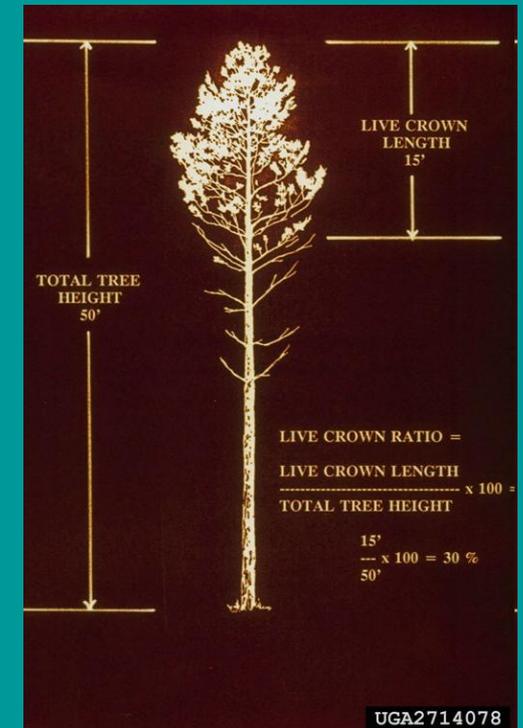
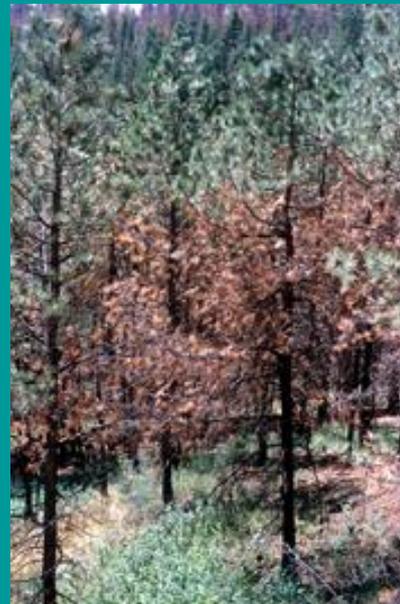
Soil erosion bridges



Automatic infrared wildlife cameras

# Post Fire Monitoring of Trees

- Species
- Live/Dead
- DBH
- Height
- Crown Ratio
- Crown Position
- % Crown Consumed
- % Crown scorched
- % Bole Char
- Height to Live Crown



May 2008

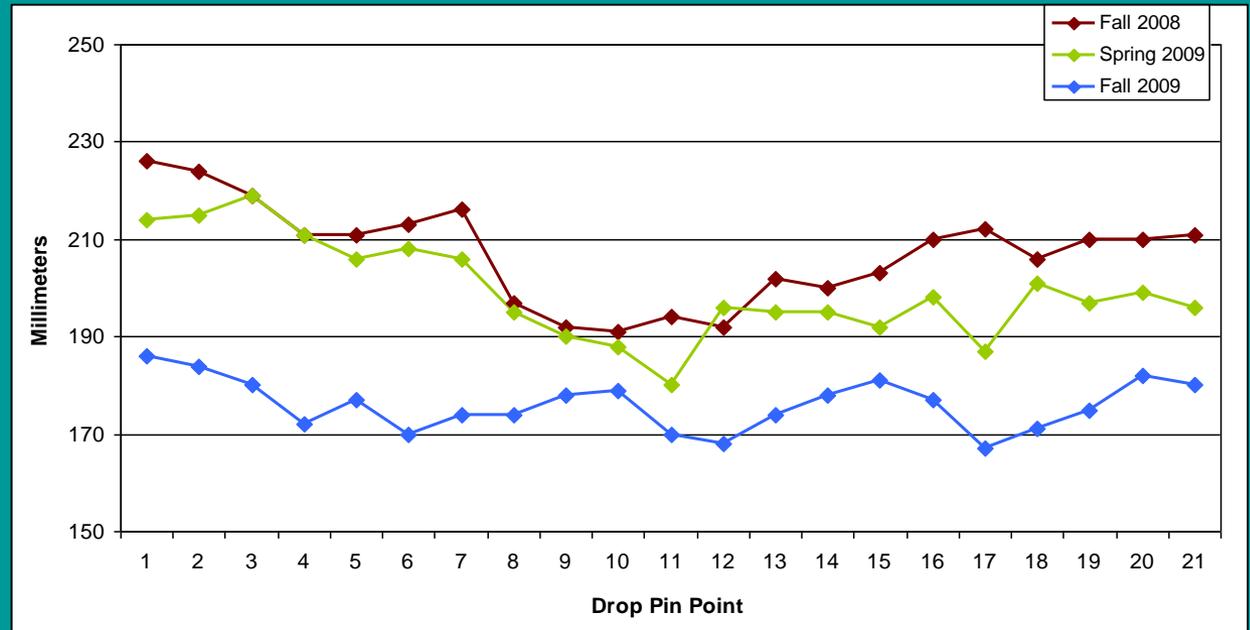


Sept 2009



# Soil Erosion

Example of one bridge repeat measurements



Initial duff & soil surface losses ~ 10 cm in high severity burn areas 2008



Herbaceous vegetation arresting soil loss in late summer 2009



# Wildlife Use of Different Burn Severity Study Plots

- Automated infrared wildlife cameras

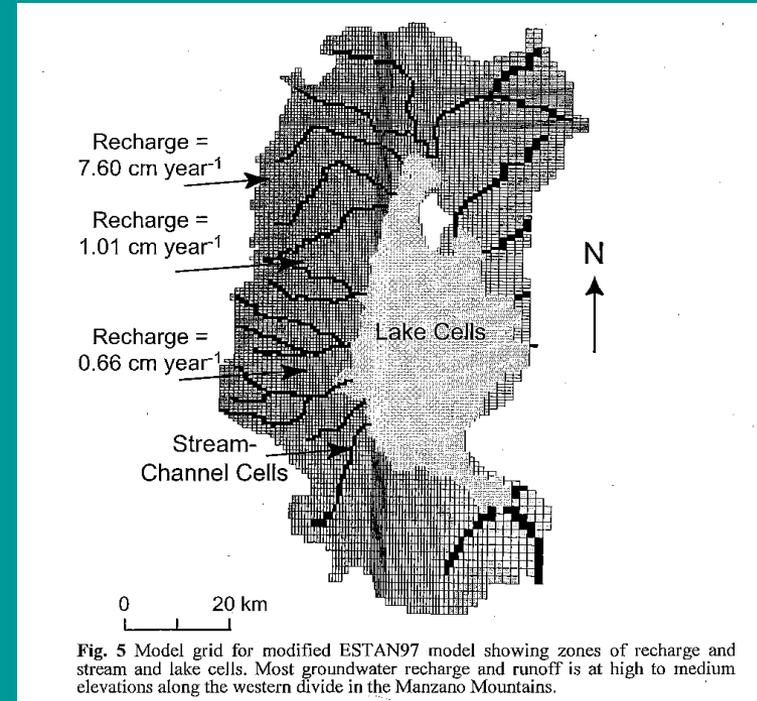
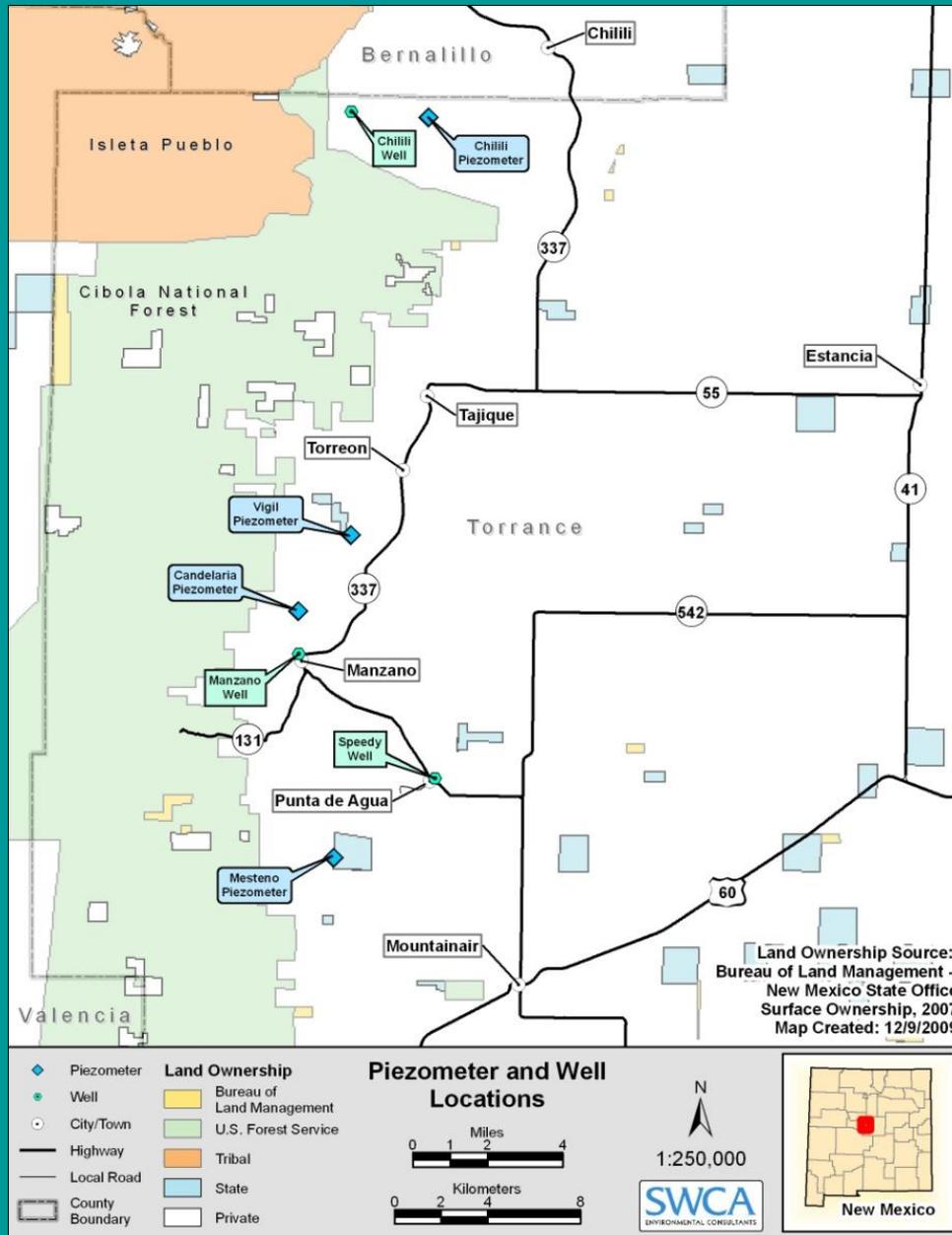
## Mule deer



Watershed	Plot	Dates of Monitoring Period	Species Detected	Frequency/Day
Cuervo 2	Bouton high severity	3/5/09–5/27/09	Mule deer	0.302
	Sanchez low severity	3/5/09–5/27/09	Mule deer	0.095
	Bouton unburned	3/5/09–5/27/09	Mule deer	0.127
Cuervo 1	Salazar high severity	5/27/09–9/25/09	None	0.00
	Salazar low severity	5/27/09–9/25/09	Mule deer	0.314
	Manzano Mountain	5/27/09–9/25/09	Mule deer	0.043
	Retreat unburned		Turkey	0.022
			Bobcat	0.011



# Ephemeral Stream and Ground Water Well Monitoring



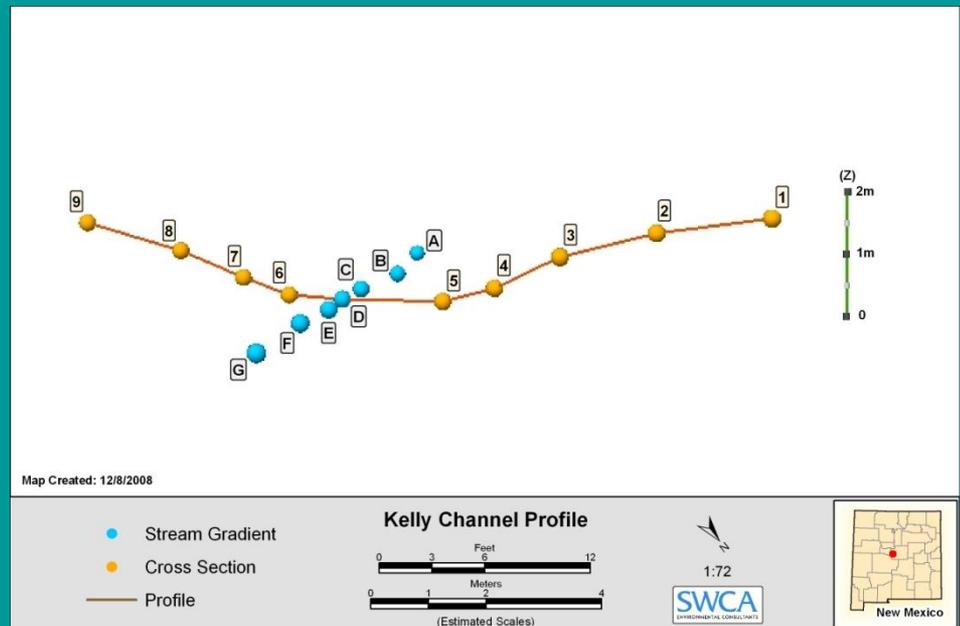
from Menking et al. 2010

# Piezometers

- Pressure sensor water level automatic data loggers

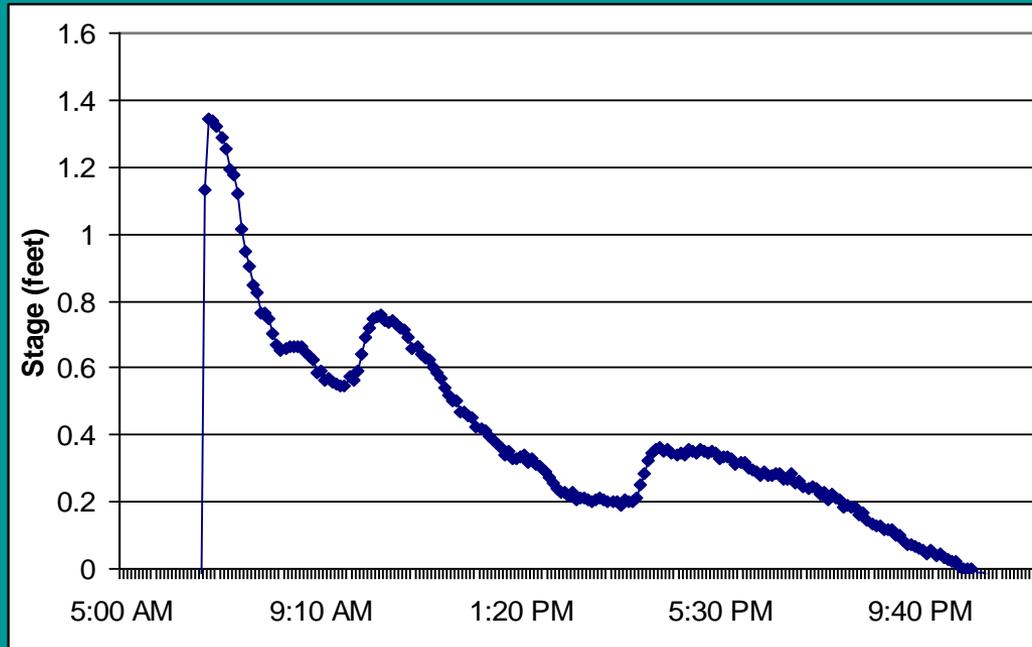


Stream profiles at piezometer locations to calculate flow volumes and rates based on stage level data over time.



# Stream Monitoring

Example of stream stage over time following a storm

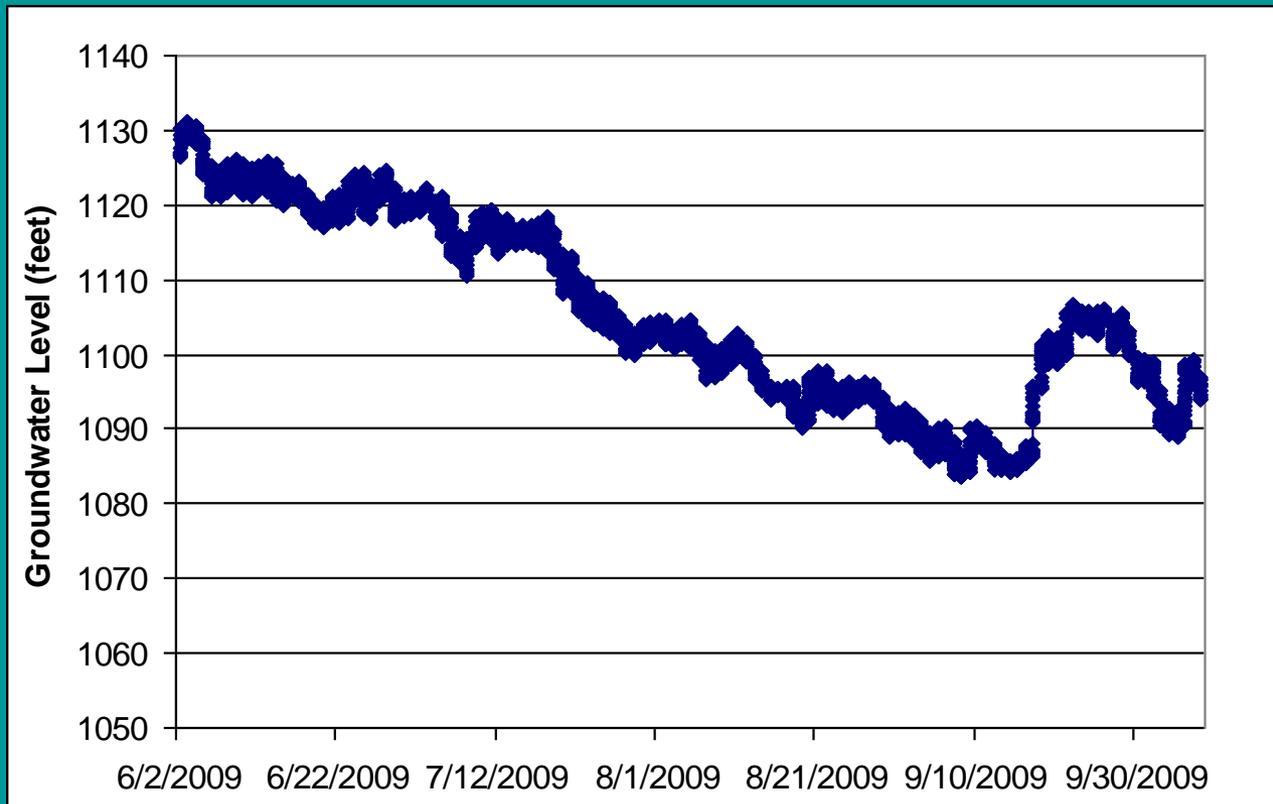


Example of runoff information determined by piezometer and stream profile data

Location	Date	Duration (hrs)	Peak Stage Height (ft)	Peak Flow (cfs)	Total Volume (acre-feet)
Vigil	10/5/08	24	1.44	30.03	40.39
Kelly	10/5/08	24	0.00	0.00	0.00

# Ground Water Well Monitoring

Example of ground water well data showing spike following a large storm event (Chilili)



# Conclusions

- Experimental forest thinning monitoring – treatments in fall 2010, post-treatment monitoring at least through 2013.
- Trigo Fire findings: fire severity, tree mortality, and soil loss less in low density and thinned ponderosa stands.



Thinned ponderosa stand post-Trigo



Adjacent non-thinned stand post-Trigo

All of our information and findings are posted on the New Mexico Forest and Watershed Restoration Institute web site:  
<http://www.nmfwri.org/estancia-basin-monitoring>

# Acknowledgements

We thank the New Mexico Water Trust Board for providing the majority of funding for this project. The Estancia Basin Water Planning Committee for supplemental funding to establish a new Chilili ponderosa site following the Trigo Fire. Dierdre Tarr of the Claunch-Pinto Soil and Water Conservation District (SWCD) has been critical to the implementation and success of this project, along with the help of Brenda Smythe and Cheri Lujan from the Edgewood and East Torrance SWCDs, Kent Reid and Joe Zebrowski from the New Mexico Forest and Watershed Restoration Institute, Lawrence Crane from New Mexico State Forestry, and Mike Matush from the New Mexico Environment Department. Vernon Kohler and Kelly Smith from the Claunch-Pinto and Edgewood SWCDs have helped considerably with field data collections. Thanks to SWCA staff Chris Garrett, Mike Pease, Anne Russell, Terri Thompson, Ryan Trollinger, and Duncan Wadsworth for field data collection and analytical assistance. Joseph Fluder is the SWCA manager for this project.

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