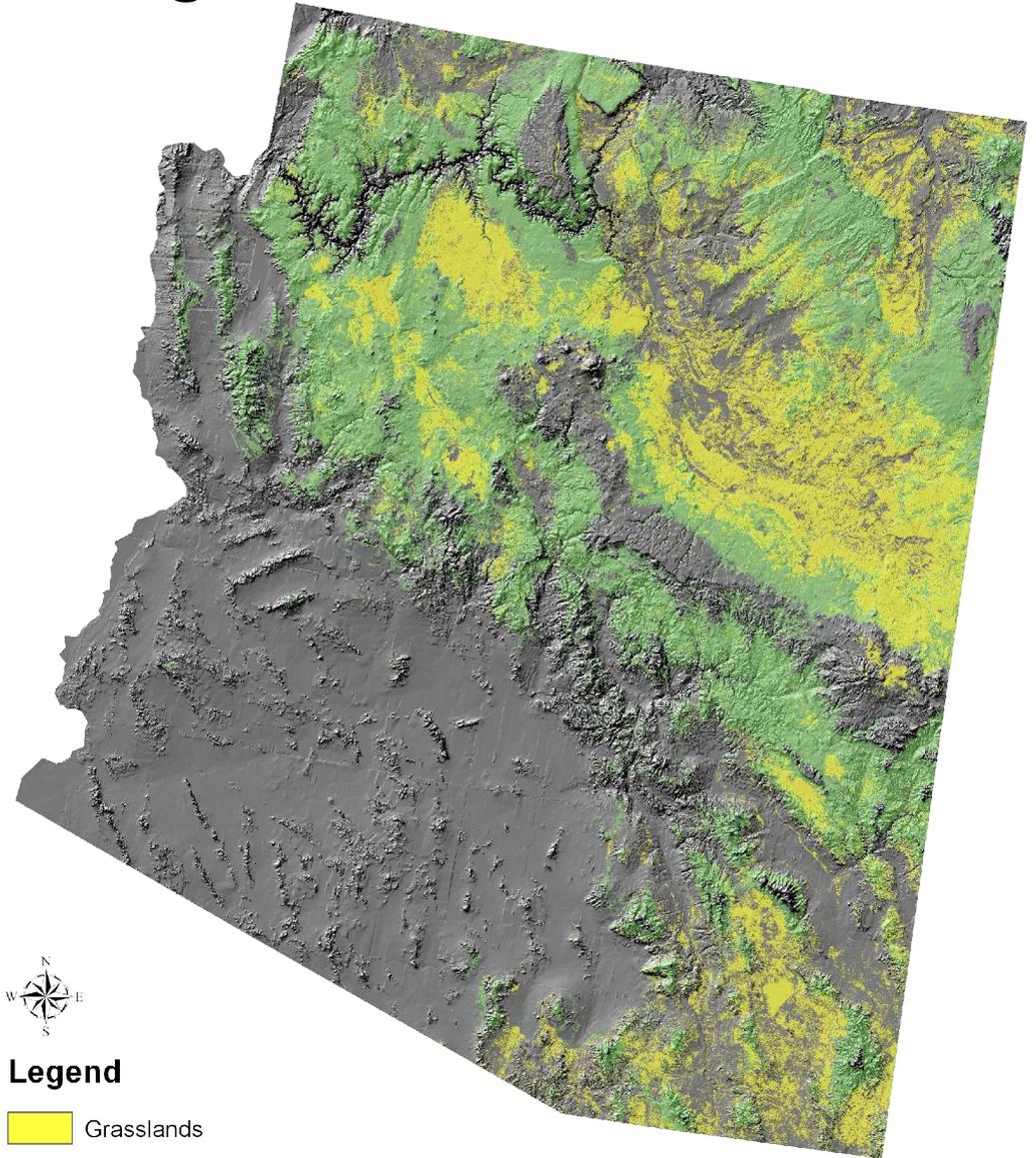


The Greater Grand Canyon-Peaks Ecosystem & the Arizona Ecological Transect

by
Neil Cobb
Kirsten Ironside
Amy Whipple

Northern Arizona University



Legend

-  Grasslands
-  Pinyon-Juniper Woodlands



0 25 50 100 150 200 Kilometers

The Greater Grand Canyon-Peaks Ecosystem & the Arizona Ecological Transect

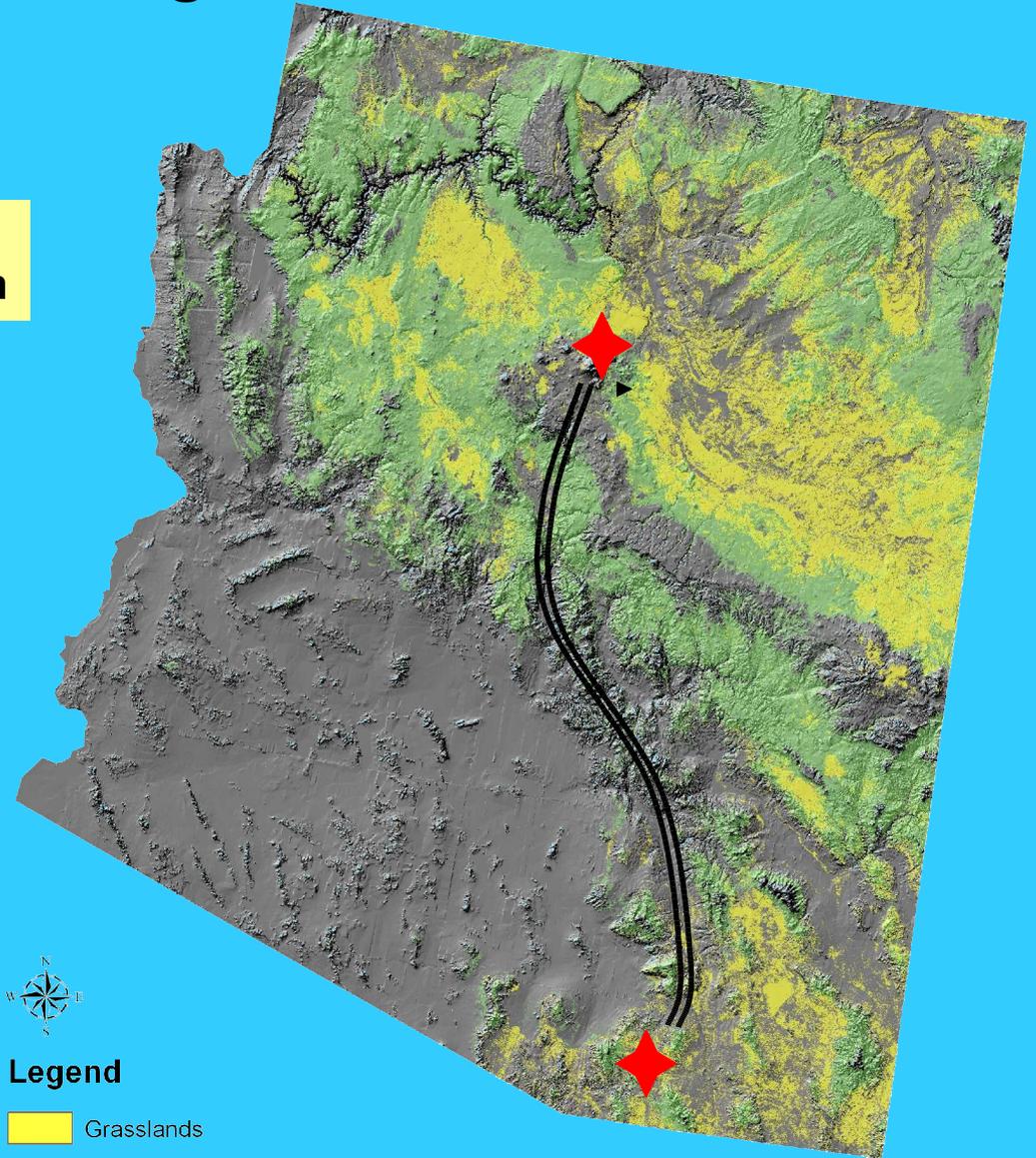
Building Bridges

**The Arizona Ecological Transect:
Greater Grand Canyon-Peaks Ecosystem**

Climate Change Research

Regional Networks

Drought – Pinyon – Global Warming

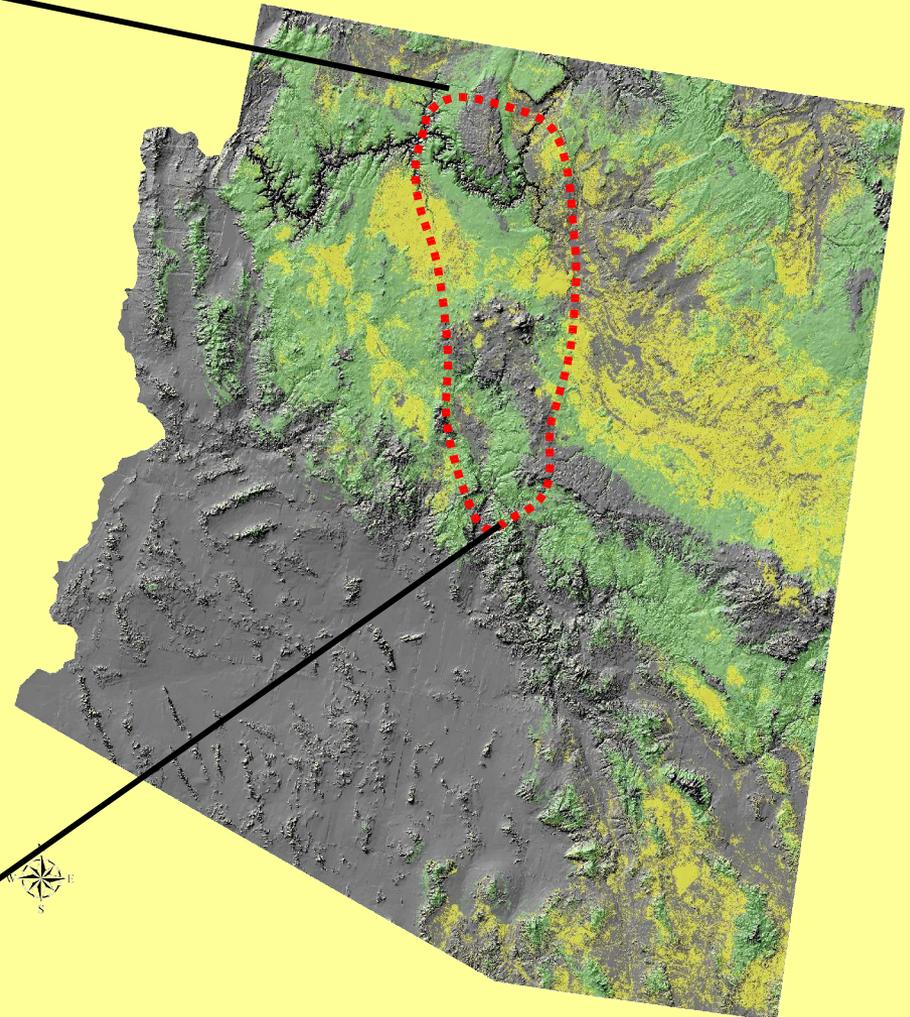
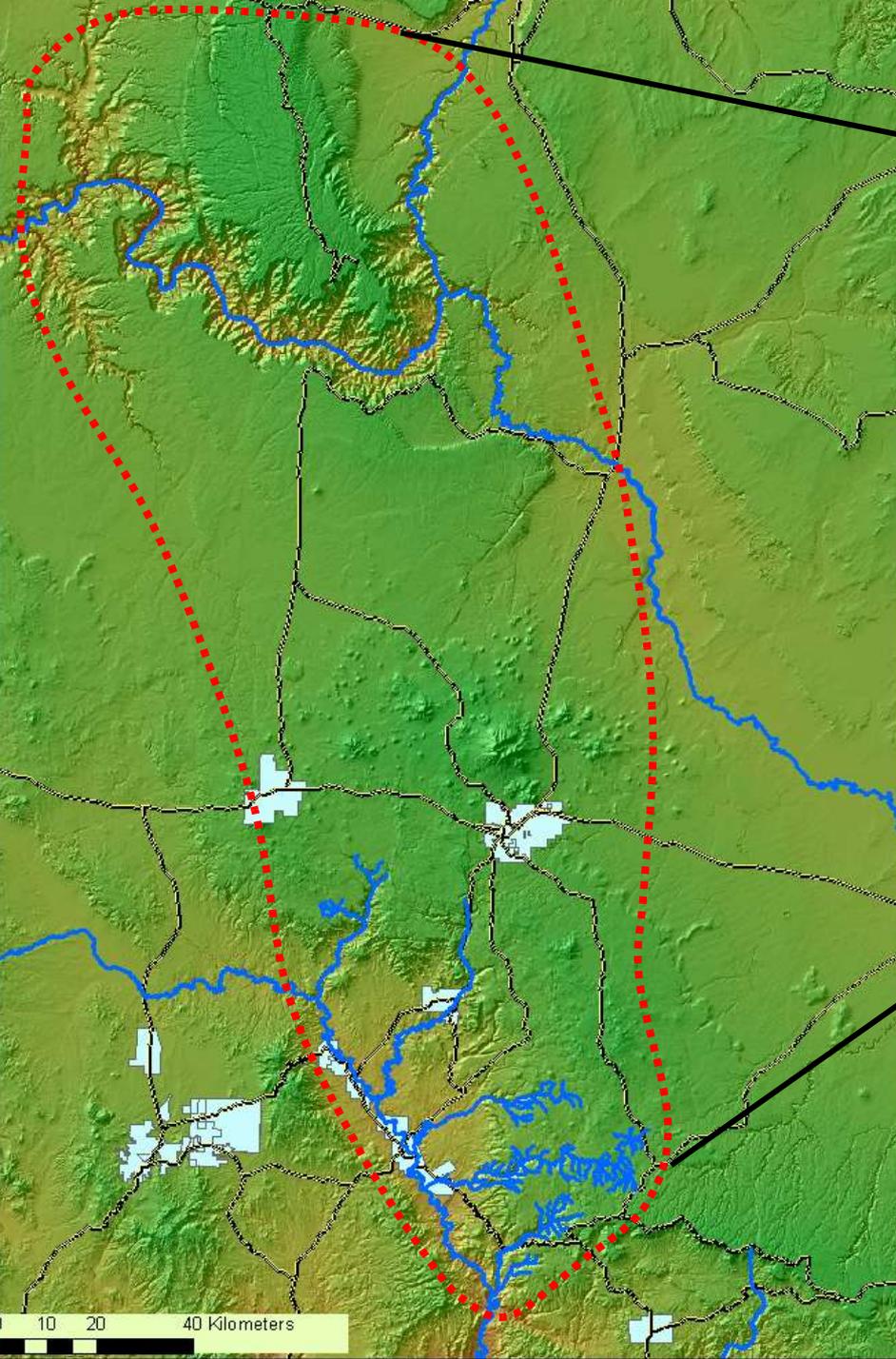


Legend

-  Grasslands
-  Pinyon-Juniper Woodlands

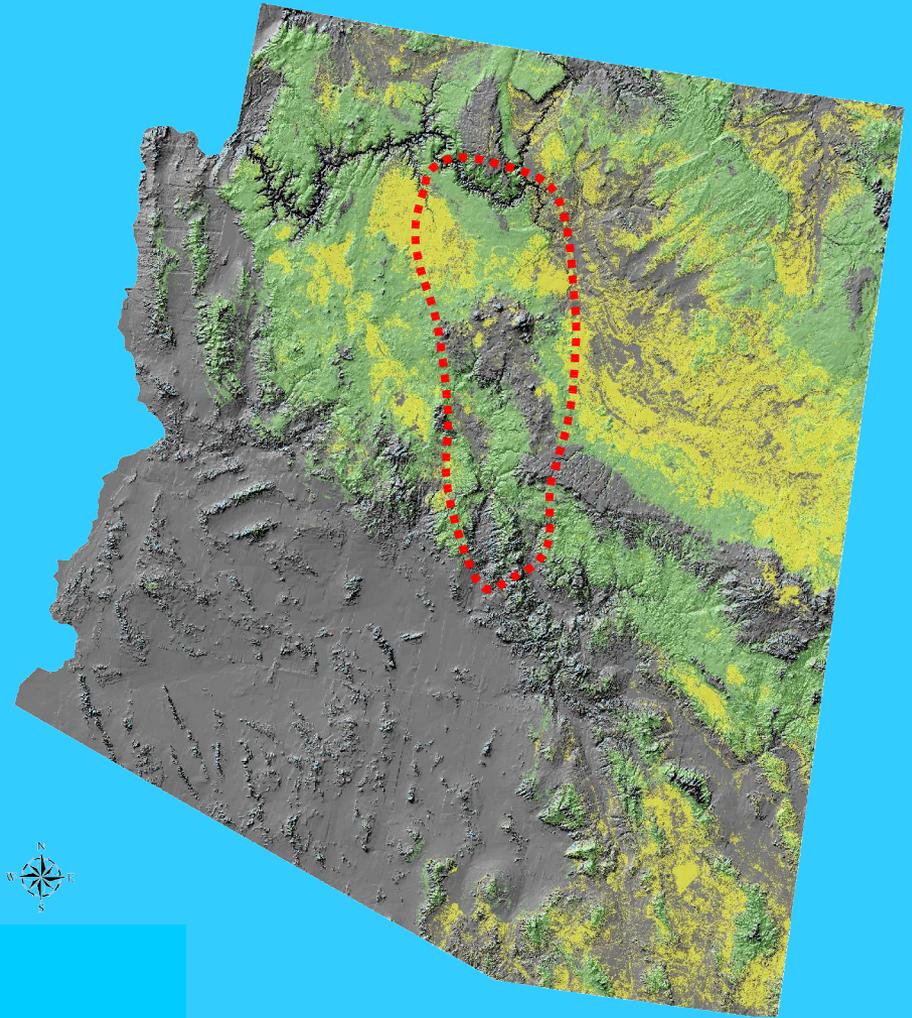
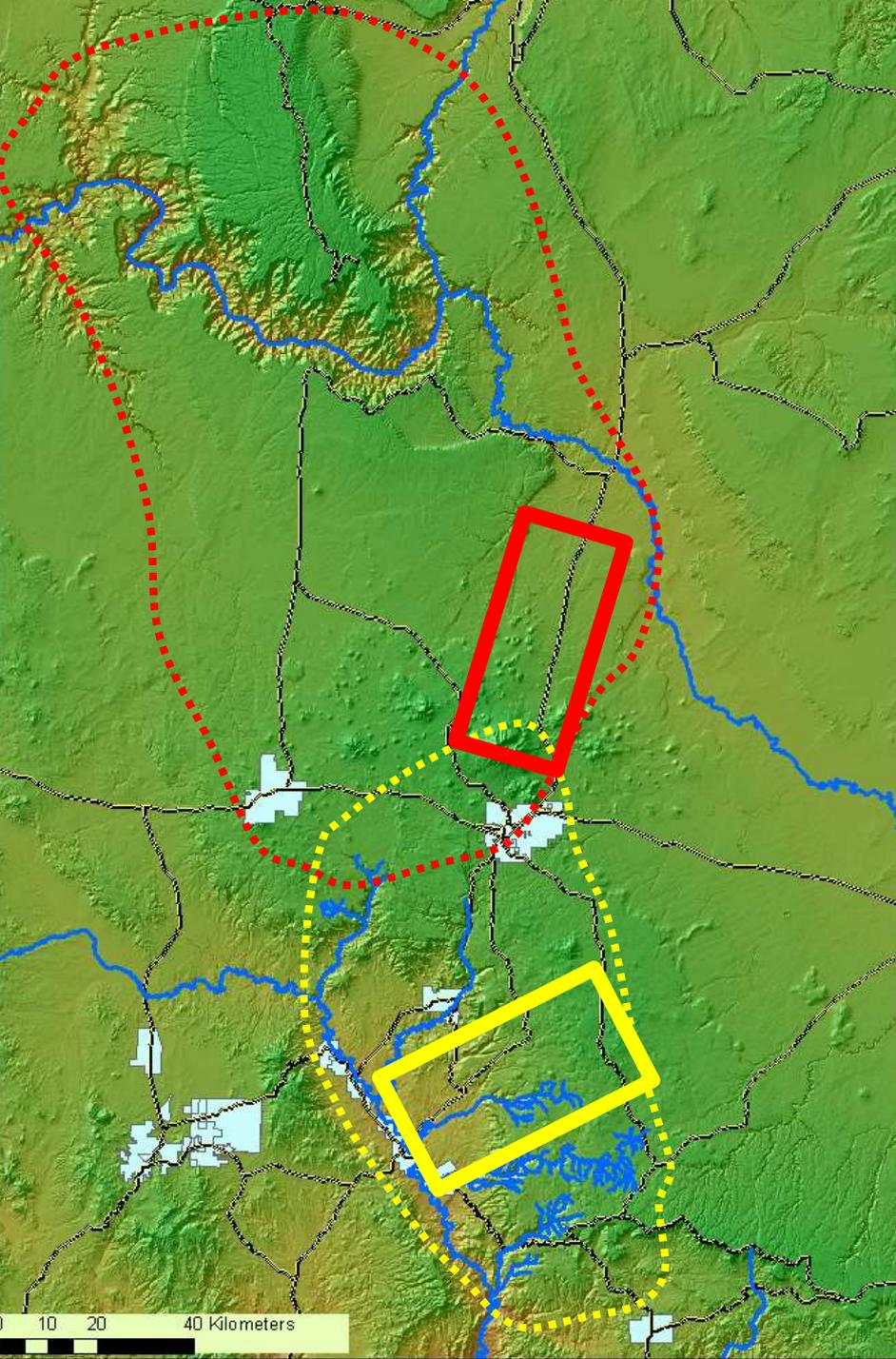


Greater Grand Canyon-Peaks Ecosystem



-  Greater Grand Canyon-Peaks Ecosystem
-  Streams
-  Highways
-  Cities

Greater Grand Canyon-Peaks Ecosystem



-  Northern Greater Grand Canyon-Peaks Ecosystem
-  C Hart Merriam Elevation Gradient
-  Southern Greater Grand Canyon-Peaks Ecosystem
-  Beaver Creek Experimental Watershed

Northern Arizona Environmental Gradients

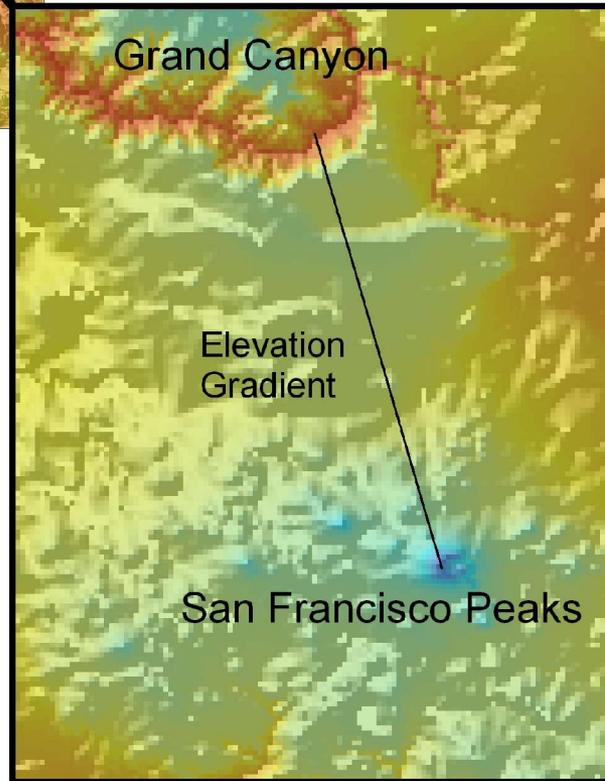
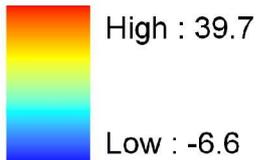


Arizona Climatic Gradients for Monsoon Temperature

Arizona

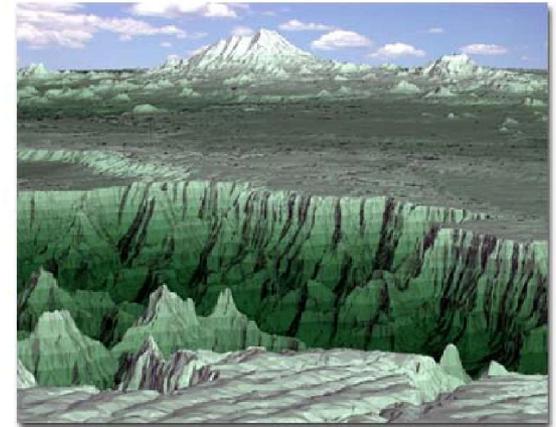


Legend
Average Maximum Temperature
Degrees Celcius

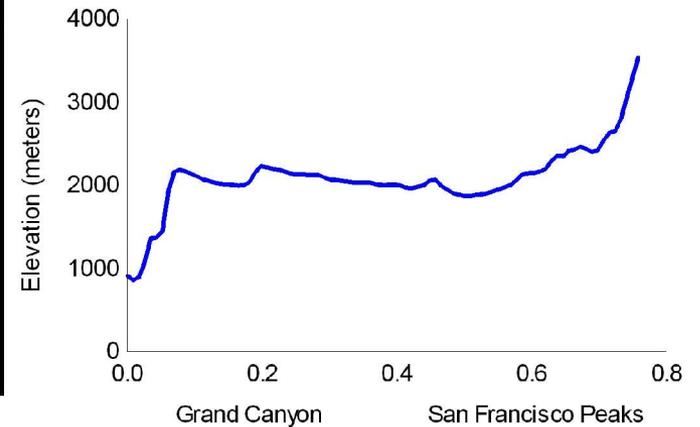


0 5 10 20 30 40 Kilometers

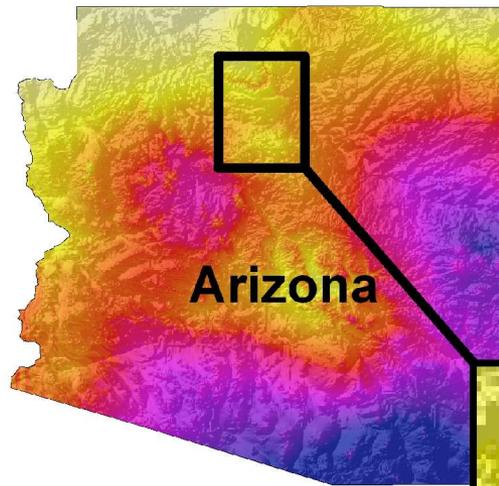
Northern Arizona Elevation Gradient



Elevation Gradient from the Grand Canyon to the San Francisco Peaks

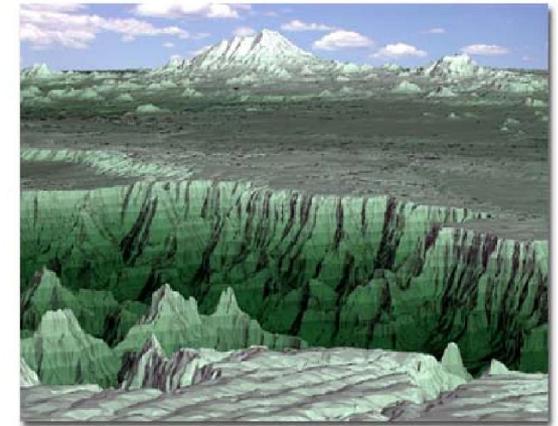


Northern Arizona Environmental Gradients



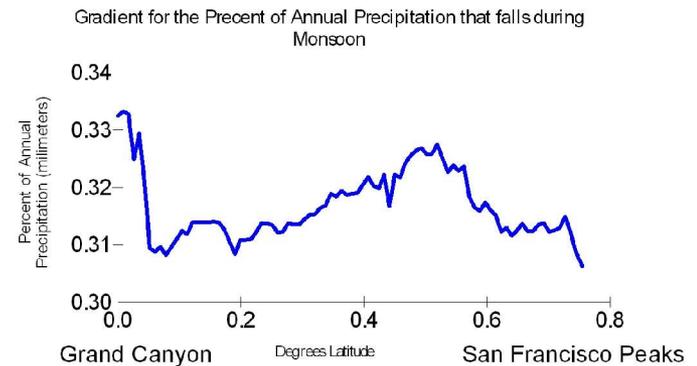
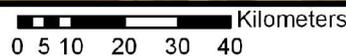
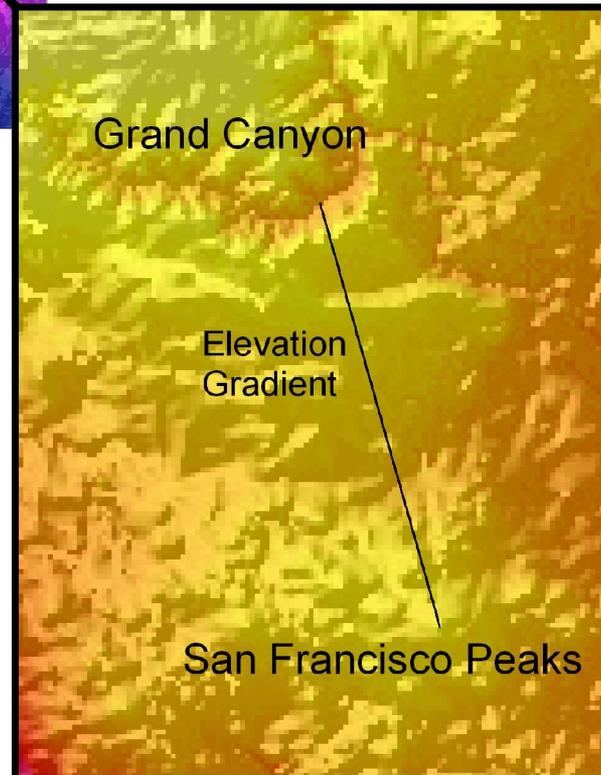
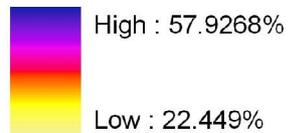
**Percent of Annual
Precipitation that
falls during the
Monsoon Season
(July, August, &
September)**

**Northern Arizona
Elevational Gradient**



Legend

**Percent Average
Maximum Precipitation
millimeters**

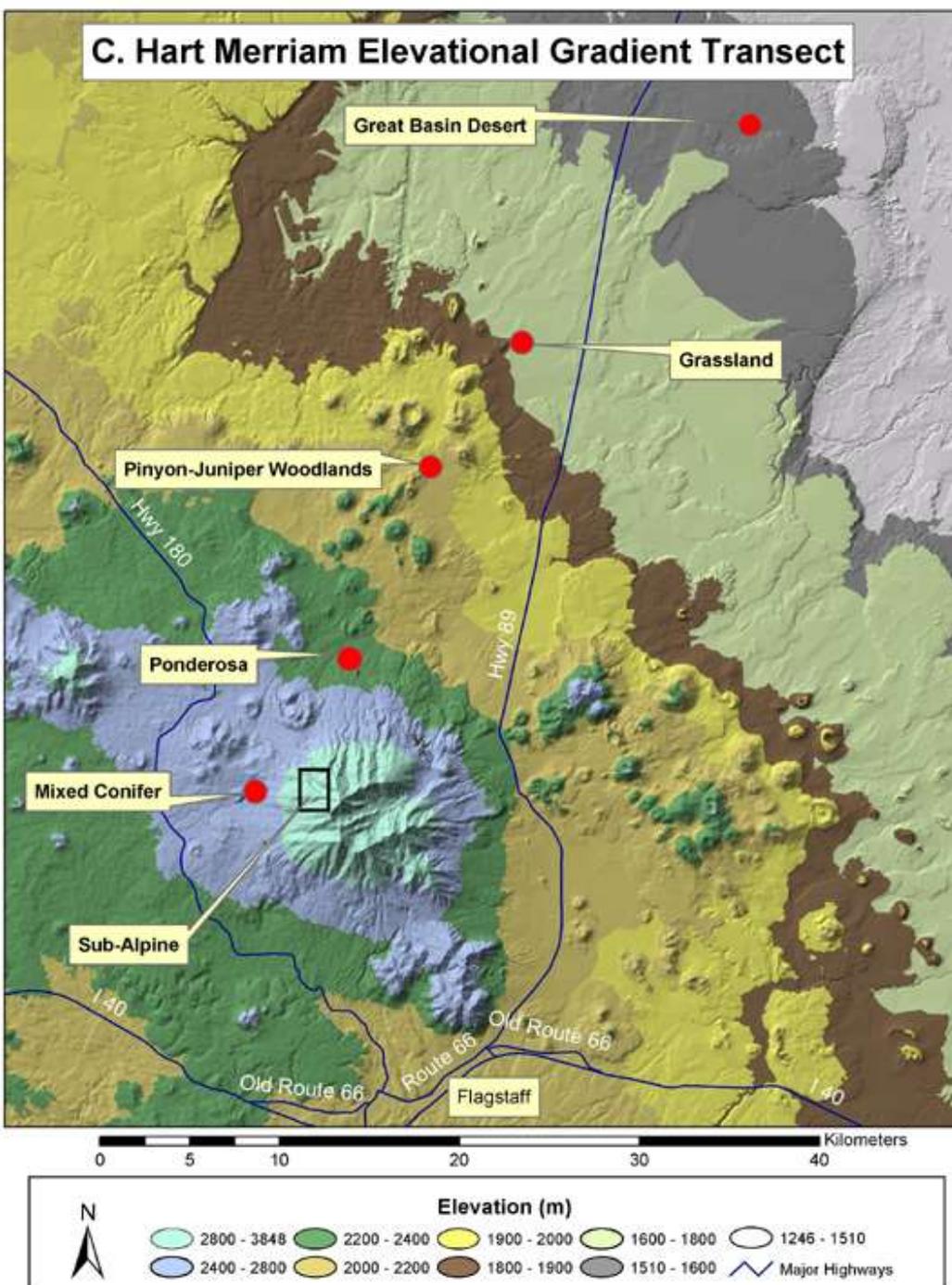


C Hart Merriam Gradient

Environmental Gradients as Barometers of Global Change

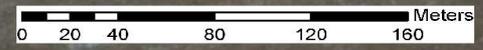
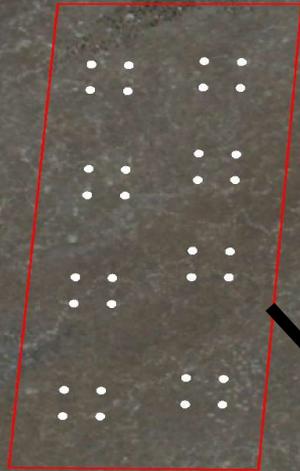
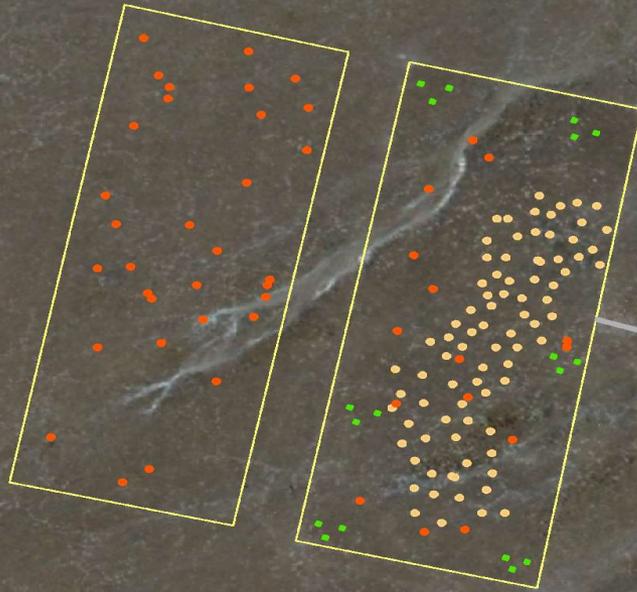
Major Gradients

1. Temperature
2. Precipitation
3. Urban-Wildlands & Land Use
4. Soil Chronosequence (5 mya)



Gradient Research and Education Projects

- Rainout/Rainon Shelters
- Arthropod Pitfall Traps
- Pinyon Transplants
- Transect Corners
- Nitrogen Fertilization Plots



Climate Change Research: Ecosystem Perspective

Ecosystem Ecology

Bruce Hungate Steve Hart

Plant Physiological Ecology

George Koch Tom Kolb

Microbial Ecology

Egbert Schwartz Maribeth Watwood

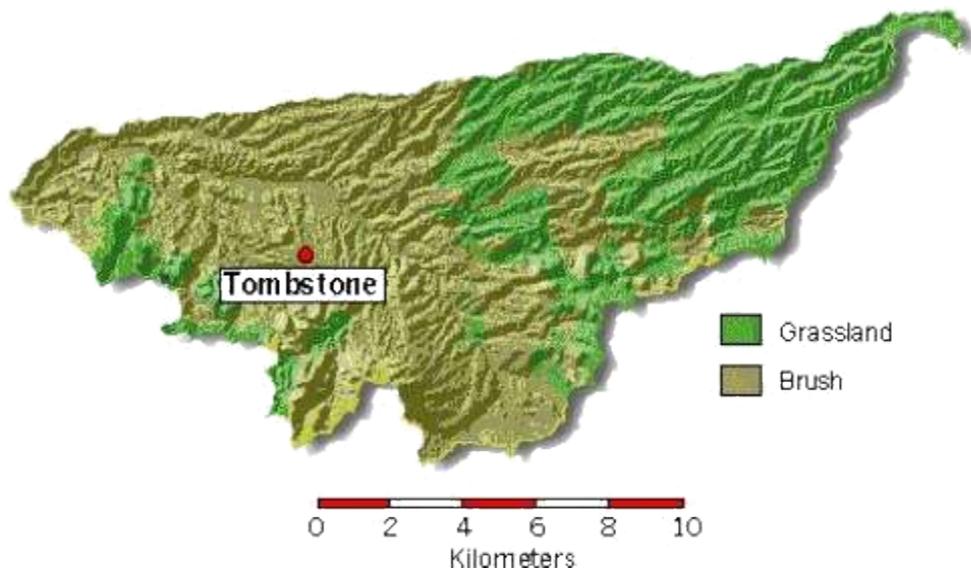
Mycorrhizal Ecology & Ecological Genetics

Nancy Johnson Kitty Gehring



Wireless Sensor Networks

Paul Flikkema



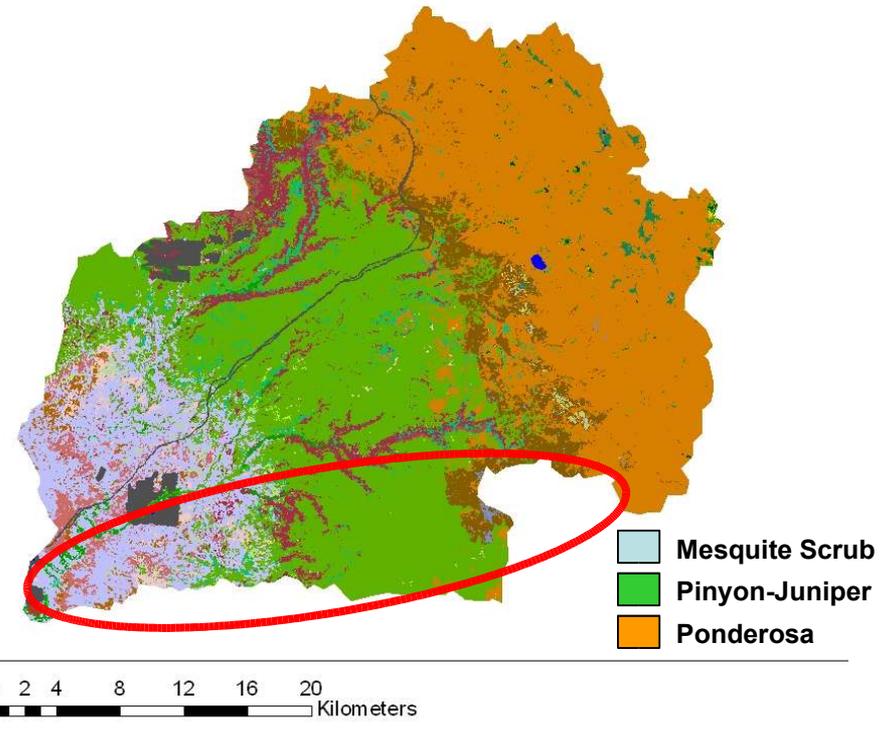
Walnut Gulch Experimental Watershed

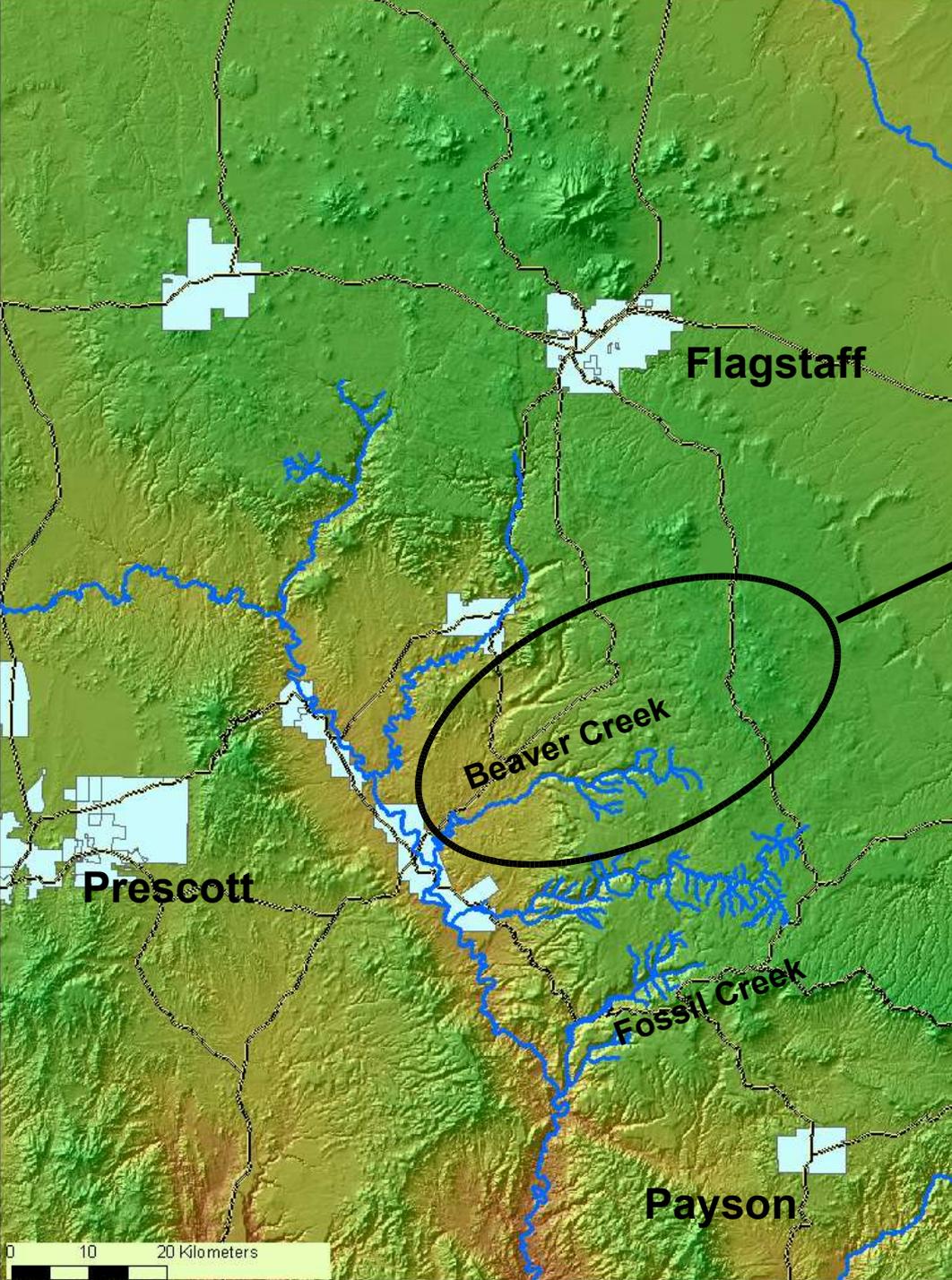
Beaver Creek Experimental Watershed

USFS Rocky Mountain Research Station & UofA research activities dating back to the 1950's.

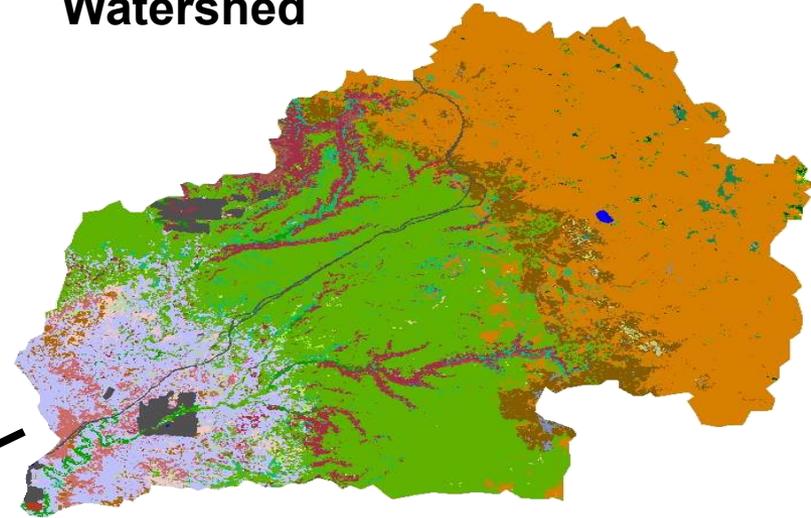
The United Nations "Man and the Biosphere" Preserve

The V-V ranch





Beaver Creek Experimental Watershed



- Mesquite Scrub
- Pinyon-Juniper
- Ponderosa

“Sinagua Circle”

Conserving Water through the
Ages

USFS-University Collaboration

Arizona Field Station Network

A Framework
For building
The transect

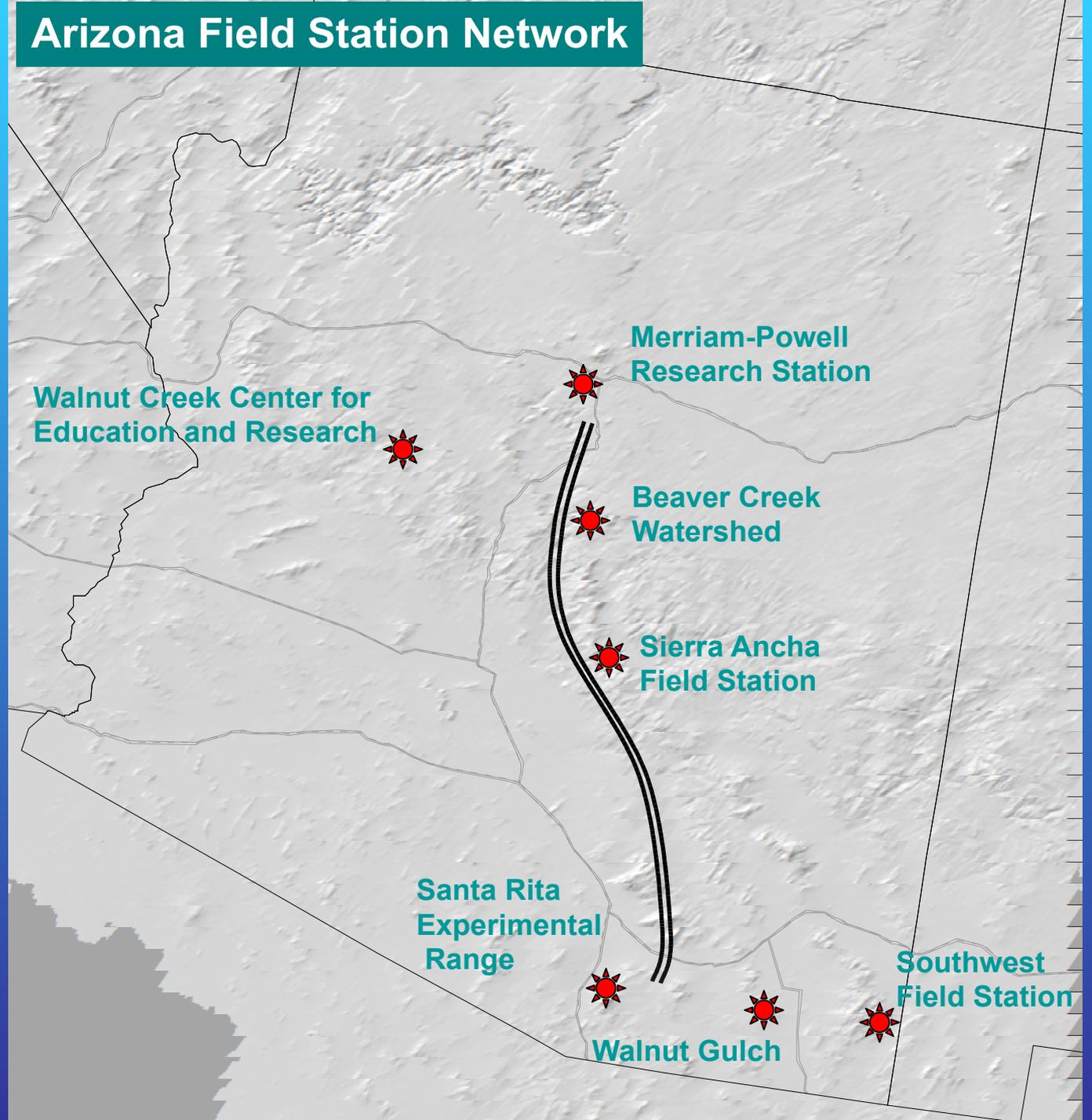
 Precipitation Exps

 Temperature Exps

 Flux Towers

 Phenology Networks

 Legacy Networks



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[STANDARD ACCESS TO DATA](#)

[Register for Updates](#)

Background Information

- [The Data Access Project](#)
- [Field Sites](#)
- [Instrumentation](#)

Notices:

Last update 8/1/2005



Data Information

- [Dataset Descriptions](#)
- [Data Use Agreement](#)
- [Privacy Notice](#)

Data Access Project

Northern Arizona Research Database

NERD

Northern Arizona Environmental Research Database

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- [Permit FAQ](#)
- [Permit Form](#)
- [NERD](#)
- [Contact Info](#)
- [Related Links](#)

Using MS Access

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[Searching GIS Layers](#) | [ArcMap Tabular Data](#) | [ArcCatalog Tabular Data](#) | [MSAccess](#) | [Metadata](#)

Note: use this link to refer to metadata elements

NAU Environmental Research Database

- Project Information
- Contacts
- Search by Principal Investigator
- Search by Township and Range
- Exit



DOE National Institute for Climatic Change Research (NICCR)

Northern Arizona University – Duke University
Michigan Technological University – Pennsylvania State University



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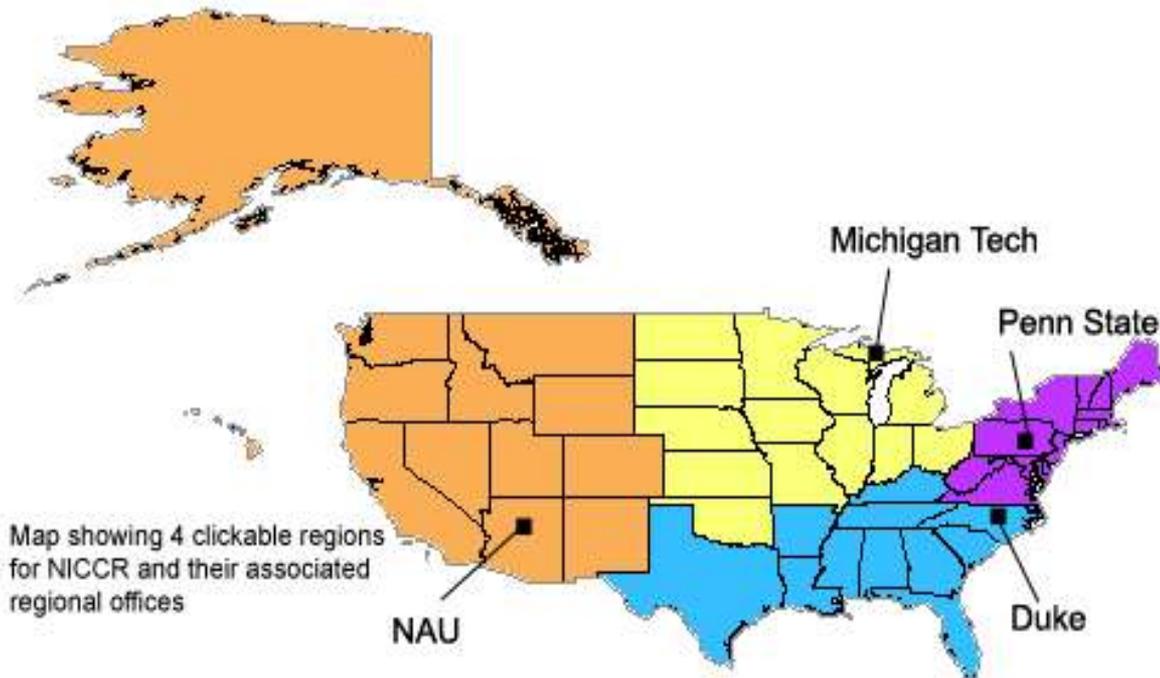
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Overview::



LEGEND

	Western Regional Center		Southeastern Regional Center
	Midwestern Regional Center		Northeastern Regional Center



Drought Impacts on Regional Ecosystems Network

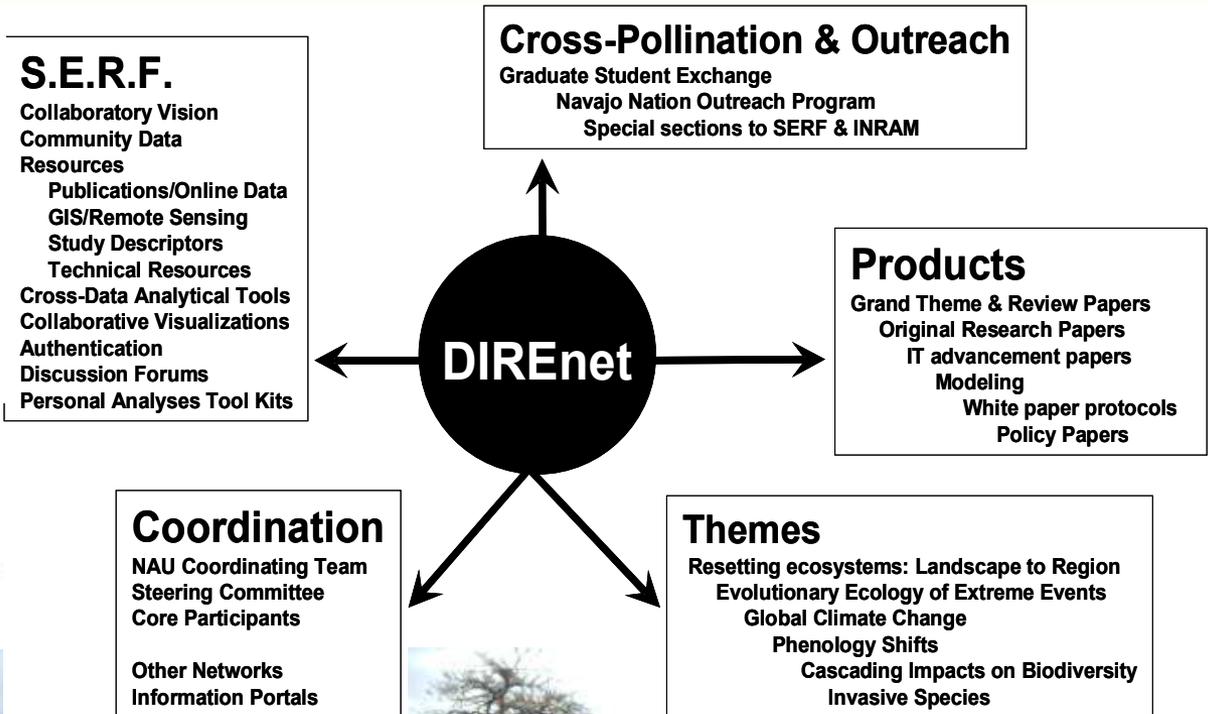


Coordinating Drought Studies on Southwest Ecosystems

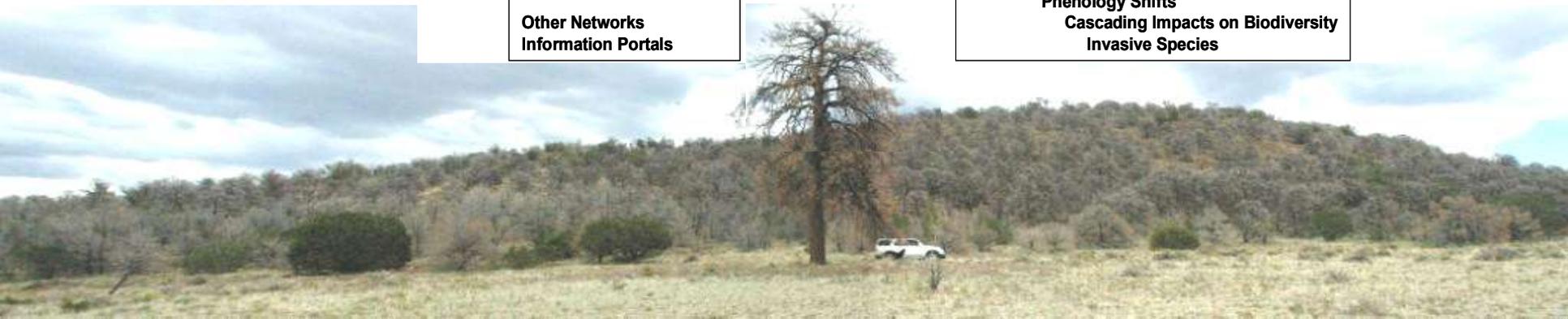
INSIDE DIREnet

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- [Research Sites](#)
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- [Education](#)
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Overview::



- HTML
- Microsoft Word
- PDF



Drought as an **Additional** Control on PJ Woodlands

Paradigm

**Grazing & Fire Suppression
Promote Woodlands**

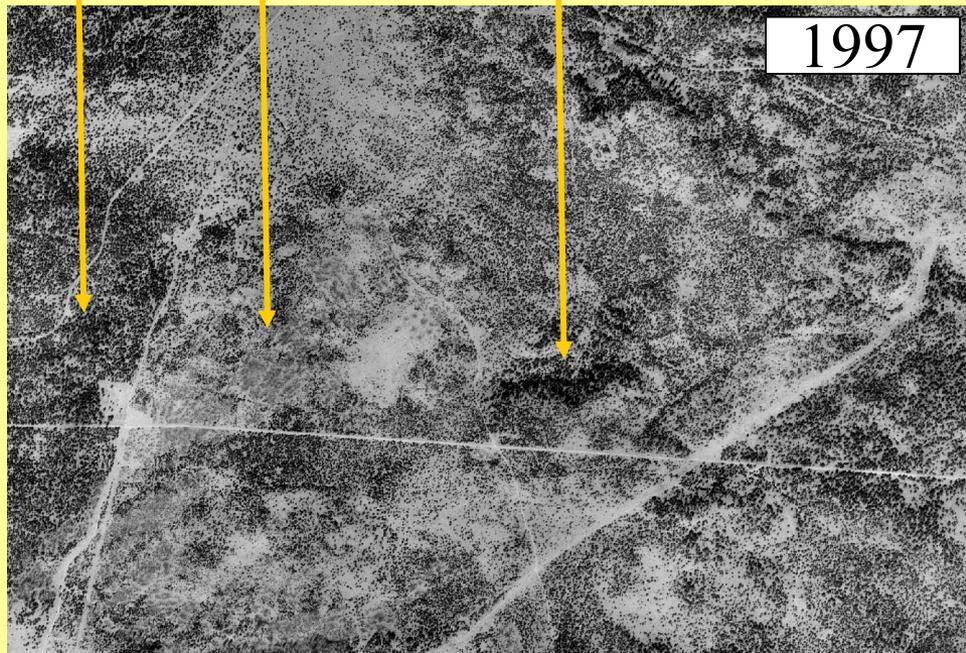
Modified Paradigm

**Droughts Can Reset
Successional Clock of Woodlands**





1936



1997

Infilling of Pinyon-Juniper Woodlands

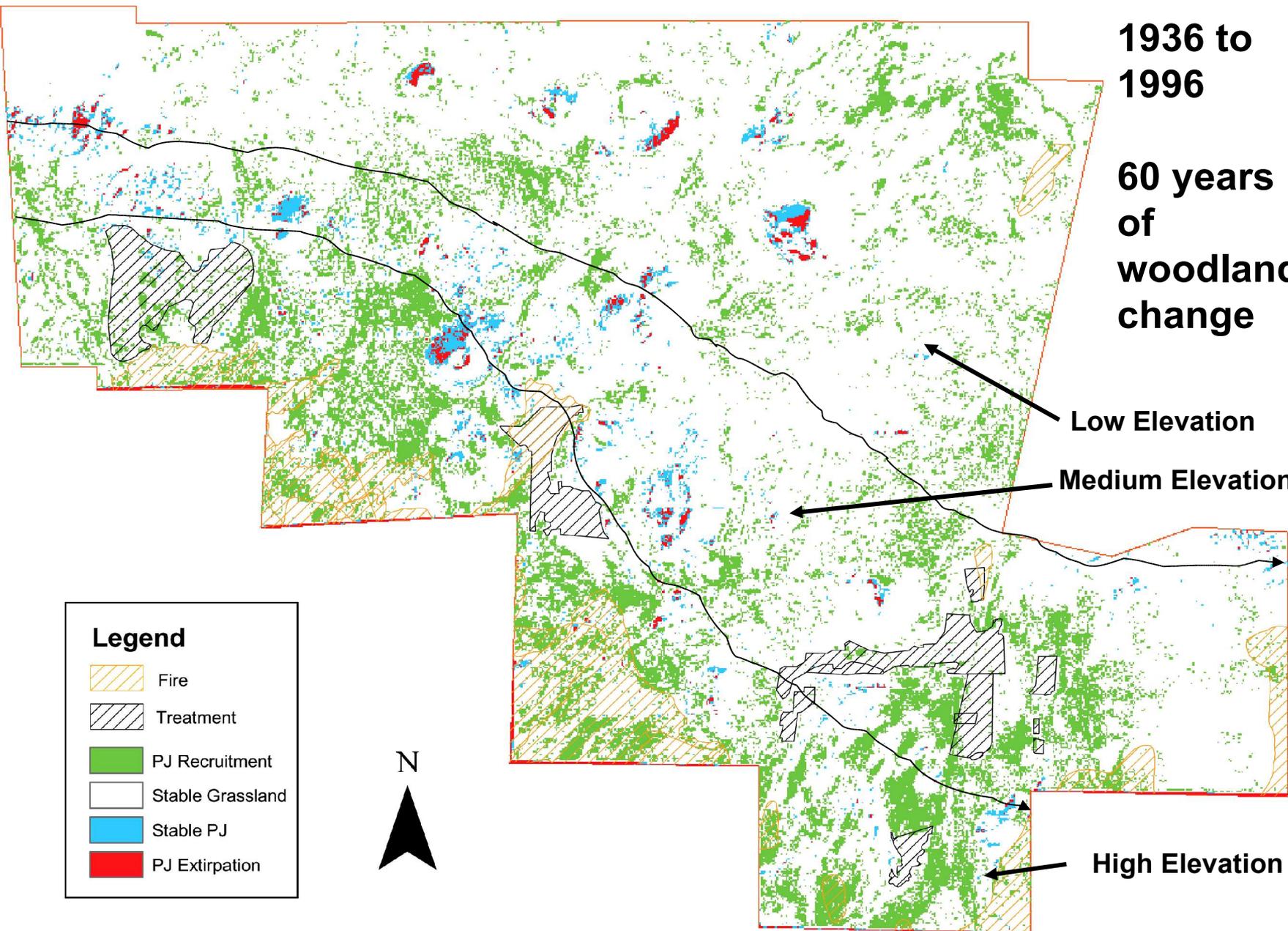
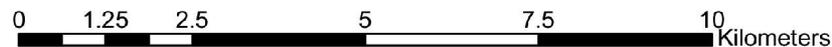
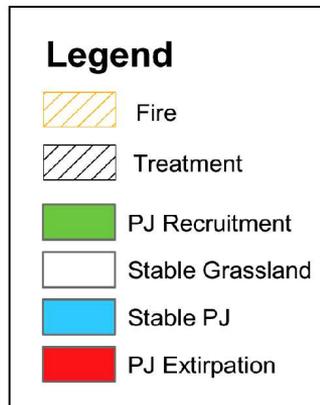
**1936 to
1996**

**60 years
of
woodland
change**

Low Elevation

Medium Elevation

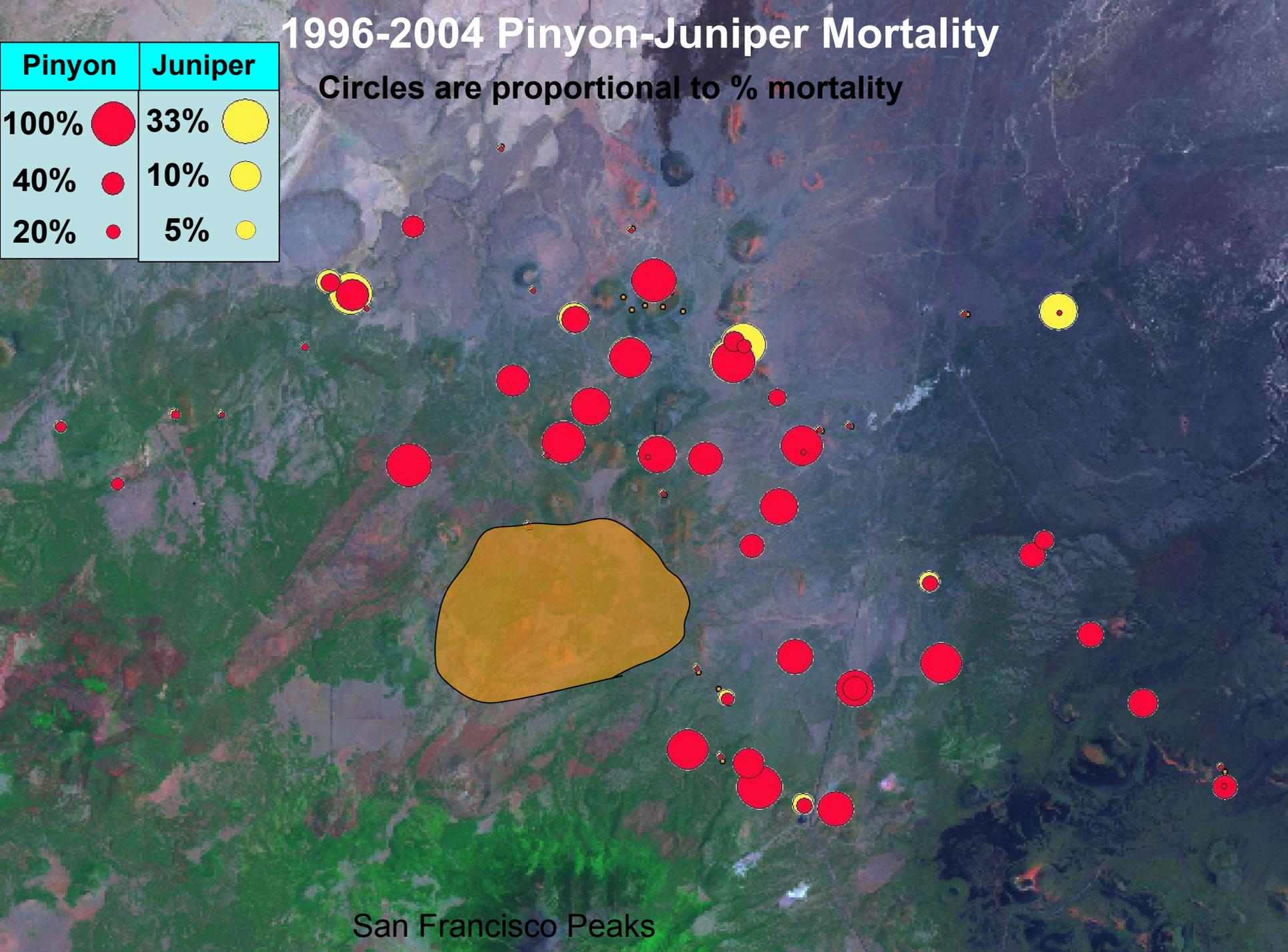
High Elevation



1996-2004 Pinyon-Juniper Mortality

Circles are proportional to % mortality

Pinyon	Juniper
100% 	33% 
40% 	10% 
20% 	5% 



San Francisco Peaks

May 17, 2003 North of San Francisco Peaks



September 20, 2003 North of San Francisco Peaks

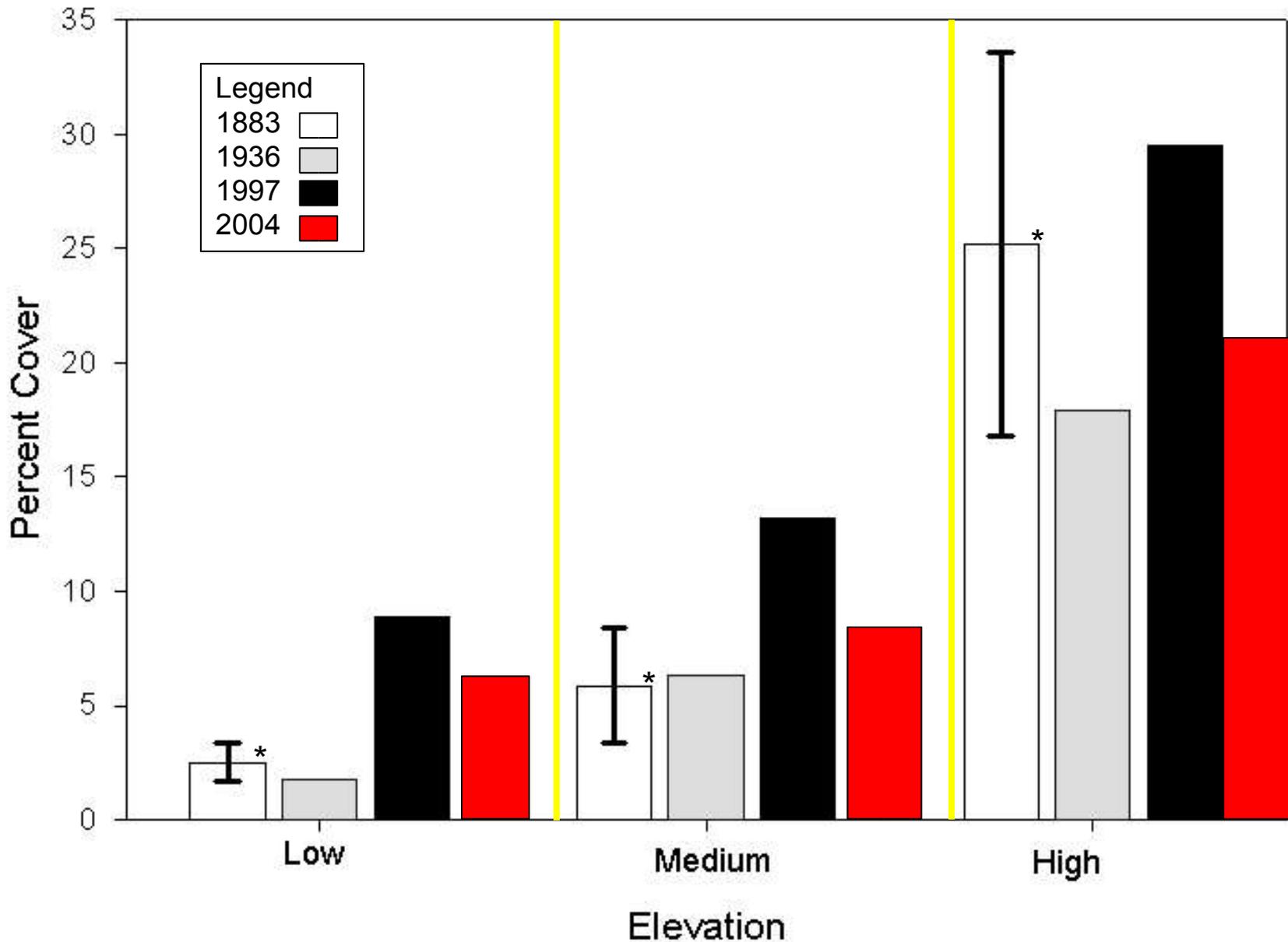


PJ Woodland



Juniper Woodland

Percent Cover Change 1883-2004



*Error bars represent range of possible 1883 values, not SEM

1892

Resetting Ecosystems



2001

109 Years of Increasing Woodland



2003

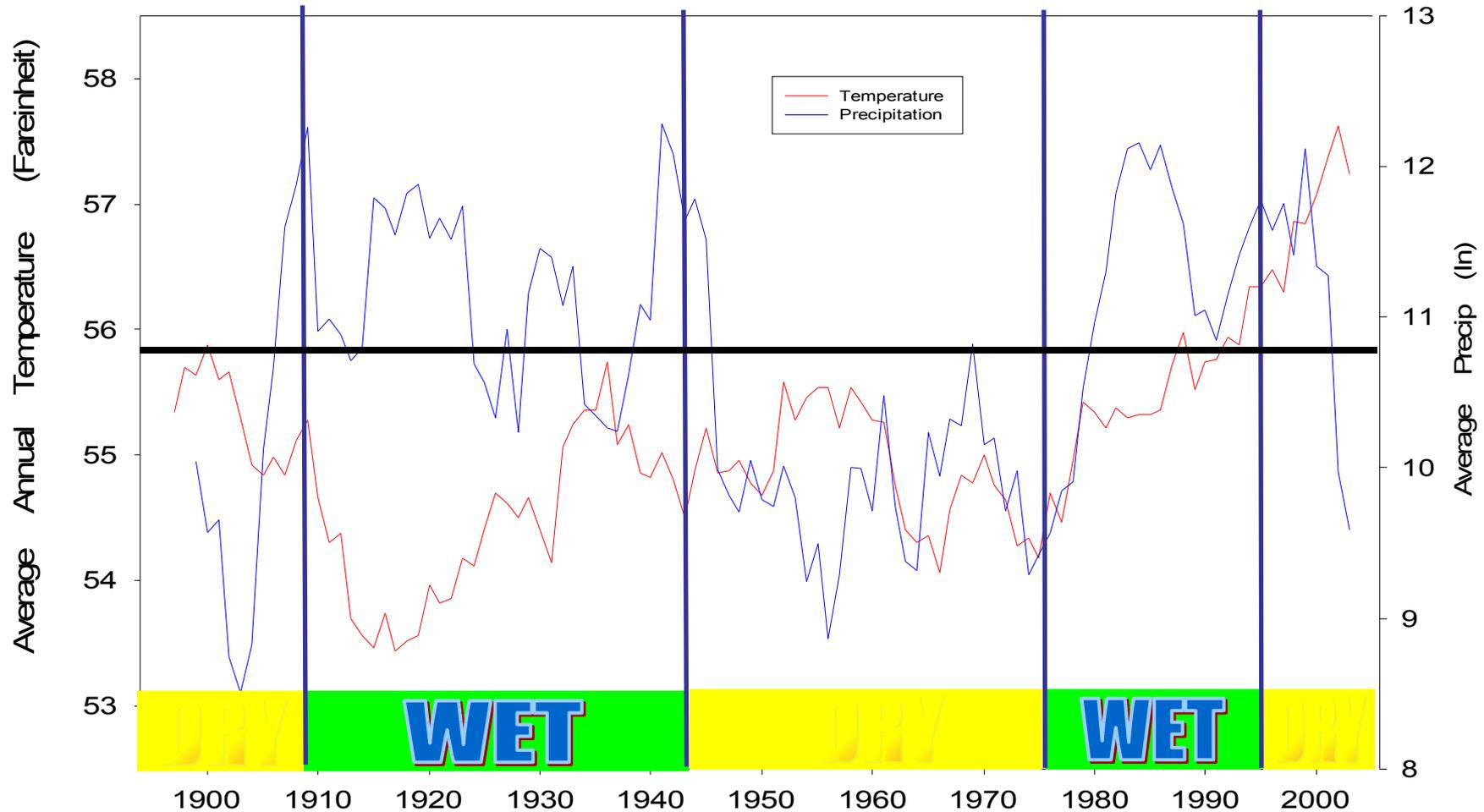
**Densities Comparable to 1883
Government Land Office Records**

**Are Pinyon-Juniper Woodlands
Set for a New Trajectory??**



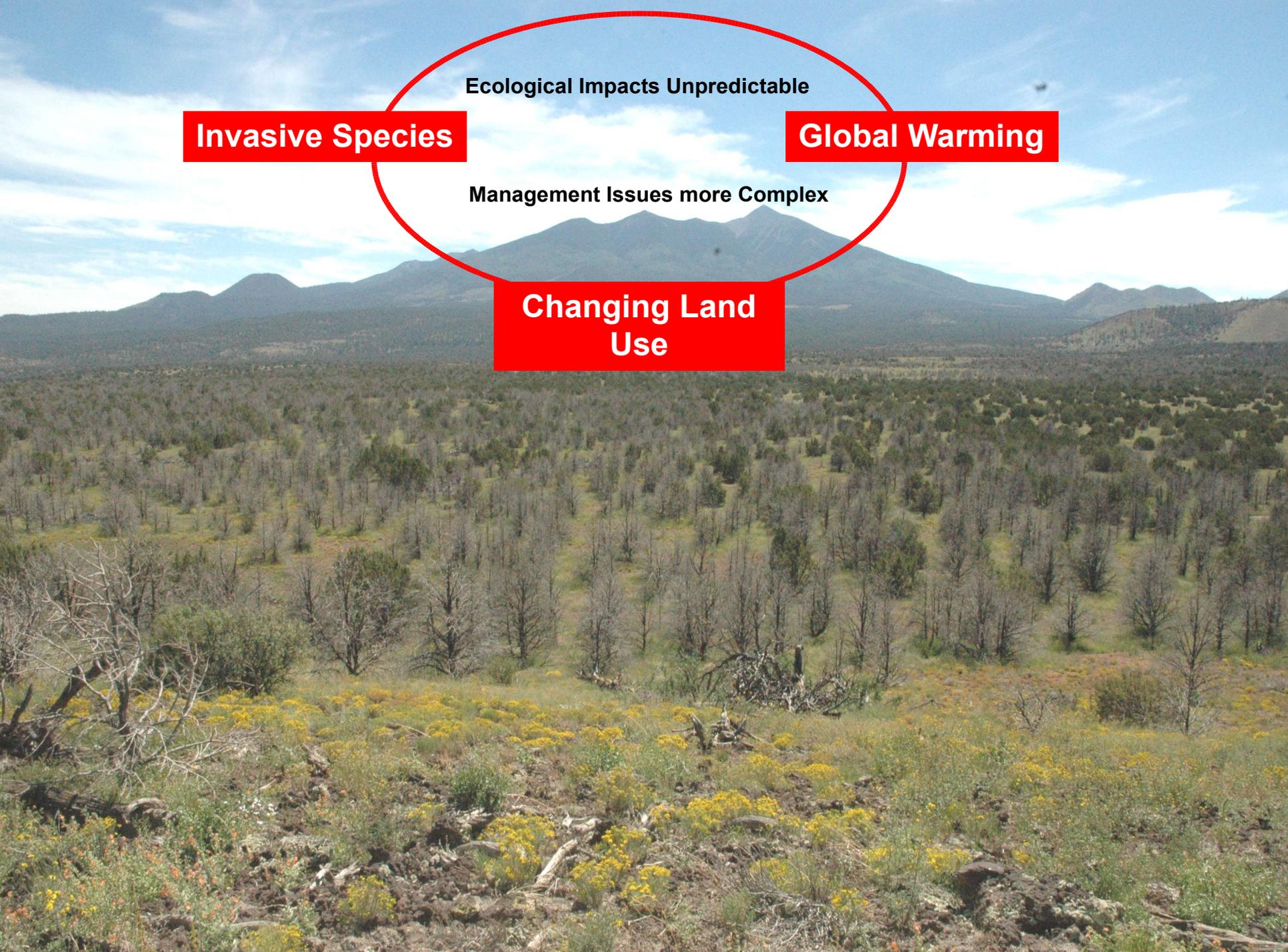
A Hotter Drought: A First Look at Global Warming

Drought? Southwest Climate



Breshears et al. 2005. Regional vegetation die-off in response to global-change type drought.

(In Press, Proceedings of National Academy of Sciences USA).



Ecological Impacts Unpredictable

Invasive Species

Global Warming

Management Issues more Complex

Changing Land Use