Forest Restoration: Principles and Approaches

A framework for re-creating fire resilient landscapes

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Amy Waltz

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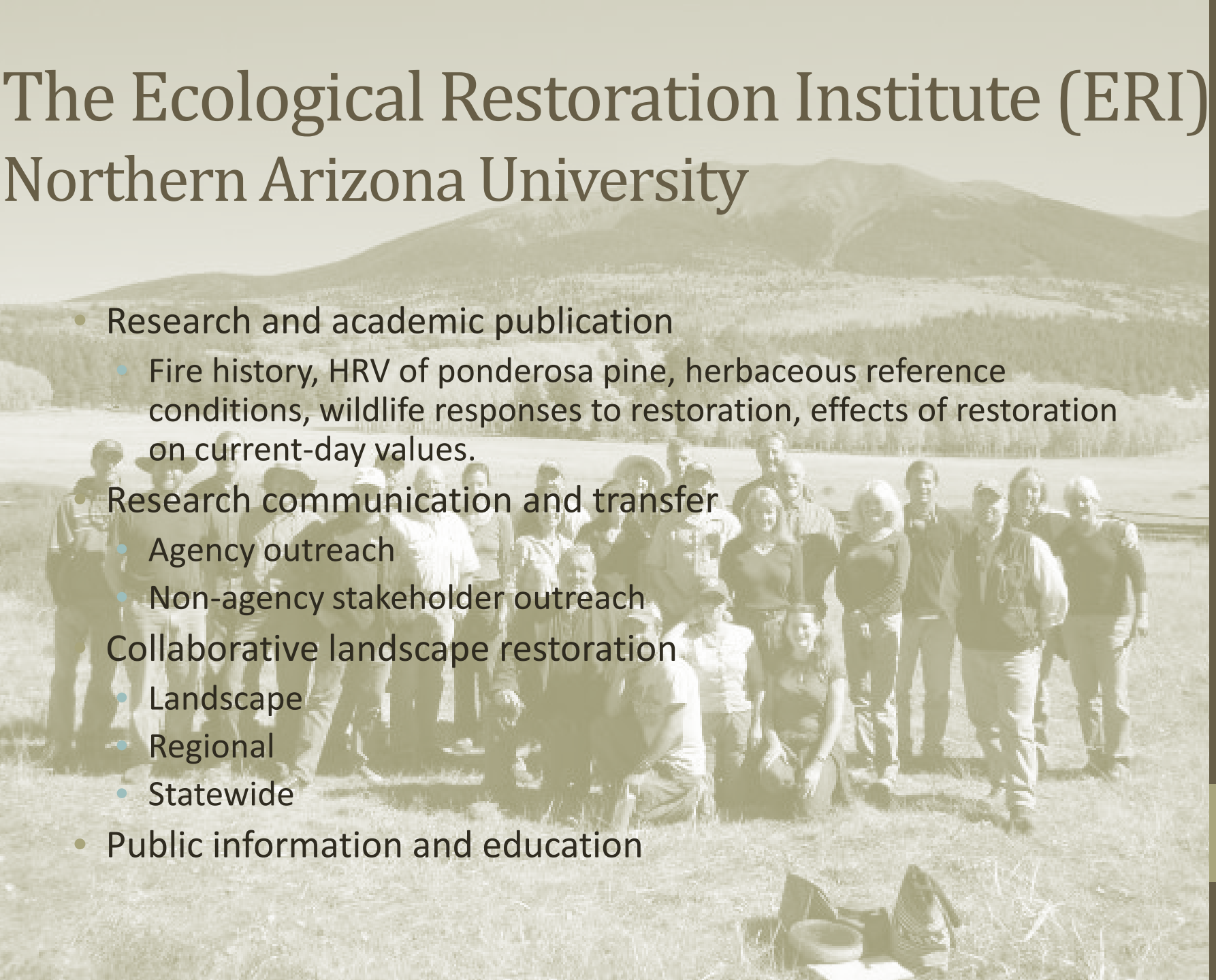
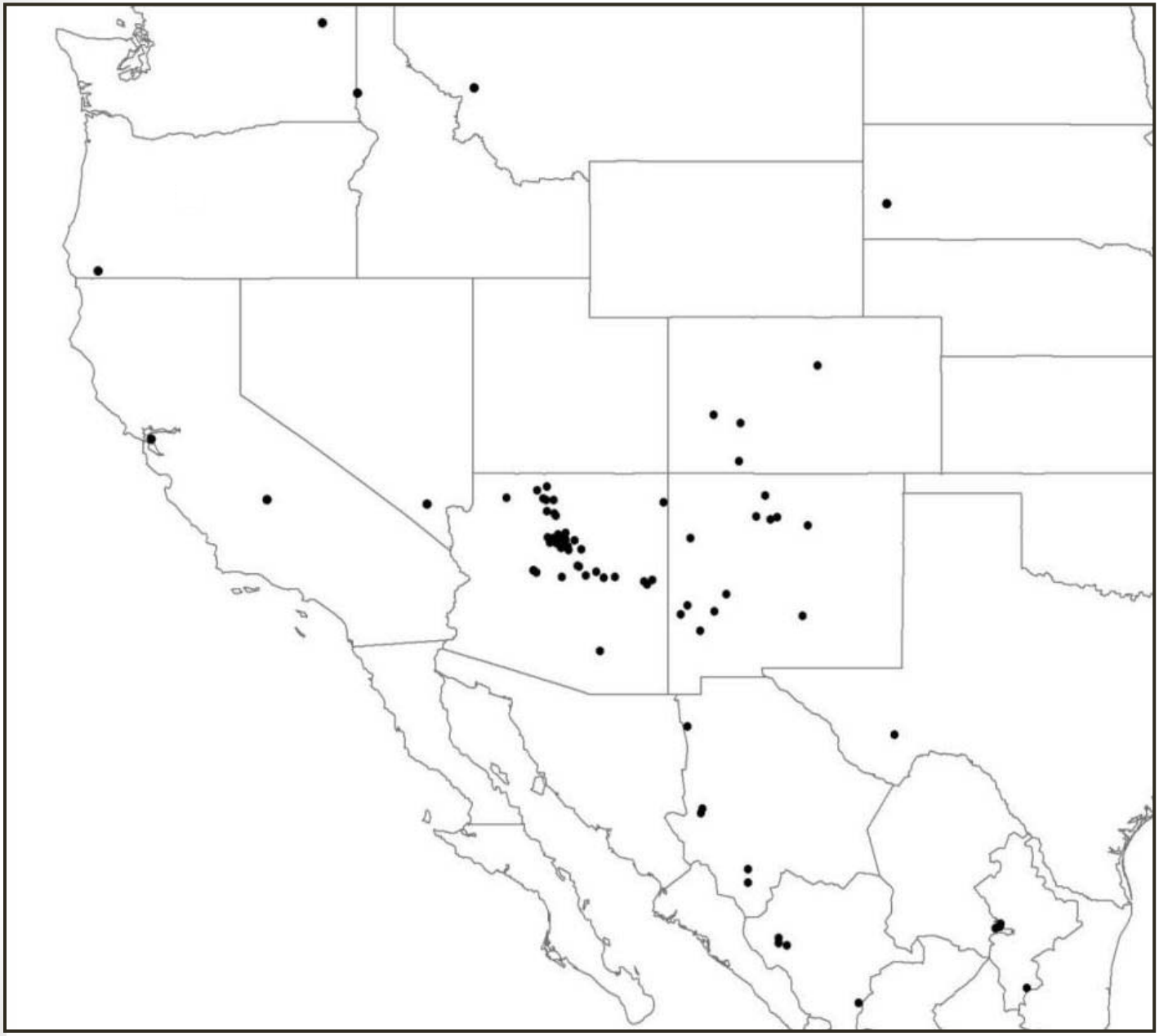


- Research and academic publication
  - Fire history, HRV of ponderosa pine, herbaceous reference conditions, wildlife responses to restoration, effects of restoration on current-day values.
- Research communication and transfer
  - Agency outreach
  - Non-agency stakeholder outreach
- Collaborative landscape restoration
  - Landscape
  - Regional
  - Statewide
- Public information and education

outhwest Ecological Restoration nstitutes (SWERI) - 2004

- Established by Congress in 2004, under PL 108-317.
- Established at NAU, New Mexico Highlands University and Colorado State University
- Federal funds provided through annual work plans developed from stakeholder requests and approved by an Interagency Team
- State funding provided by host universities
- Chartered by the Western Governors' Association in 2005 as SWERI
- Opportunity:
  - Need for restoration in frequent fire adapted forests is apparent and consistent across the Pacific Northwest, Intermountain West and the Southwest forests
  - Learning and adaptive management can be developed from the regional differences in methods and challenges

Photo: USFS #20171A, G. Pearson, 1914



Restoration

A Multi-disciplinary Framework

Scientific framework

Social, economic and political framework

Adaptive management framework

Operational framework

Restoration

A Multi-disciplinary Framework

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Scientific framework

The aim of restoration is to re-establish and enhance the resilience, adaptive capacity, and sustainability of forests through treatments that incrementally return the ecosystem to a state that is within a historic range of variability of conditions.

Operational framework

Restoration

A Multi-disciplinary Framework

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Social, economic and political framework

- Reference conditions overlaid with other values (ecological, social, economic) are used to develop desired condition.

Adaptive management framework

Operational framework

Restoration

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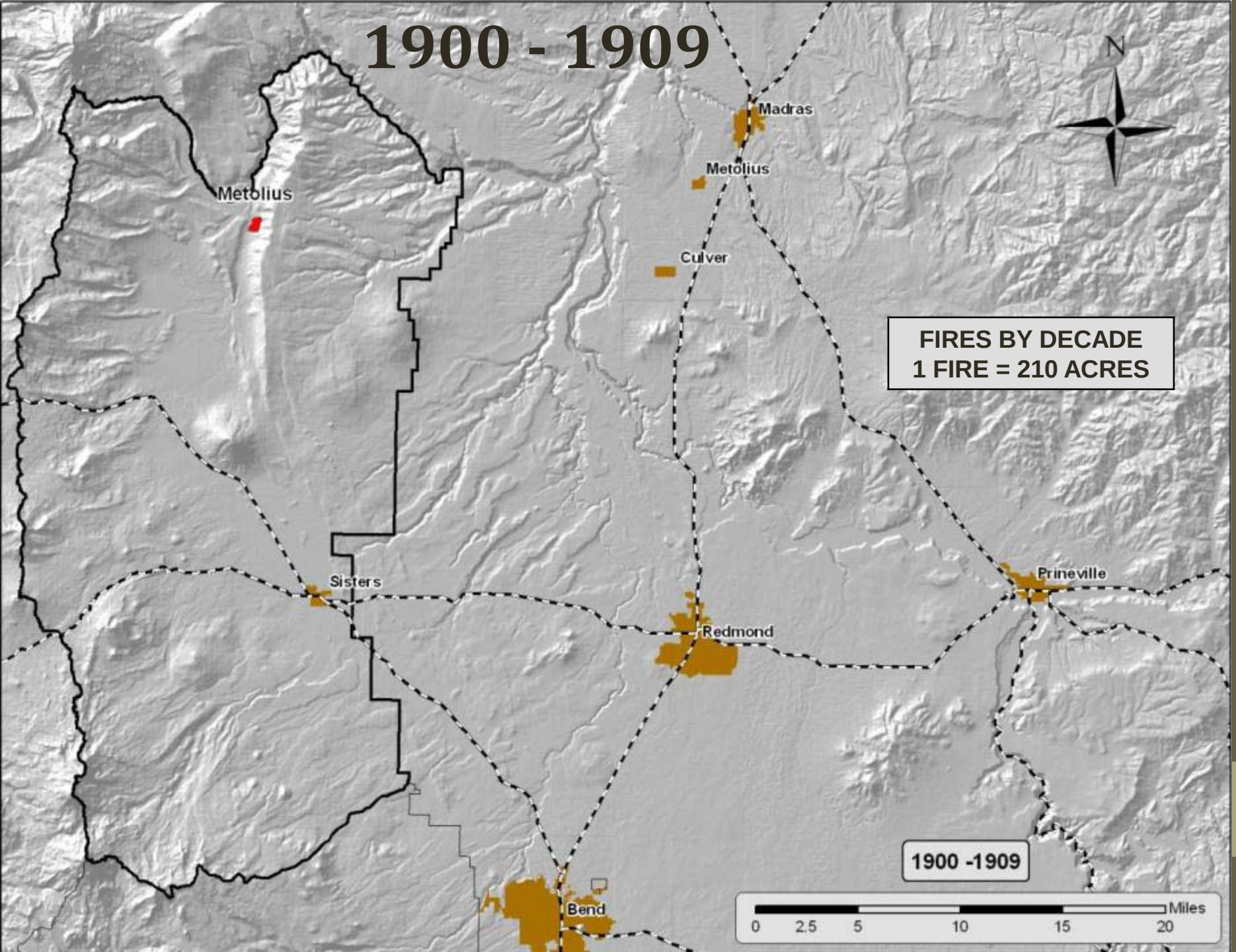
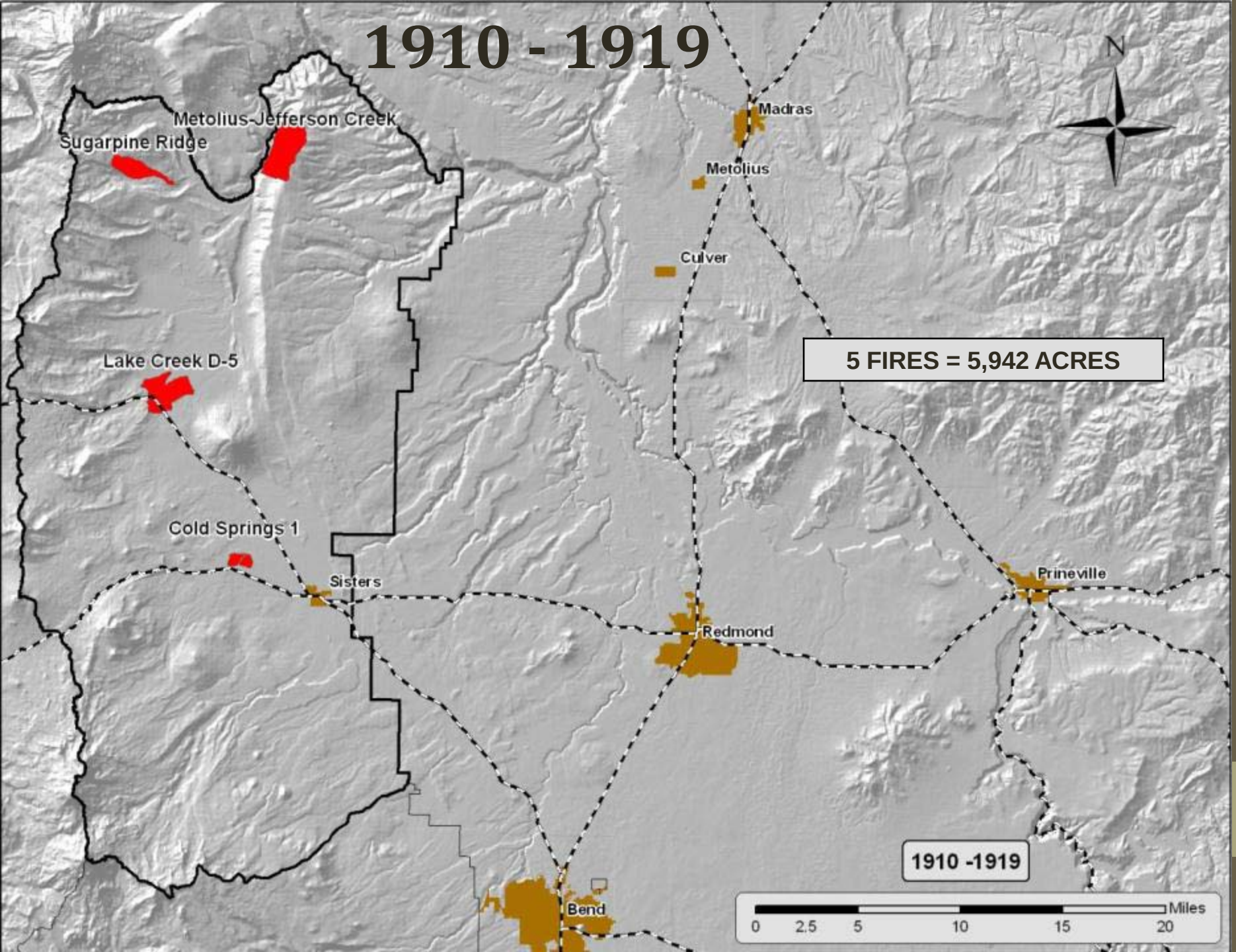
Social, economic and political framework

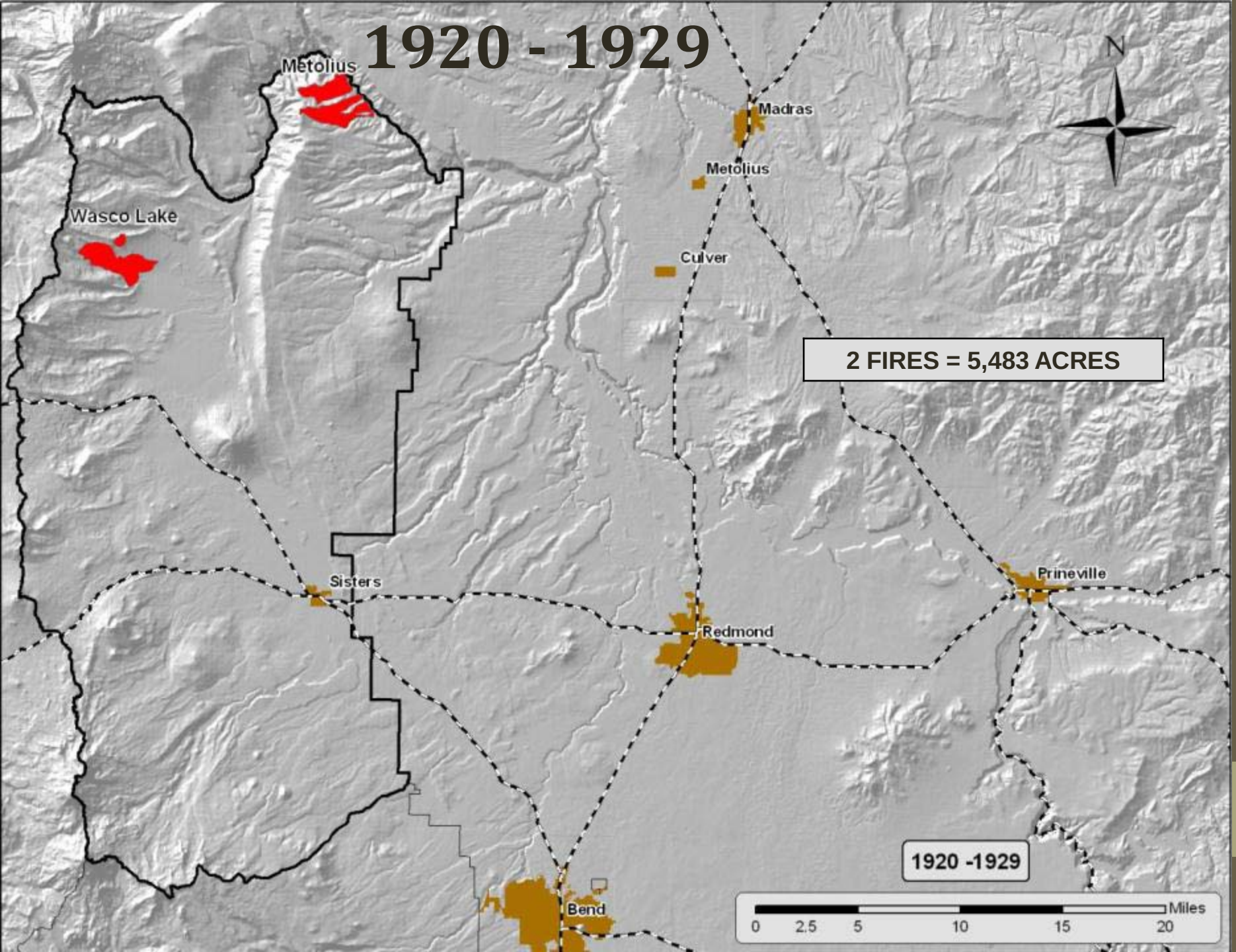
Adaptive management framework

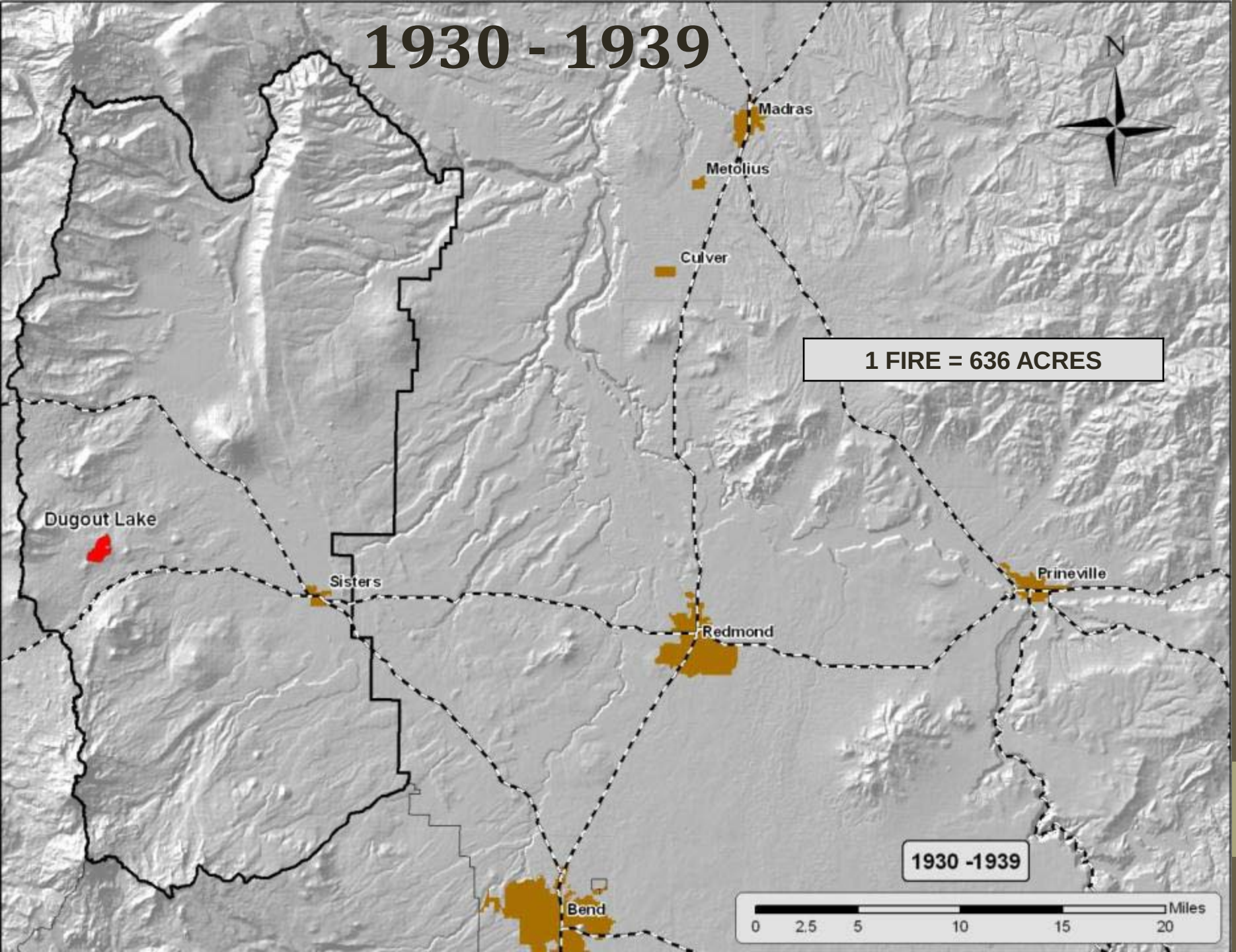
- Developing the question
- Monitoring
- Effective learning from doing

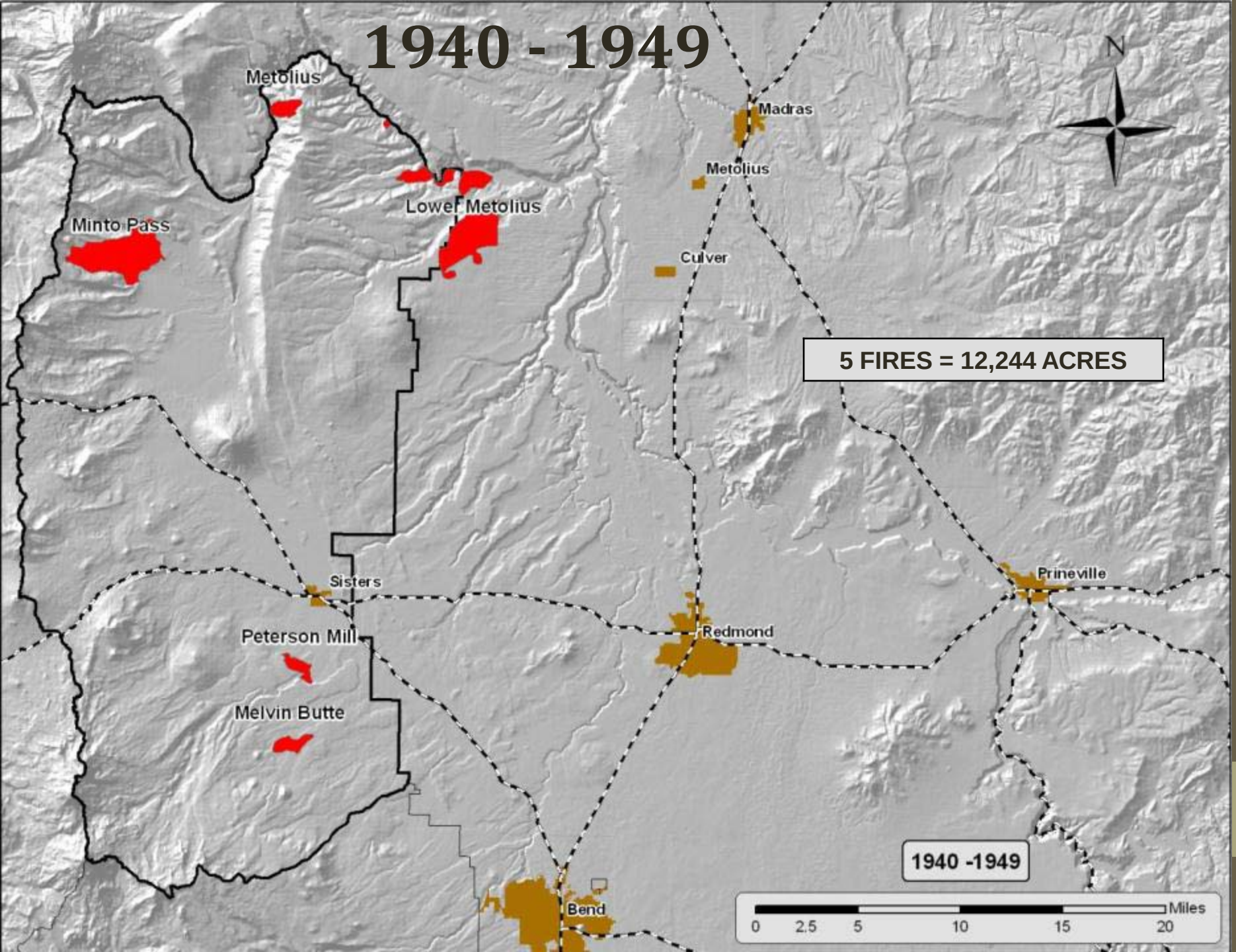
Operational framework

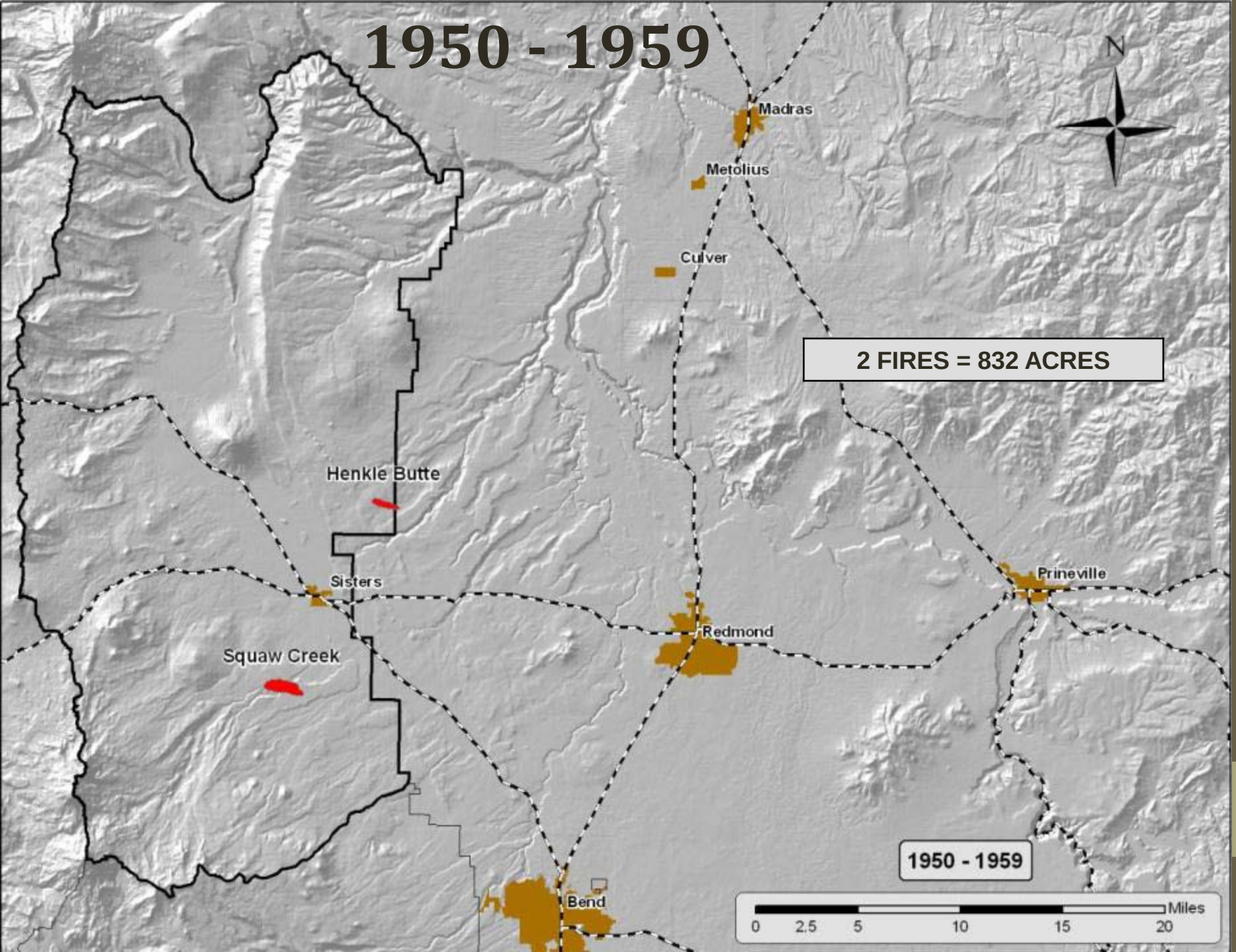

1900 - 1909
N
Madras
Metolius
Metolius
Culver
FIRES BY DECADE
1 FIRE = 210 ACRES
Sisters
Prineville
Redmond
Bend
1900 -1909
Miles
0
2.5
5
10
15
20

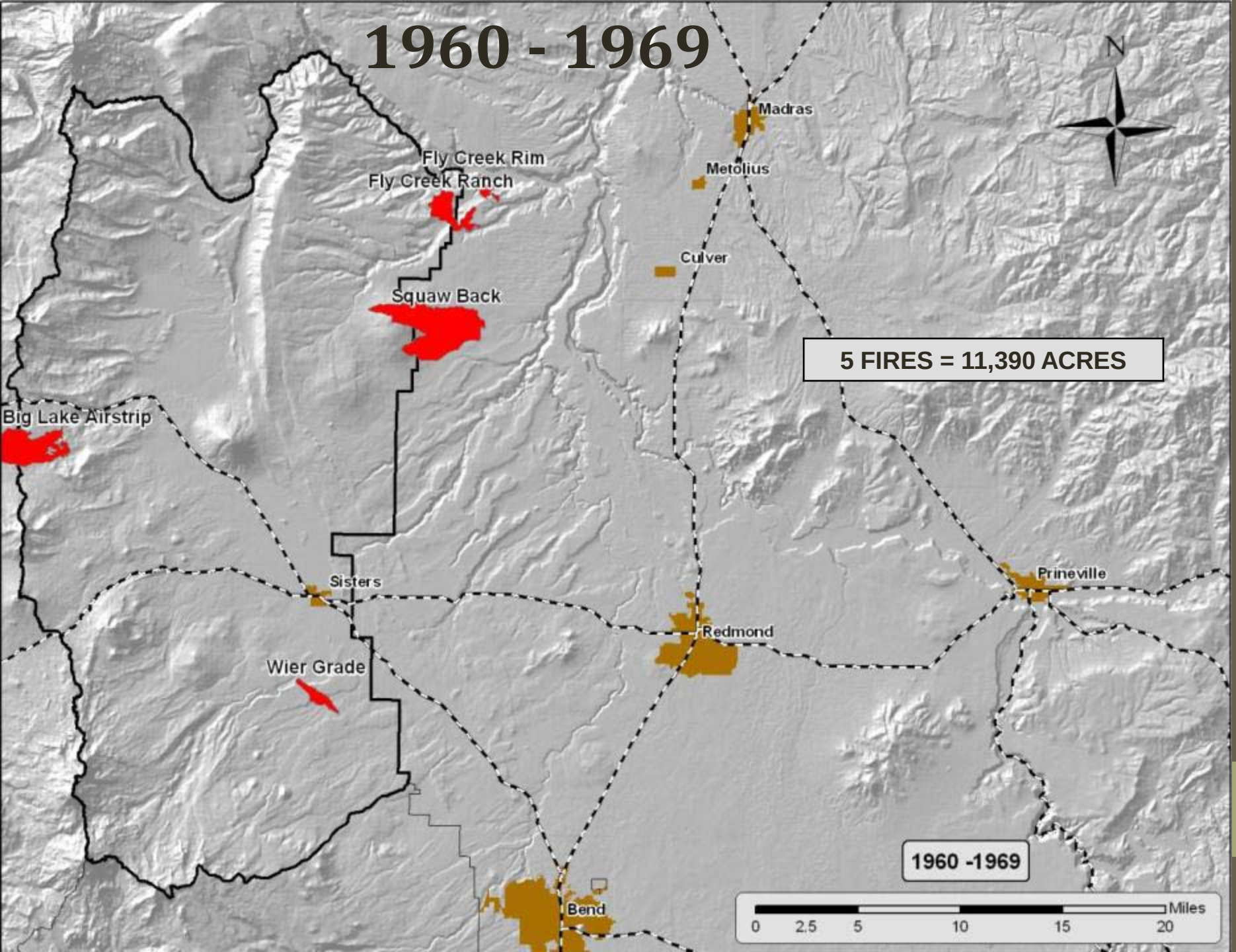

1910 - 1919
Metolius-Jefferson Creek
Sugarpine Ridge
Madras
Metolius
Culver
Lake Creek D-5
5 FIRES = 5,942 ACRES
Cold Springs 1
Sisters
Prineville
Redmond
Bend
N
1910 -1919
Miles
0
2.5
5
10
15
20

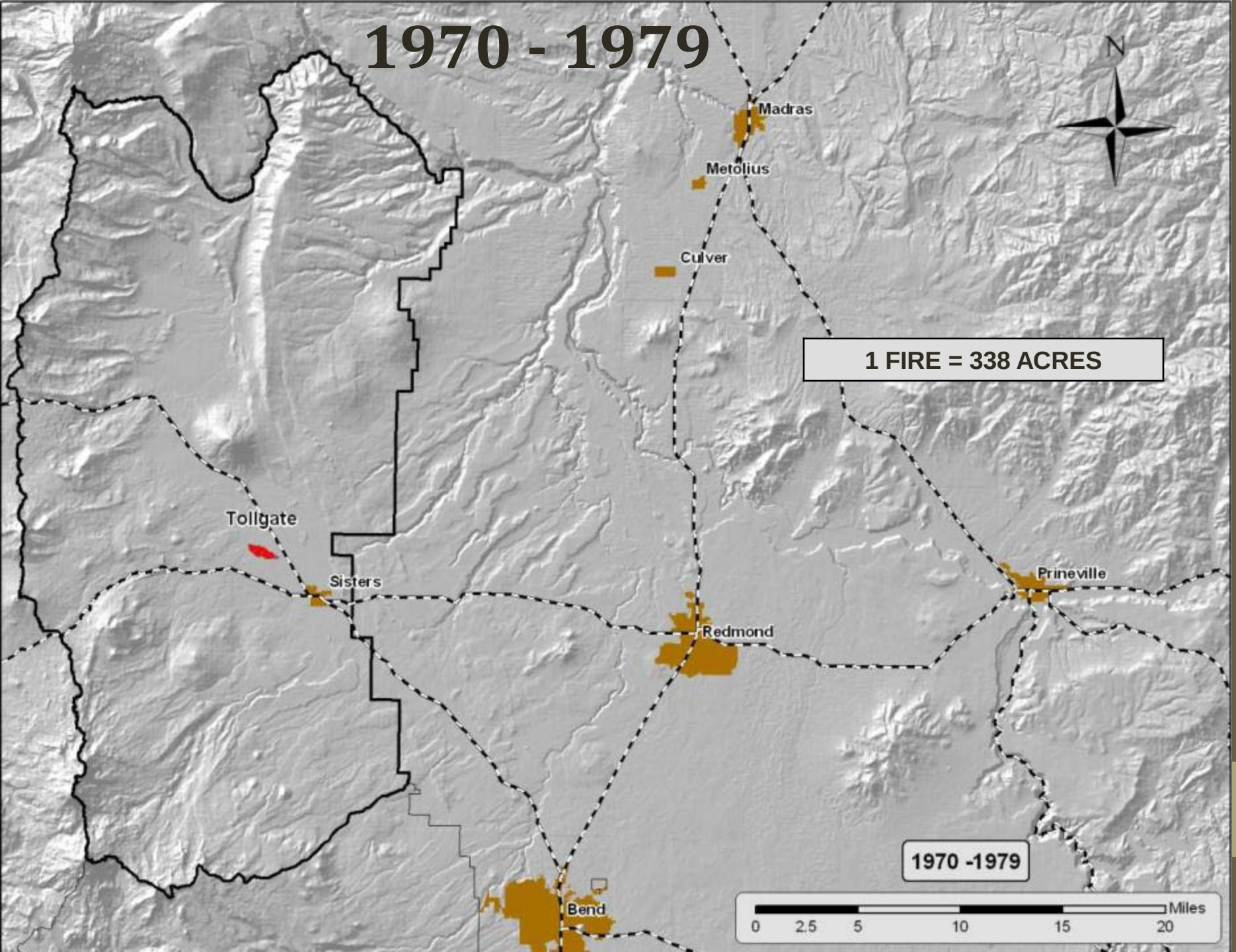

1920 - 1929
Metolius
Madras
Metolius
Wasco Lake
Culver
2 FIRES = 5,483 ACRES
Sisters
Prineville
Redmond
Bend
1920 -1929
Miles
0
2.5
5
10
15
20
N

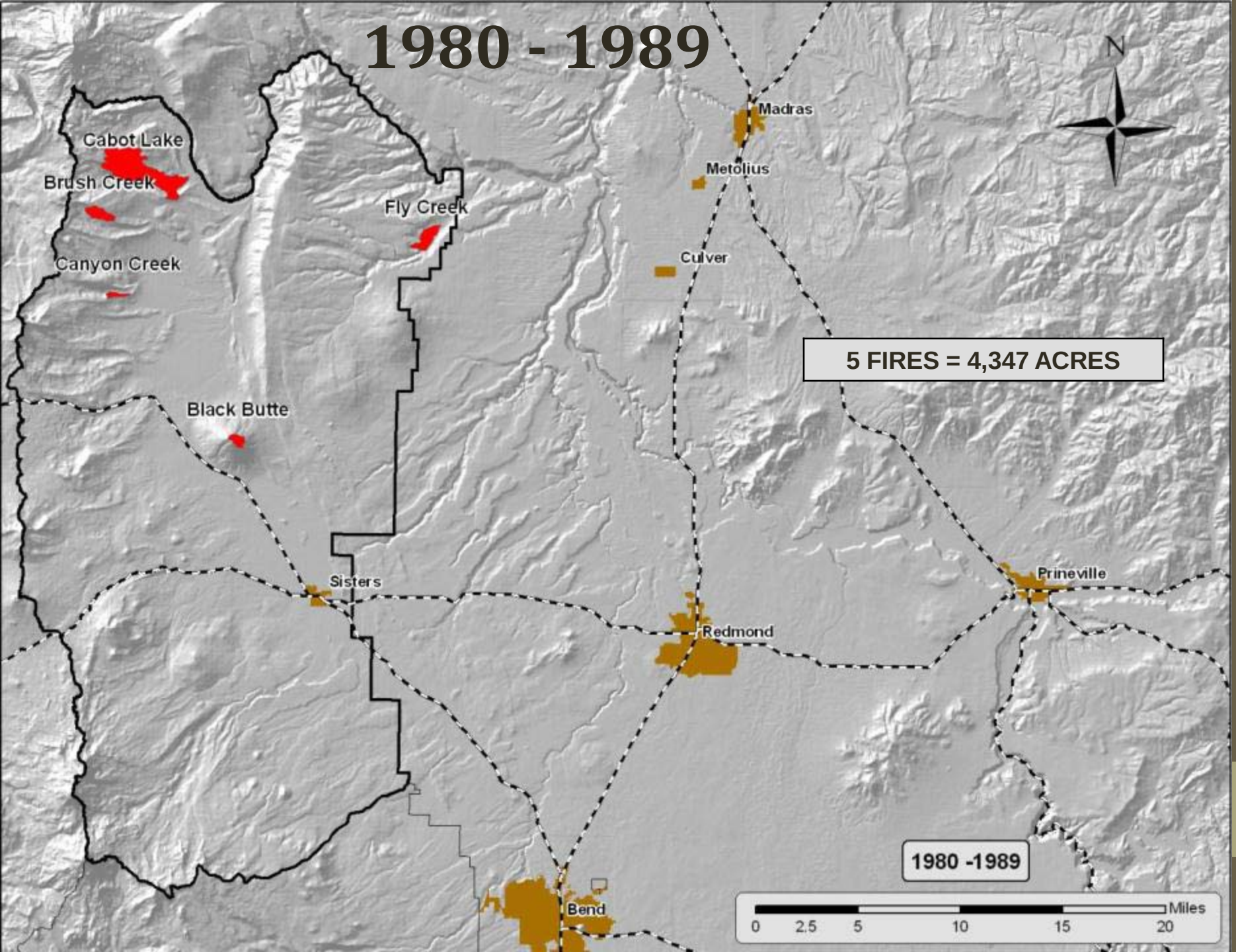

1930 - 1939
N
Madras
Metolius
Culver
1 FIRE = 636 ACRES
Dugout Lake
Sisters
Redmond
Prineville
Bend
1930 -1939
Miles
0
2.5
5
10
15
20

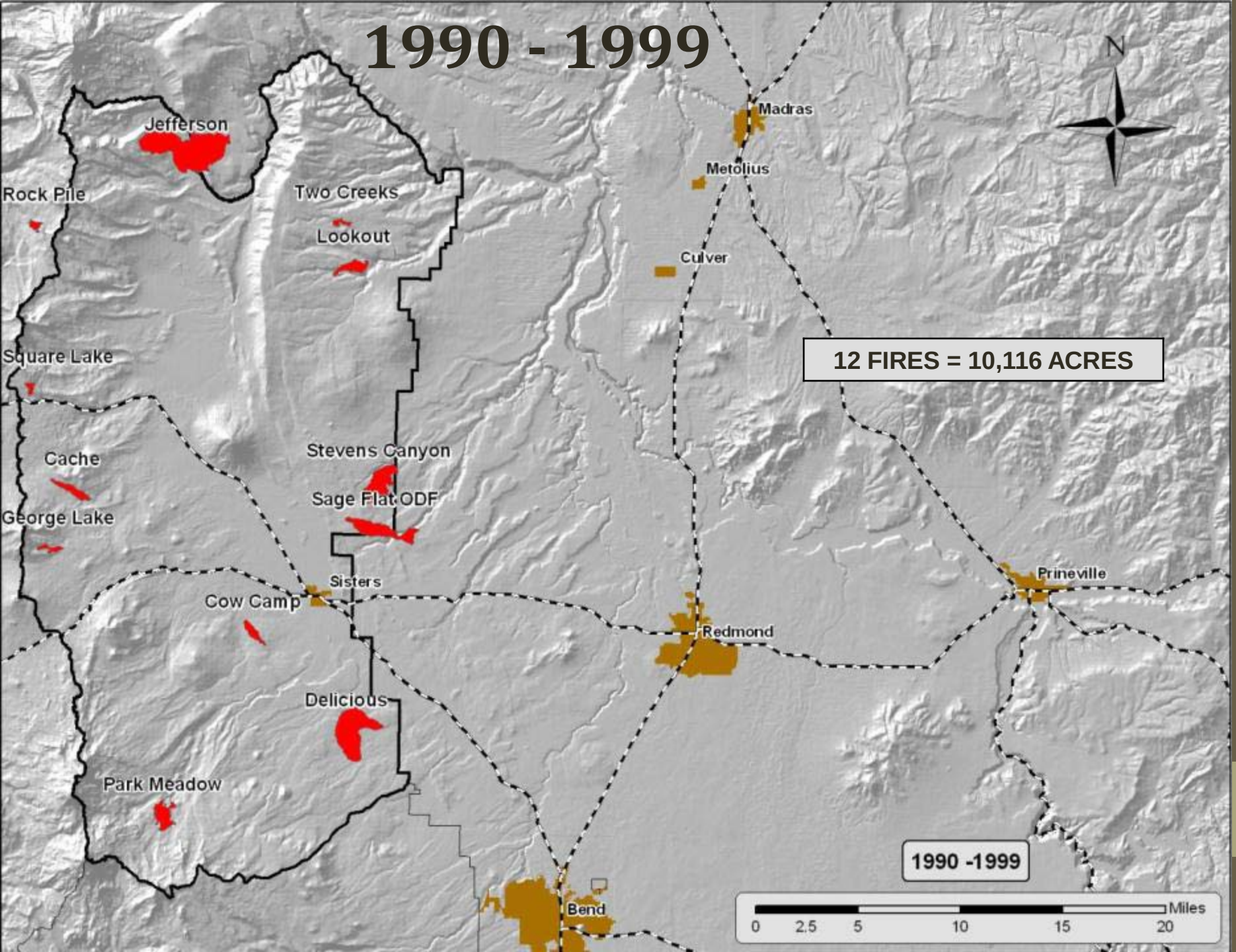

1940 - 1949
Metolius
Madras
Metolius
Lower Metolius
Minto Pass
Culver
5 FIRES = 12,244 ACRES
Sisters
Prineville
Peterson Mill
Redmond
Melvin Butte
Bend
1940 -1949
Miles
0
2.5
5
10
15
20
N


1950 - 1959
N
Madras
Metolius
Culver
2 FIRES = 832 ACRES
Henkle Butte
Sisters
Squaw Creek
Redmond
Prineville
Bend
1950 - 1959
Miles
0
2.5
5
10
15
20

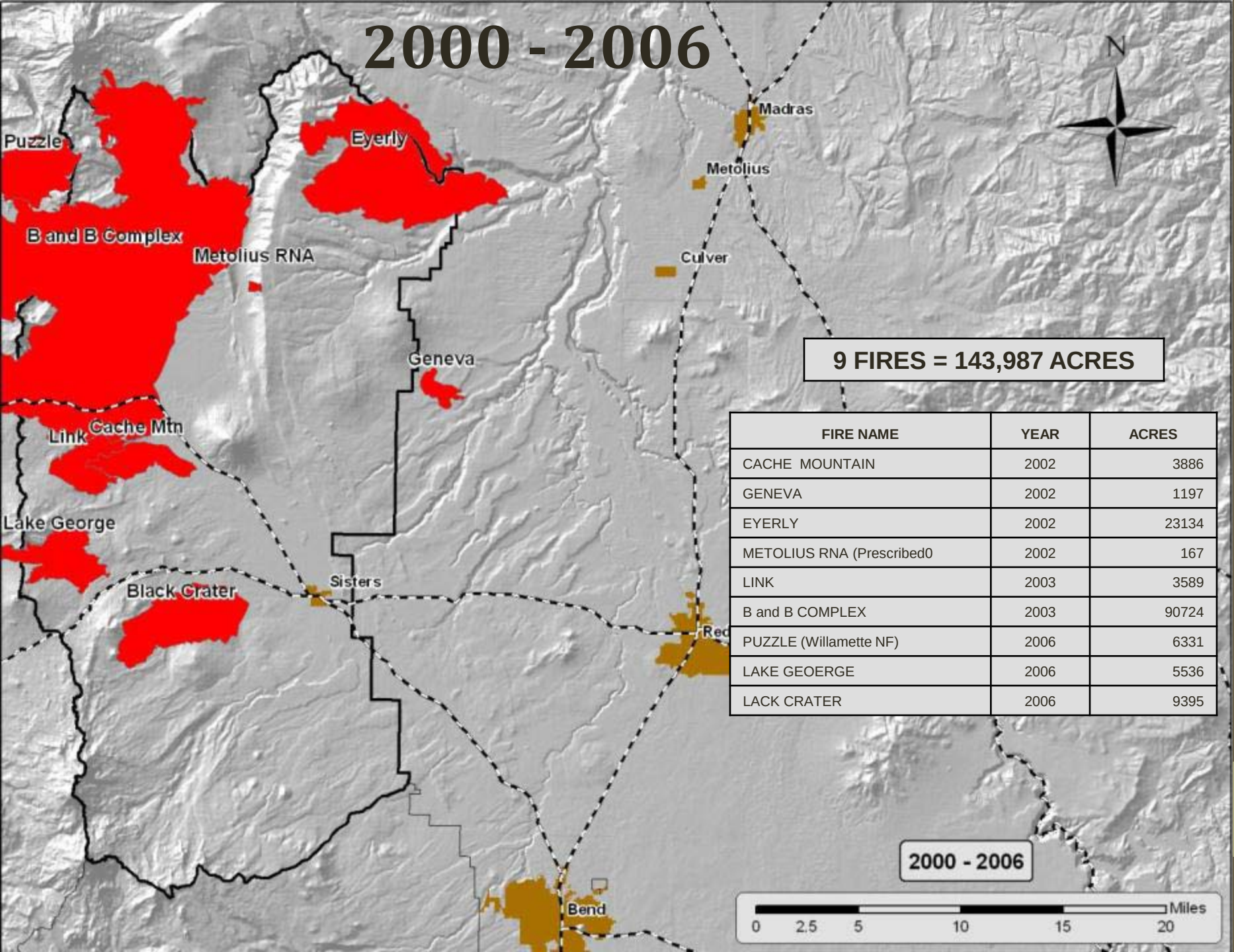

1960 - 1969
N
Madras
Metolius
Fly Creek Rim
Fly Creek Ranch
Culver
Squaw Back
5 FIRES = 11,390 ACRES
Big Lake Airstrip
Sisters
Prineville
Redmond
Wier Grade
Bend
1960 -1969
Miles
0
2.5
5
10
15
20


1970 - 1979
N
Madras
Metolius
Culver
1 FIRE = 338 ACRES
Tollgate
Sisters
Prineville
Redmond
Bend
1970 -1979
Miles
0
2.5
5
10
15
20

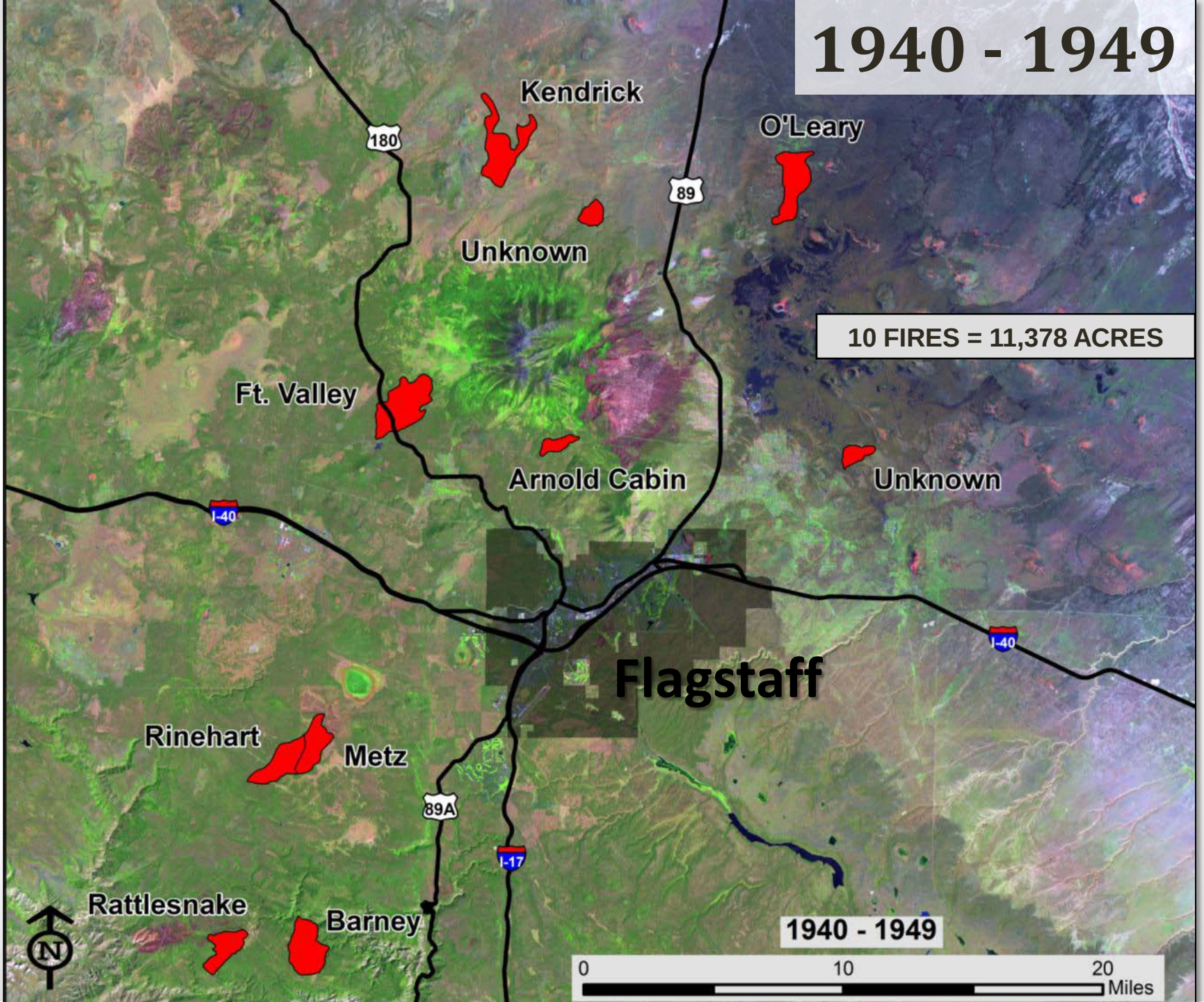

1980 - 1989
N
Madras
Metolius
Culver
Cabot Lake
Brush Creek
Fly Creek
Canyon Creek
Black Butte
5 FIRES = 4,347 ACRES
Sisters
Redmond
Prineville
Bend
1980 -1989
Miles
0
2.5
5
10
15
20

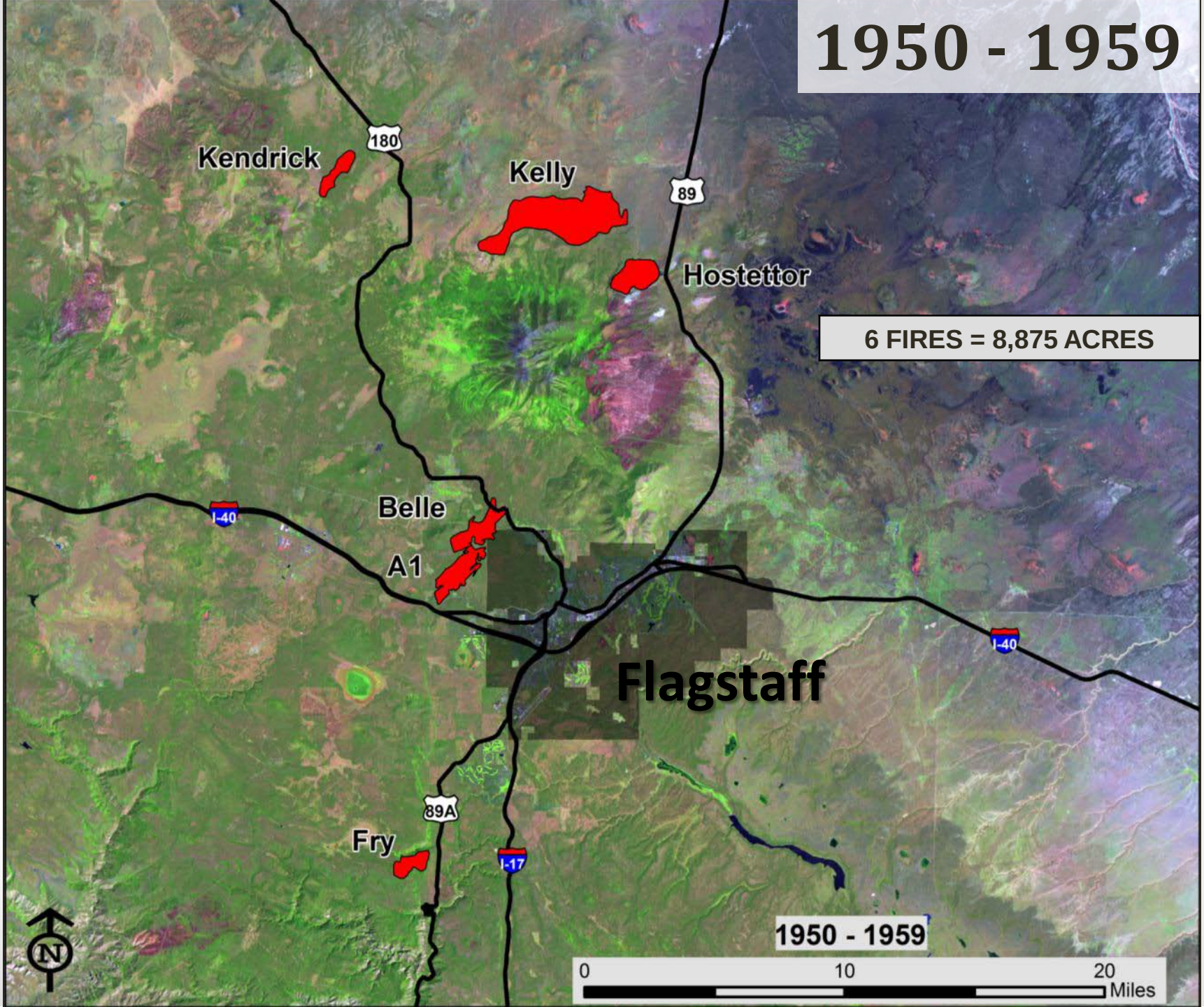

1990 - 1999
N
Jefferson
Rock Pile
Two Creeks
Lookout
Square Lake
Cache
George Lake
Stevens Canyon
Sage Flat ODF
Sisters
Cow Camp
Delicious
Park Meadow
Madras
Metolius
Culver
Redmond
Prineville
Bend
12 FIRES = 10,116 ACRES
1990 -1999
Miles
0
2.5
5
10
15
20

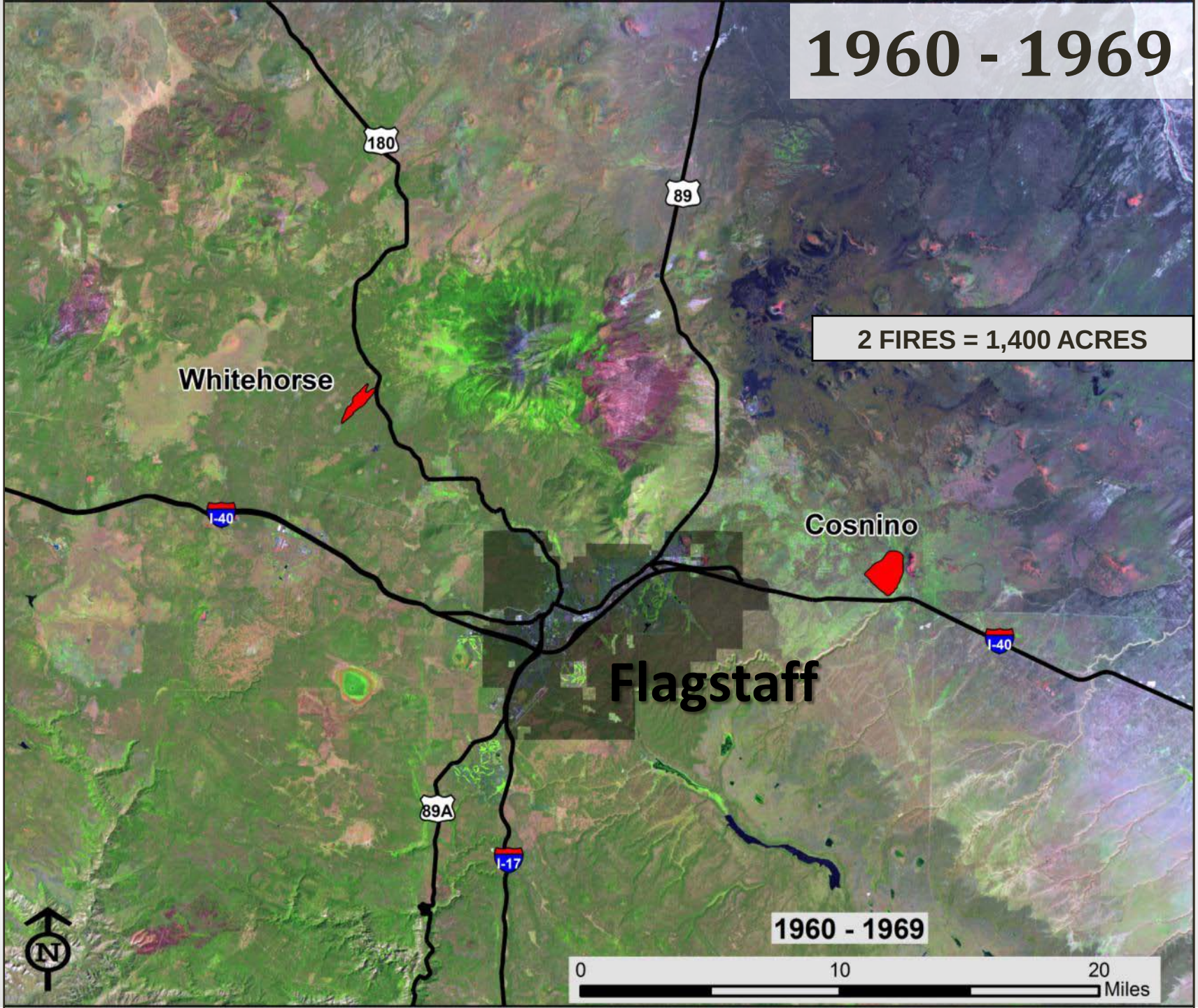
2000 - 2006

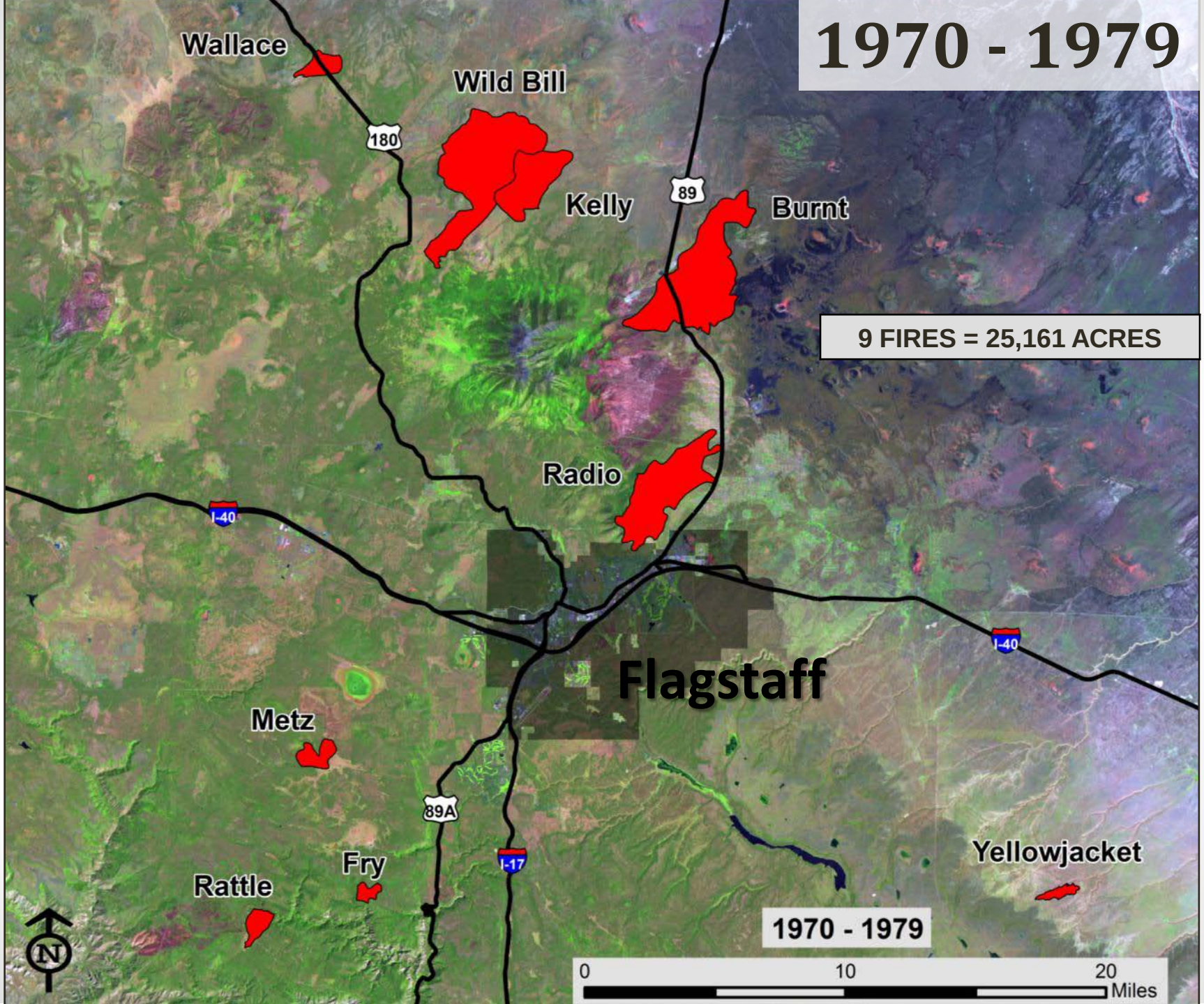


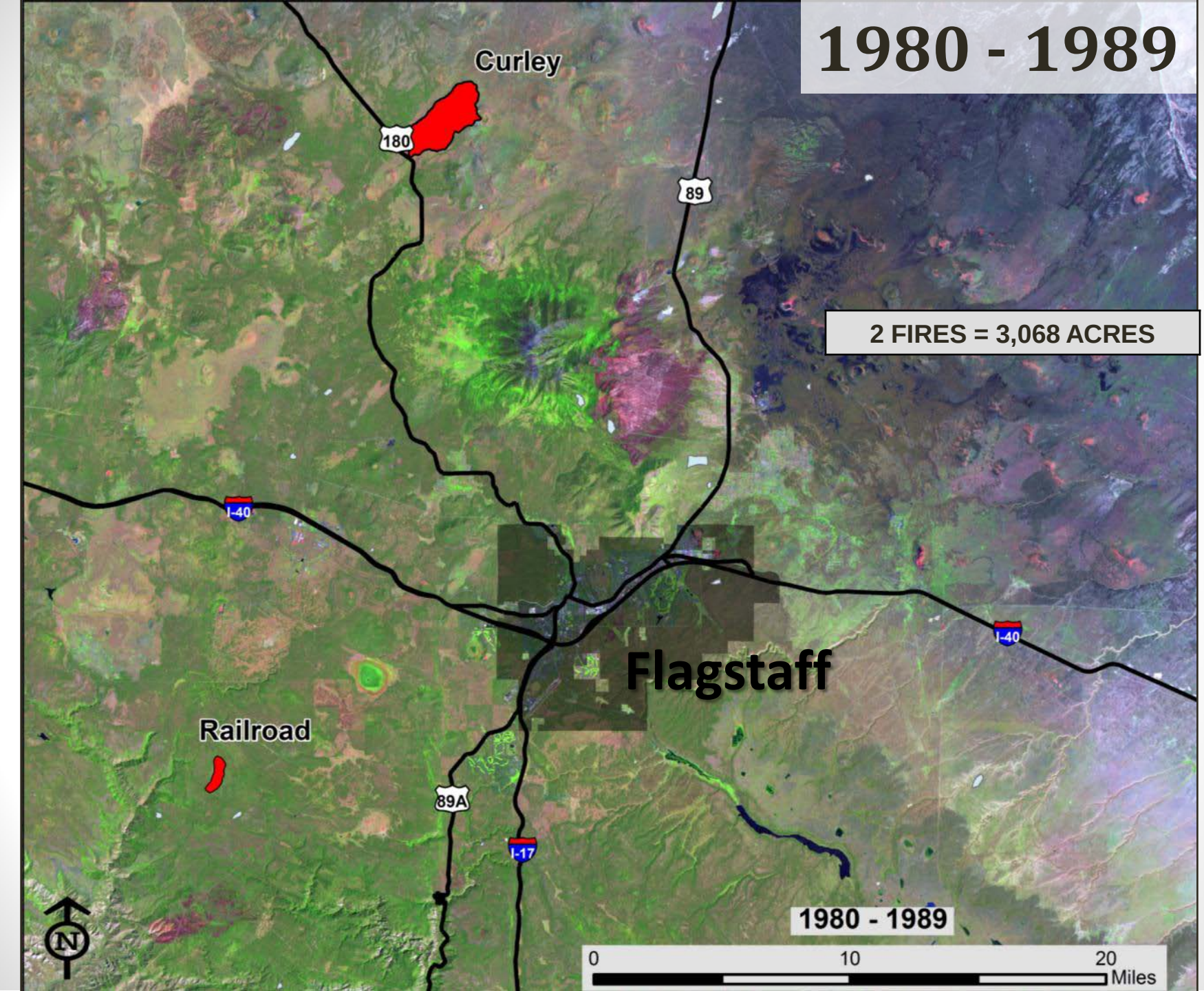
FIRE NAME	YEAR	ACRES
CACHE MOUNTAIN	2002	3886
GENEVA	2002	1197
EYERLY	2002	23134
METOLIUS RNA (Prescribed0	2002	167
LINK	2003	3589
B and B COMPLEX	2003	90724
PUZZLE (Willamette NF)	2006	6331
LAKE GEOERGE	2006	5536
LACK CRATER	2006	9395

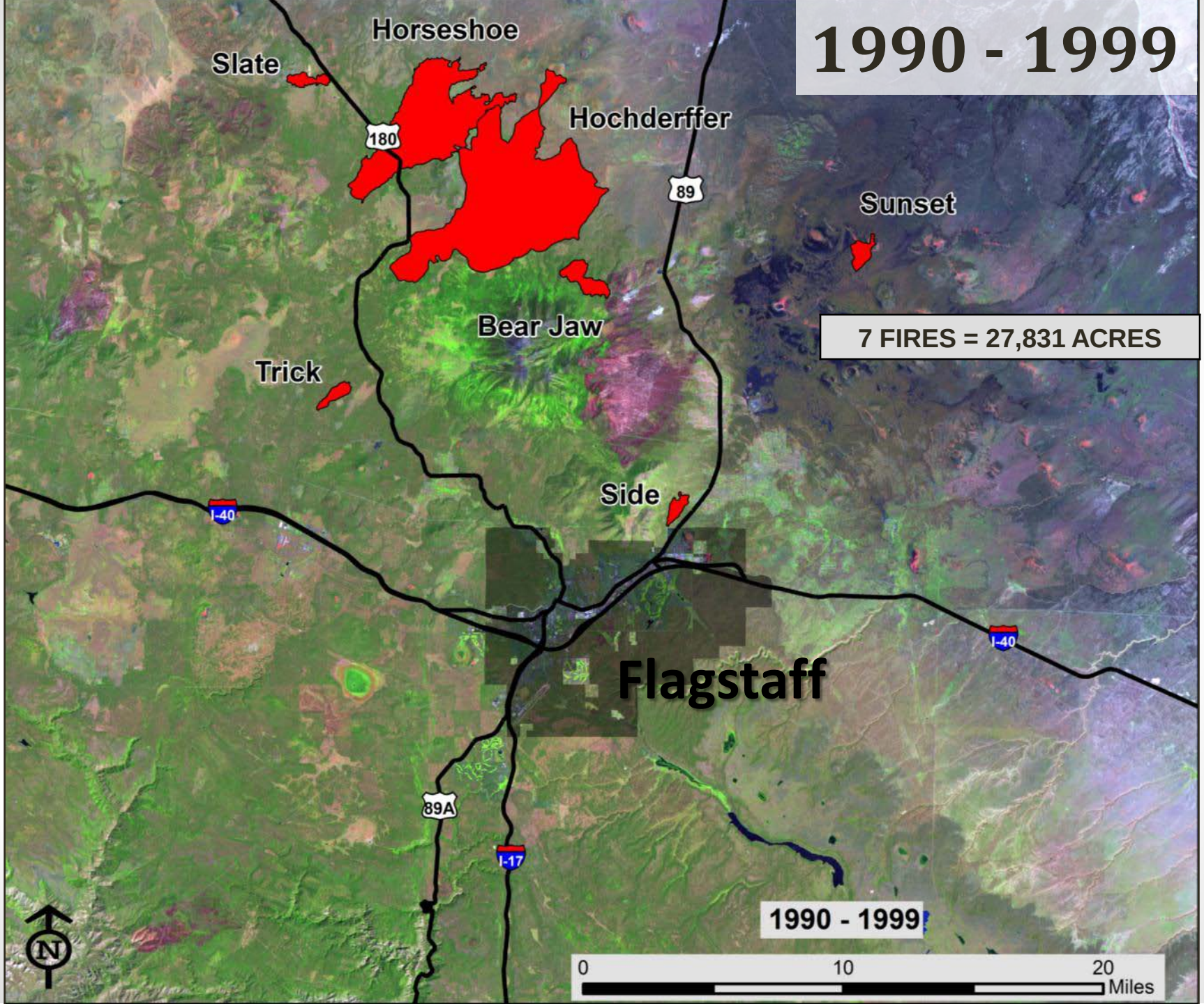

1940 - 1949
Kendrick
O'Leary
180
89
Unknown
10 FIRES = 11,378 ACRES
Ft. Valley
Arnold Cabin
Unknown
I-40
Flagstaff
I-40
Rinehart
Metz
89A
I-17
Rattlesnake
Barney
N
1940 - 1949
0
10
20
Miles

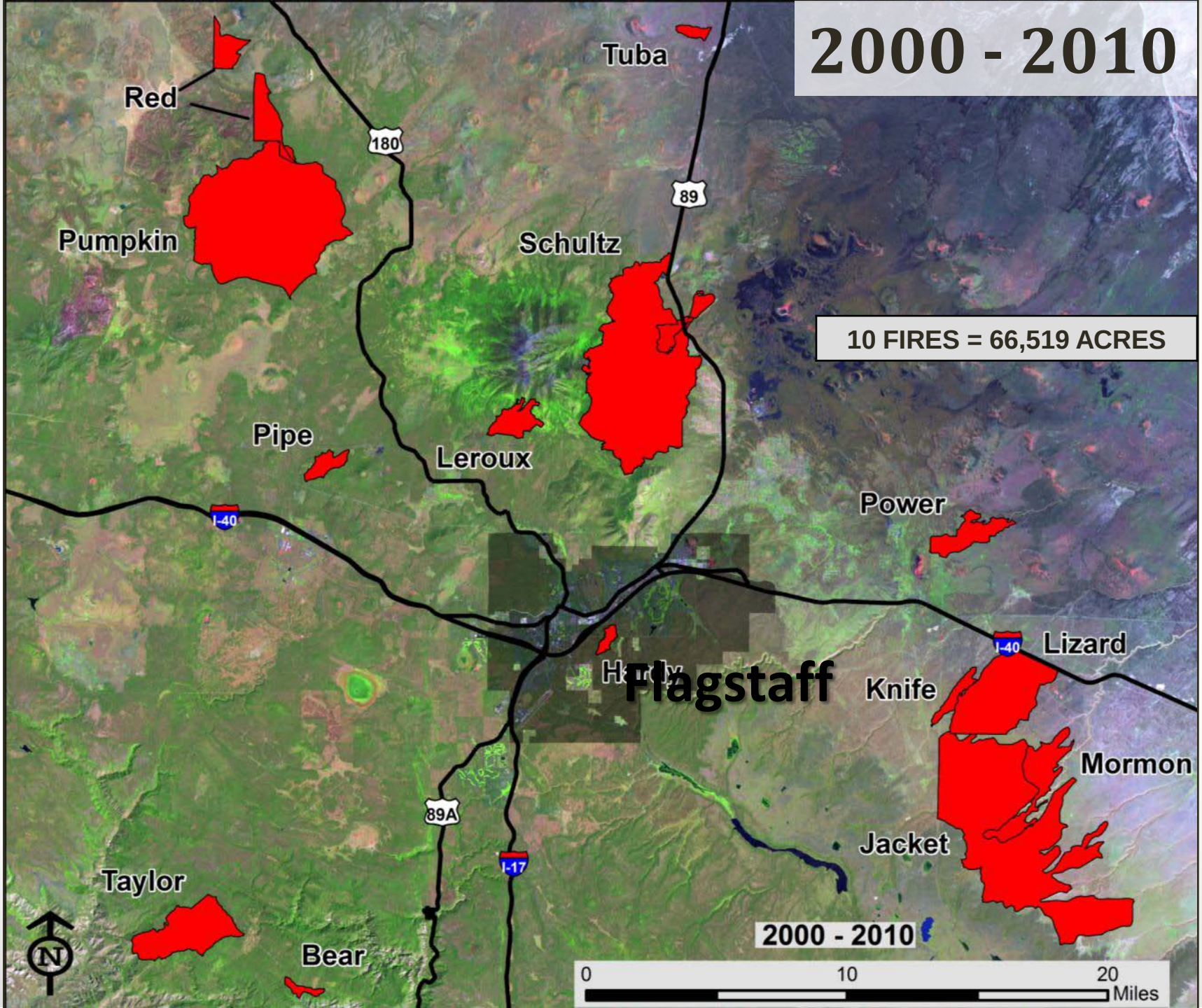

1950 - 1959
Kendrick
180
Kelly
89
Hostettor
6 FIRES = 8,875 ACRES
Belle
A1
I-40
Flagstaff
I-40
89A
Fry
I-17
N
1950 - 1959
0
10
20
Miles


1960 - 1969
180
89
2 FIRES = 1,400 ACRES
Whitehorse
I-40
Cosnino
I-40
Flagstaff
89A
I-17
N
1960 - 1969
0
10
20
Miles


1970 - 1979
Wallace
Wild Bill
180
Kelly
89
Burnt
9 FIRES = 25,161 ACRES
Radio
I-40
Flagstaff
I-40
Metz
89A
Fry
I-17
Rattle
Yellowjacket
N
1970 - 1979
0
10
20
Miles


1980 - 1989
Curley
180
89
2 FIRES = 3,068 ACRES
I-40
Flagstaff
I-40
Railroad
89A
I-17
N
1980 - 1989
0
10
20
Miles


1990 - 1999
Horseshoe
Slate
Hochderffer
180
89
Sunset
Bear Jaw
7 FIRES = 27,831 ACRES
Trick
Side
I-40
I-40
Flagstaff
89A
I-17
1990 - 1999
N
0
10
20
Miles

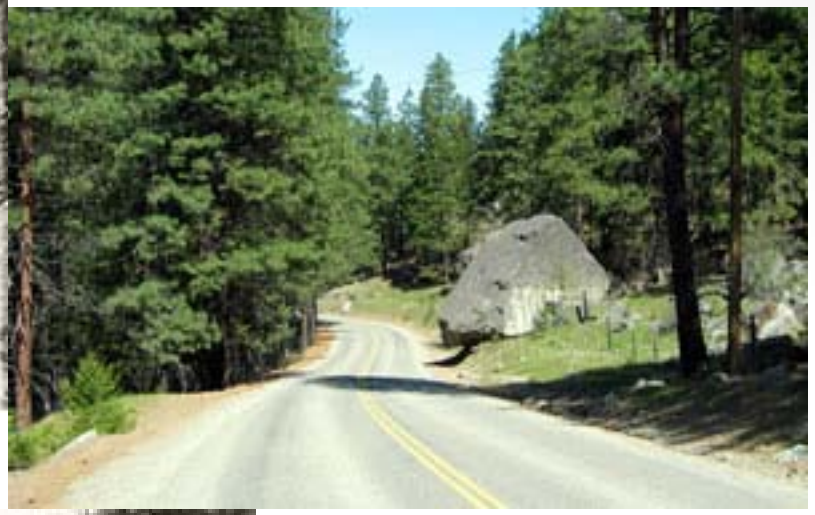

2000 - 2010
Tuba
Red
180
89
Pumpkin
Schultz
10 FIRES = 66,519 ACRES
Pipe
Leroux
I-40
Power
I-40
Lizard
Flagstaff
Knife
Mormon
89A
I-17
Jacket
Taylor
Bear
N
2000 - 2010
0
10
20
Miles

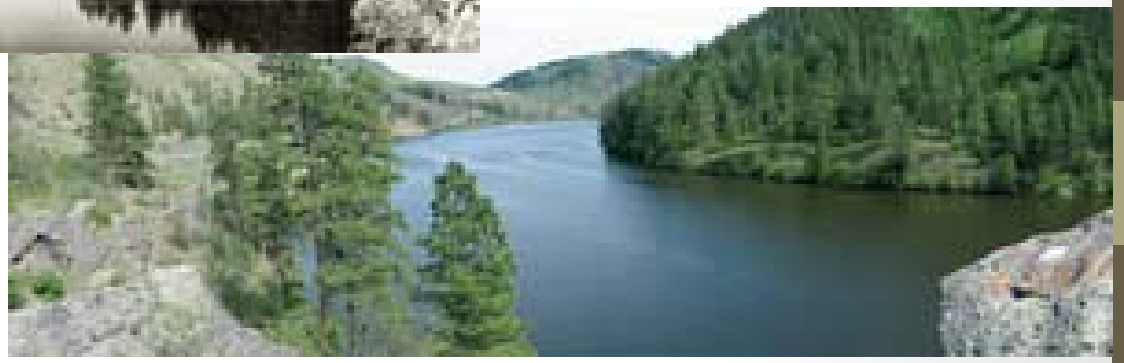
Restoration Need?

Reference Conditions

- Intersecting lines of evidence
  - Photos
  - Fire scars
  - Dendrochronology
  - Historical inventories and remeasurement

Eastern Washington

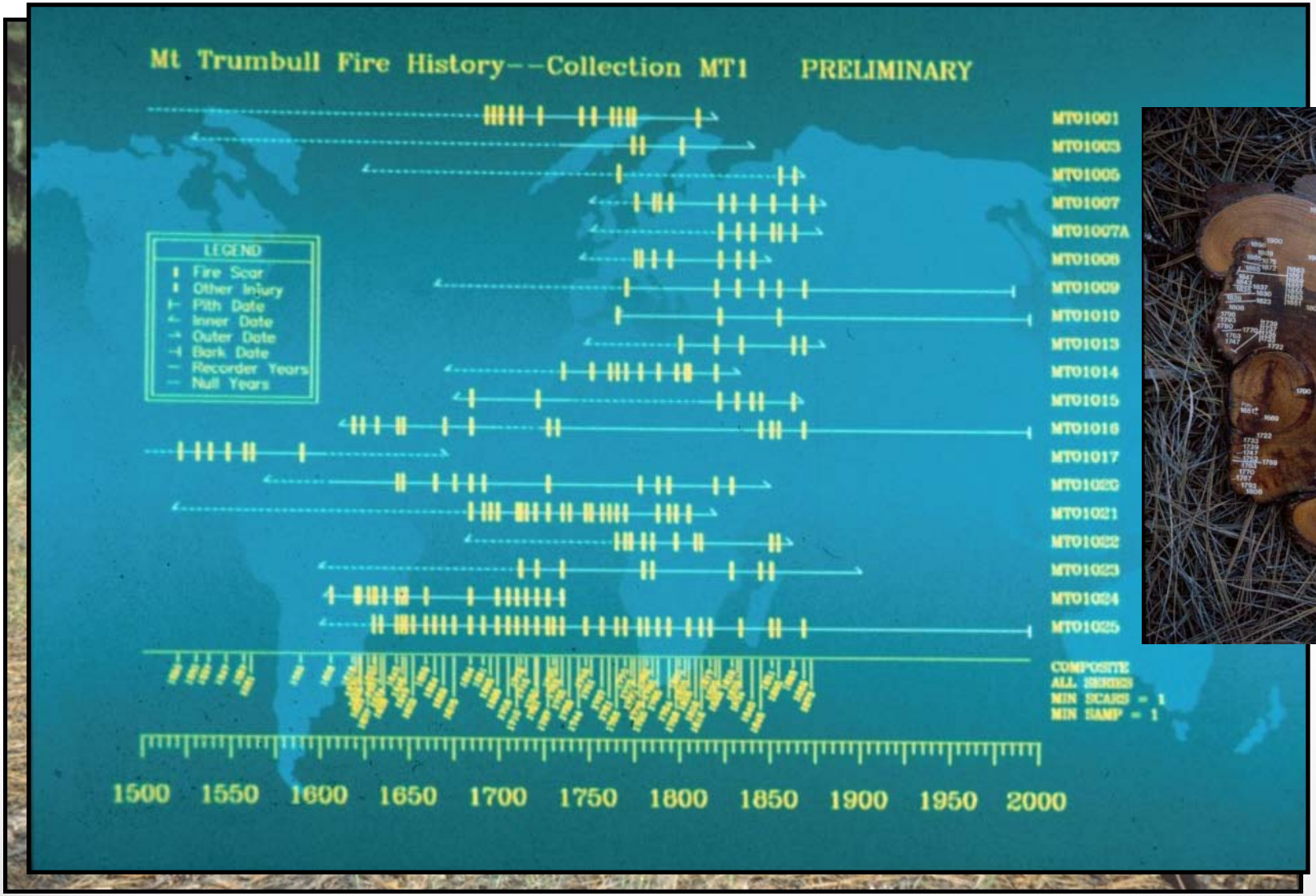




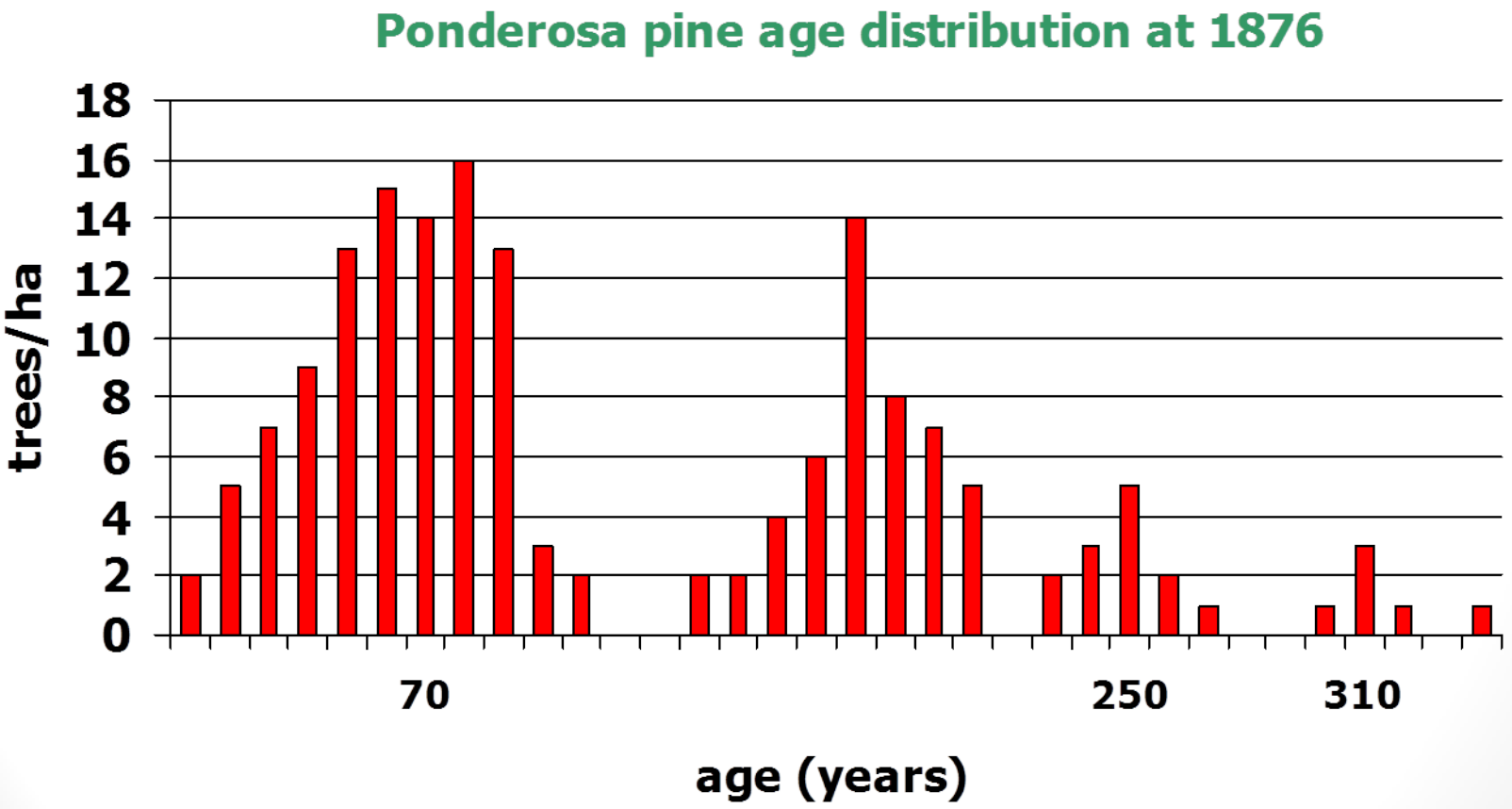
Dale Swedberg

Hart Prairie, AZ

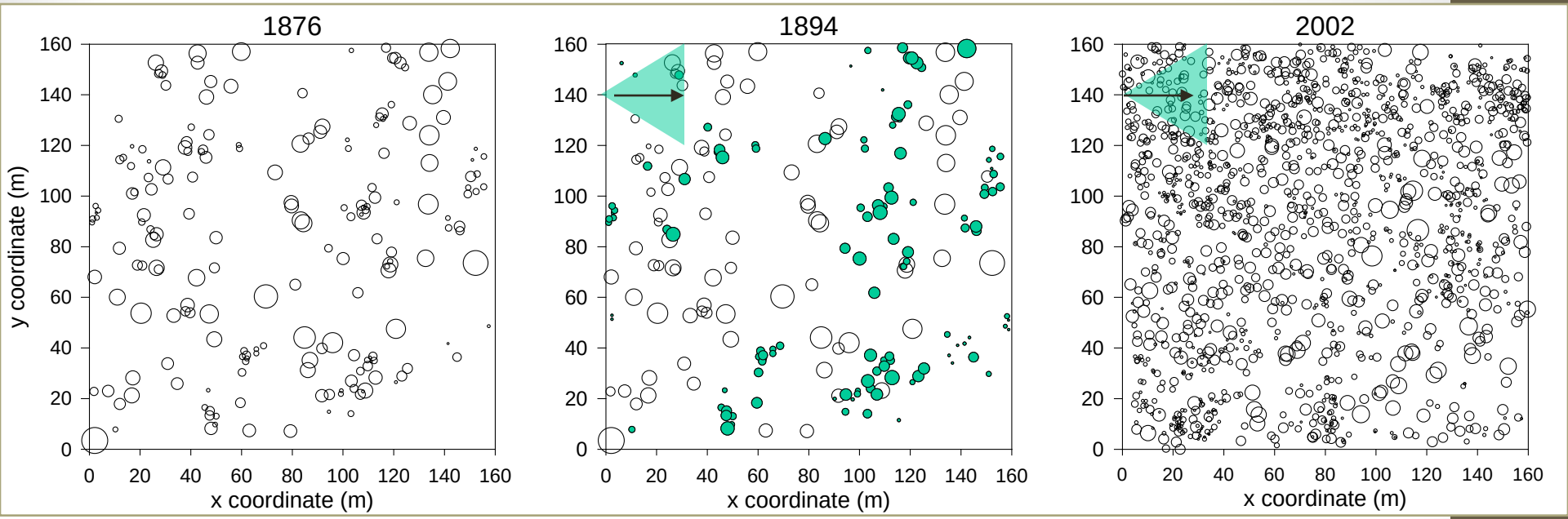
Fire Scars


Mt Trumbull Fire History--Collection MT1 PRELIMINARY
LEGEND
Fire Scar
Other Injury
Pith Date
Inner Date
Outer Date
Bark Date
Recorder Years
Null Years
MT01001
MT01003
MT01005
MT01007
MT01007A
MT01008
MT01009
MT01010
MT01013
MT01014
MT01015
MT01016
MT01017
MT01020
MT01021
MT01022
MT01023
MT01024
MT01025
COMPOSITE
ALL SERIES
MIN SCARS = 1
MIN SAMP = 1
1500 1550 1600 1650 1700 1750 1800 1850 1900 1950 2000

Dendrochronologies

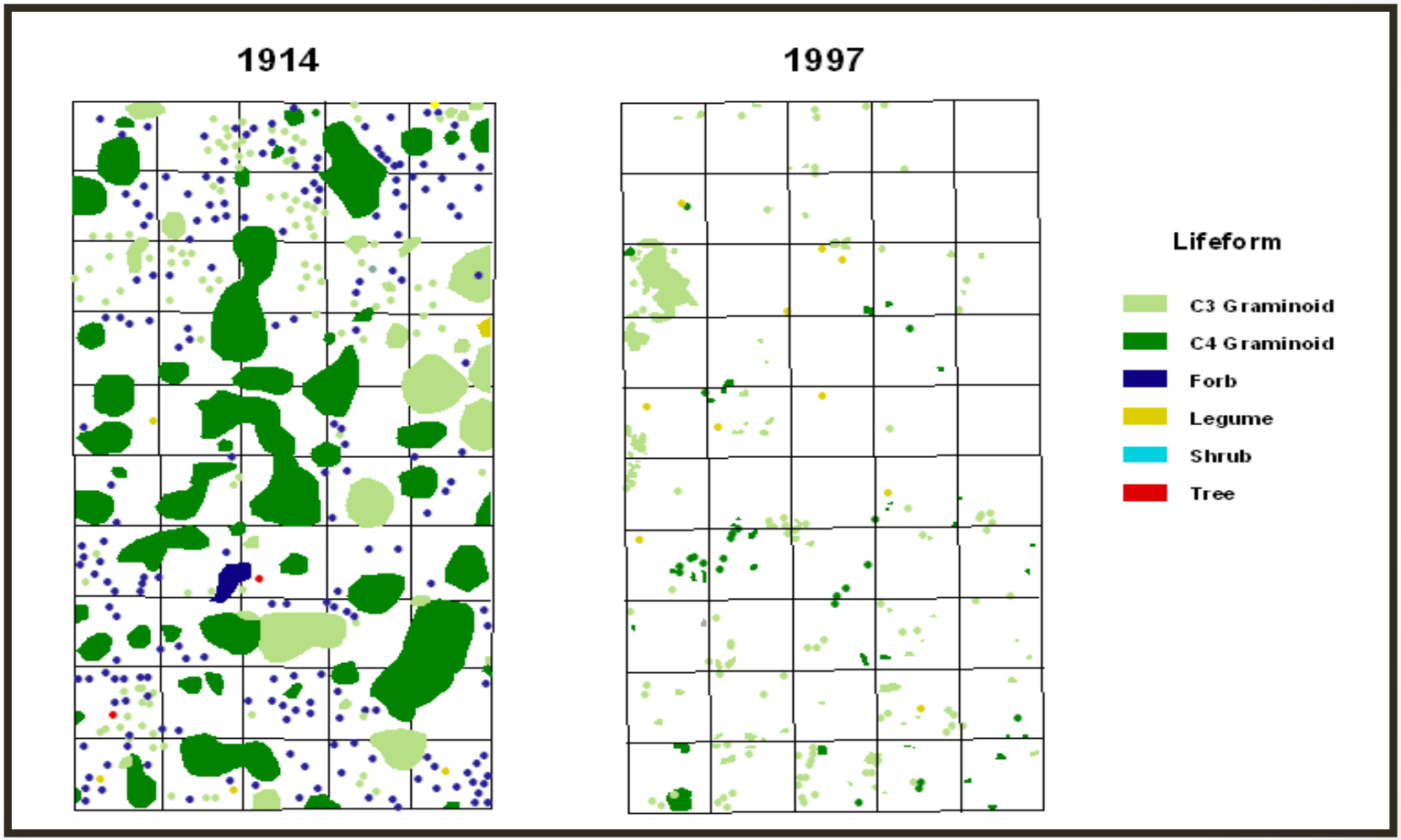


Historical Inventories – COCS1A (Sánchez Meador et al. 2010)



Harvested
Unharvested

Increased pine density → Reduced understory herbaceous plant abundance and diversity



Moore et al. 1999; Bakker et al. 2002

Frequent Fire Forests Fire Regimes

Historic Fire Regime

Fire Suppression

Time 0

+20 yrs

+80 yrs

(Franklin et al. 2008)

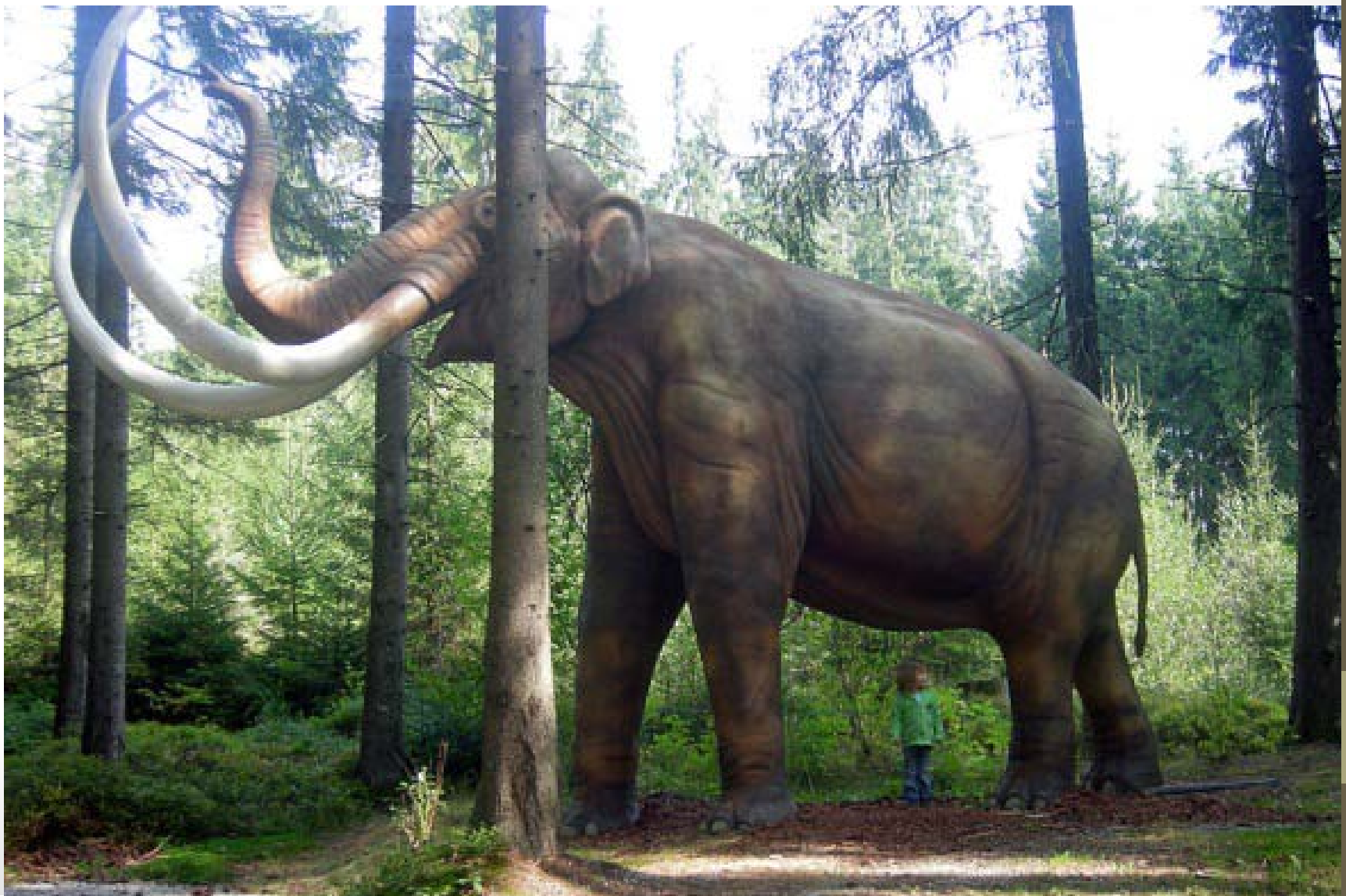
Benefits of Ecological Restoration

- Restoring ecosystems to conditions consistent with their evolutionary environments (HRV)
- Restoring resiliency to ecosystems

Added benefits

- Reduce threats to communities
- Contribute to economic sustainability
- Conserve wildlands for present and future generations

Evolutionary history of frequent fire forests

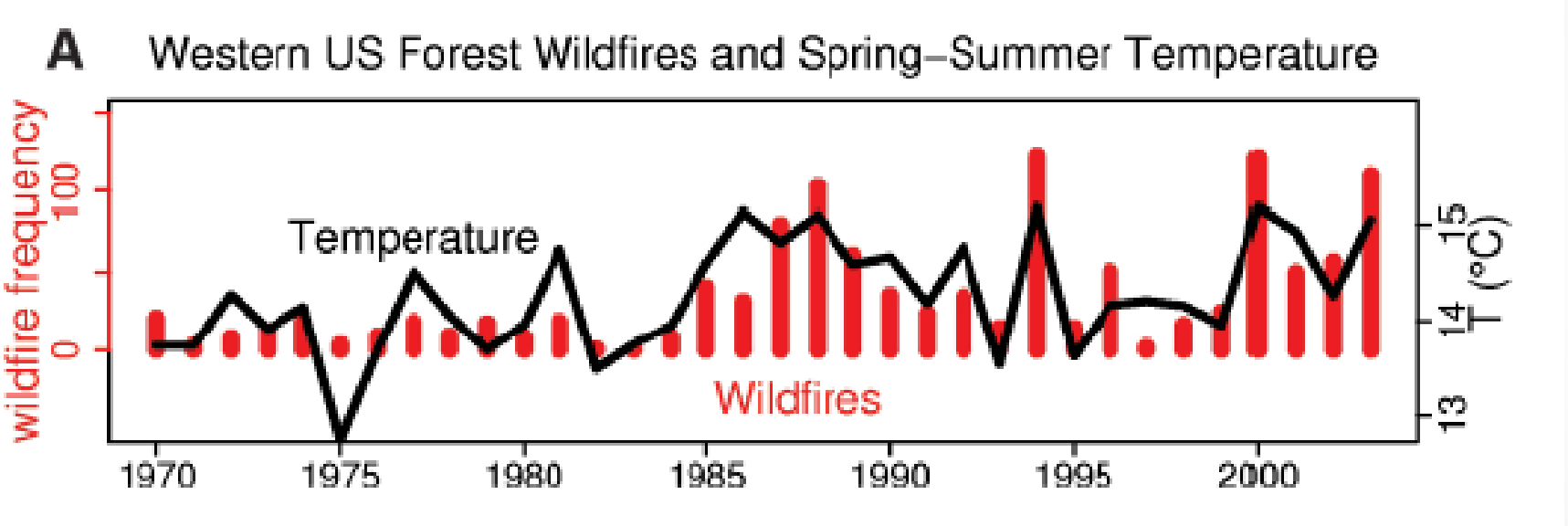


Past rapid climatic changes and implications for the future:

- Global temperatures:
  - PAST: changes up to 5 degrees C, sometimes within decades (Holocene).
  - FUTURE: predicted changes 2 – 5 deg C by 2100
- Carbon dioxide concentrations:
  - PAST: fluctuated from 260 ppm to 280 ppm in last 10,000 years
  - CURRENT: current level is 392 ppm, greater than at any time in the last 400 thousand years.

- Frequent fire landscapes have been exceptionally resilient at past temp changes: but not in their current unhealthy conditions.

Climate Change:
Warmer spring/summer temperatures



Correlation between large (>400 ha) fire frequency and spring summer temperature.

Westerling et al. 2006

Historical reference conditions

- Historically forests were:
  - resilient to fire environmental fluctuations
  - maximized carbon sequestration under frequent-fire regimes

(North et al. 2009; Dore et al. 2010).

- East of the Cascades, old growth *Pinus ponderosa* forests:
  - were multi-aged
  - had an average diameter at breast height of 25.2 inches
  - averaged 20.3 trees per acre of upper canopy trees
  - Exhibited both clumped and random distributions of trees

(Youngblood et al. 2004)

Restoration Need?

- Uncharacteristic disturbance regimes: fire, insects
- Threatened communities and infrastructure
- Decreasing understory diversity, increasing homogeneity at all levels of the ecosystem
- Spread of invasive exotic plants
- Lack of resiliency to adapt to climate change

What will be our landscape legacy?

- What kind of landscape would we like to have inherited?
- What kind of landscape would we like to pass along to future generations?

Restoration Approaches

- Retain trees which predate settlement
- Retain postsettlement trees needed to re-establish presettlement structure
- Thin and remove excess trees
- Burn to reduce accumulated surface fuels
- Burn to emulate natural disturbance regime
- Promote natives /control invasive species

Covington & Moore 1994

Fuel reduction and restoration can be mechanical, or through prescribed burning

Restoration

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- Reference conditions overlaid with other values (ecological, social, economic) are used to develop desired condition.

Adaptive management framework

Operational framework

Economic framework

Meeting Ecological Restoration Goals
Prioritizing across the landscape

- Natural disturbance regimes
- Native plants and animals at reference populations
- Changes from HRV

Prioritized implementation for:

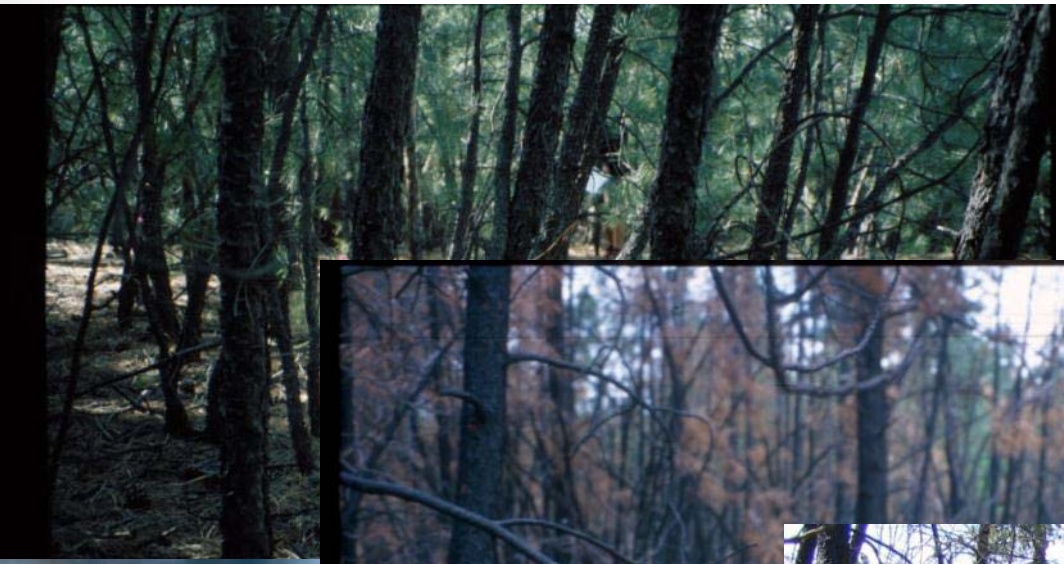
- Reduction of threats to human communities
- Reduction of threats to wildlife habitats
- Restoration corridors and patches
- Restoration implementation with economic feasibility
- Conservation networks for wildlife and humans

Change Basic Prescription for Specific Resource Objectives

- Might leave more trees to accommodate specific resource management objectives, e.g., screening cover for human or wildlife habitat goals, future wood harvesting, favoring specific uses
- Might leave fewer trees to accommodate other objectives, e.g., to favor viewsheds, wildlife goals, grazing, water balance

Alternative Restoration Thinning Prescriptions Produce Very Different Outcomes

Burn Only

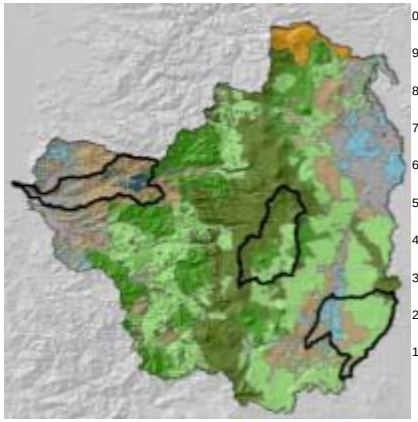


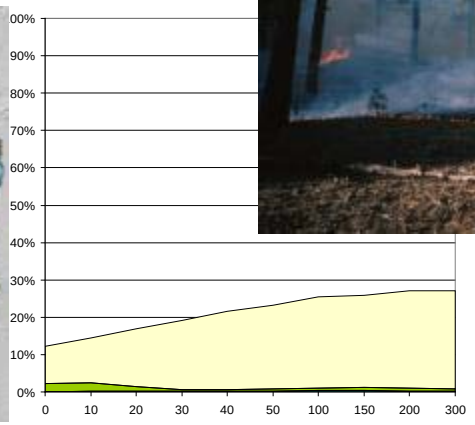
Minimal Thinning

Full Restoration

Desired Future Condition

- Integrate
  - Historic range of variability
  - Current-day values
  - On-going efforts
  - Science-based, best management practices





Restoration

A Multi-disciplinary Framework

Scientific framework

Social, economic and political framework

Adaptive management framework

- Developing the question
- Monitoring
- Effective learning from doing

Operational framework

Economic framework

What is adaptive management?

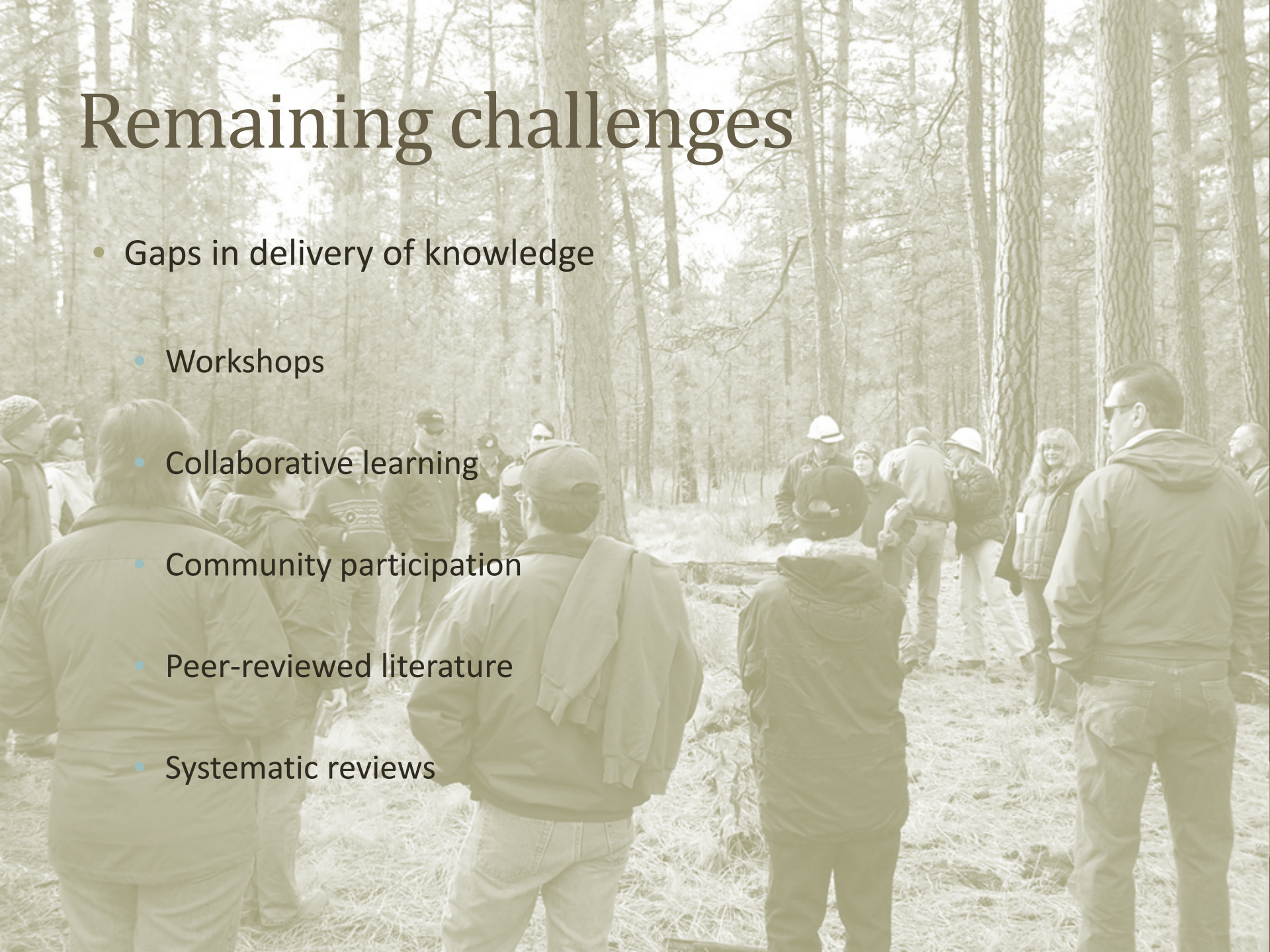
- Ruthlessly embracing uncertainty
- Developing questions
- Partnering with researchers, citizen-scientists, regional monitoring to address questions.
- Learn by doing
- Manager and stakeholder structured learning
- Adapt

Remaining challenges

- Gaps in knowledge
  - Ecosystem impacts of dry forest/woodland restoration
    - **Matt Busse, John Lehmkuhl, Brian Staab**
  - Effectiveness of restoration treatments on multiple values
    - **Martin Ritchie, George Chesley**
  - Prioritization of multiple values
    - **Alan Ager**
  - Mixed severity fire regimes
    - **Tom Spies, Michael Fisher**
  - Restoration Prescriptions
    - **John Bailey, Derek Churchill, Andy Youngblood, Steve Fitzgerald**
  - Restoration Economics
    - **Paul Harlan, Loren Kellogg**
  - Climate Change
    - **Morris Johnson**

Remaining challenges

- Gaps in delivery of knowledge
  - Workshops
  - Collaborative learning
  - Community participation
  - Peer-reviewed literature
  - Systematic reviews



Systematic Reviews

QUESTION:
Do thinning and/or burning treatments in western USA ponderosa or Jeffrey pine-1 dominated forests help restore natural fire behavior?

PROCESS:
Systematic review and meta-analysis of forest thinning and burning treatments.

HIGHLIGHTS:

- Pinus ponderosa and P. jeffreyi dense stands and high fuels, severe fires.
- 54 studies with quantitative data on treatments.
- Combined thinning + burning had the greatest effect.
- There are a number of qualifications to the findings.

P.Z. Fulé*, J.E. Crouse, J.P. Roccaforte, and E.L. Kalies (in press, Forest Ecology and Management)

Summary

- The dry, frequent fire ecosystems of the West are threatened
- Reference conditions are needed to develop the baseline for restoration
- Multiple values are an integral component of these ecosystems and desired conditions
- Adaptive management is necessary to address uncertainties
- Restoring ecological and social integrity for the future requires strategic management action today

Questions Discussion