Site and tree selection, sample design, and sampling techniques

How do we decide which trees to sample?
How do we collect tree-ring samples?

There are endless sampling designs to choose from!

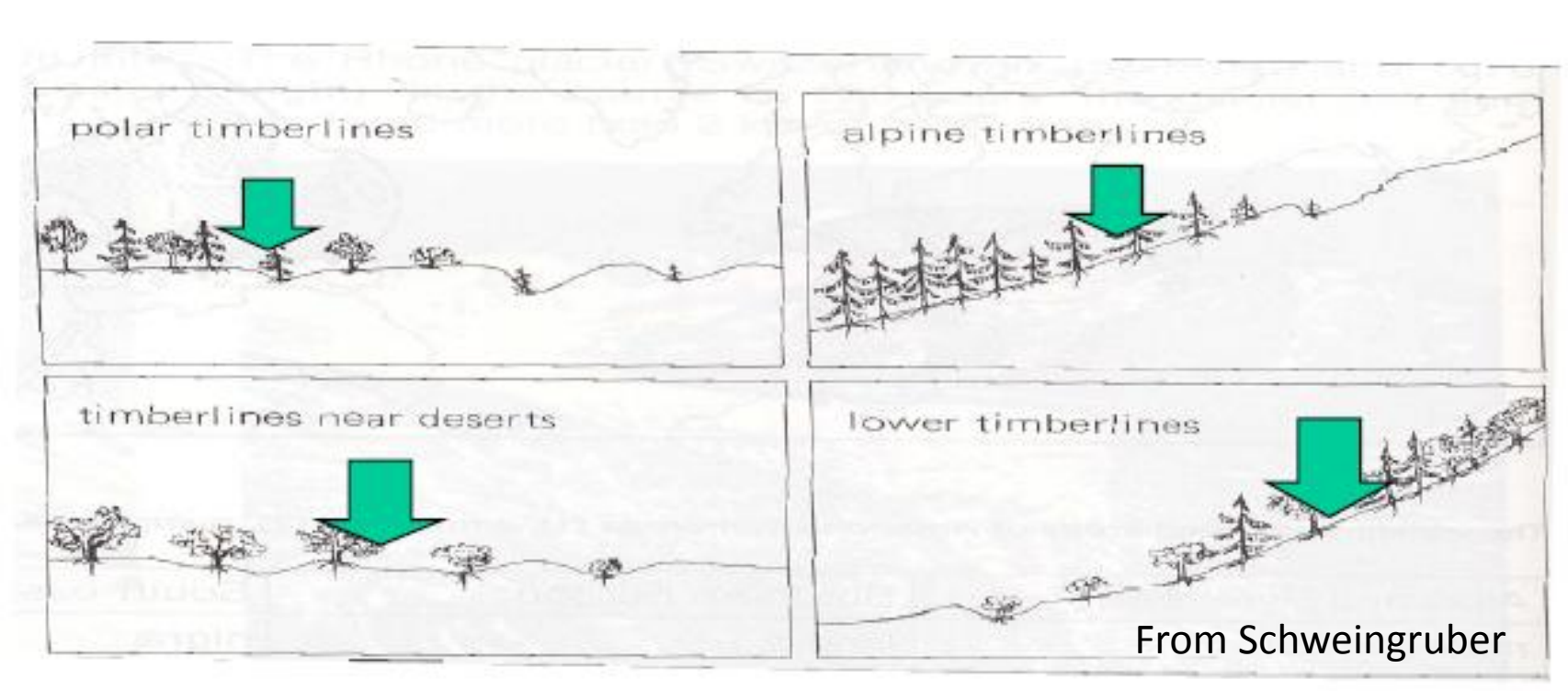
- Plots (fixed radius or n-tree)
- Targeted
- Systematic grids
- Stratified (random)
- Transects

Sampling is driven by the study design, which is always defined by the research question:

- Climate reconstruction
- Chronology building
- Tree growth along an environment gradient
- Climate change effects on tree growth
- Age structure
- Effects of topographic position on tree growth
- Fire or insect outbreak history
- Others?

Site selection for climate reconstruction

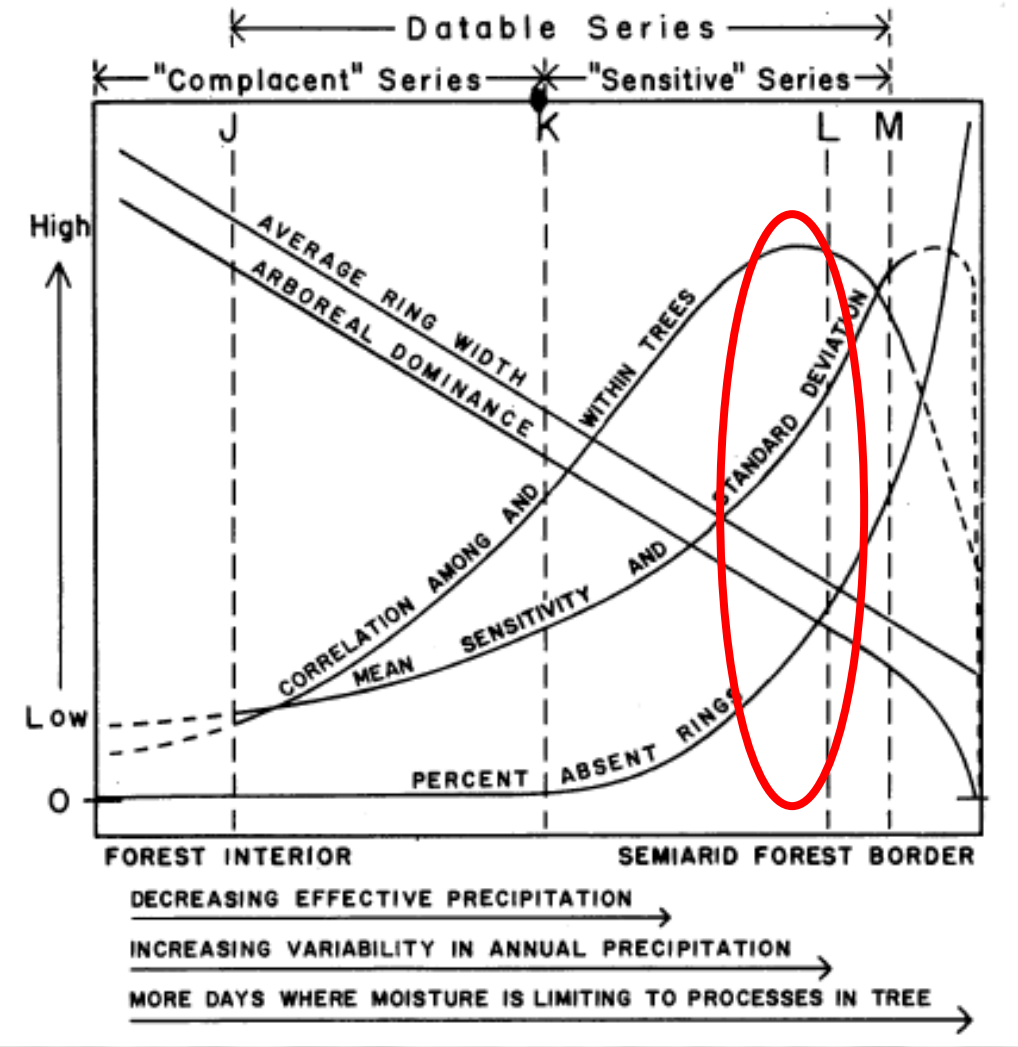
- If building a dating chronology, or seeking climate signal, one would go near, but probably not to, a distributional limit:



Why these locations?

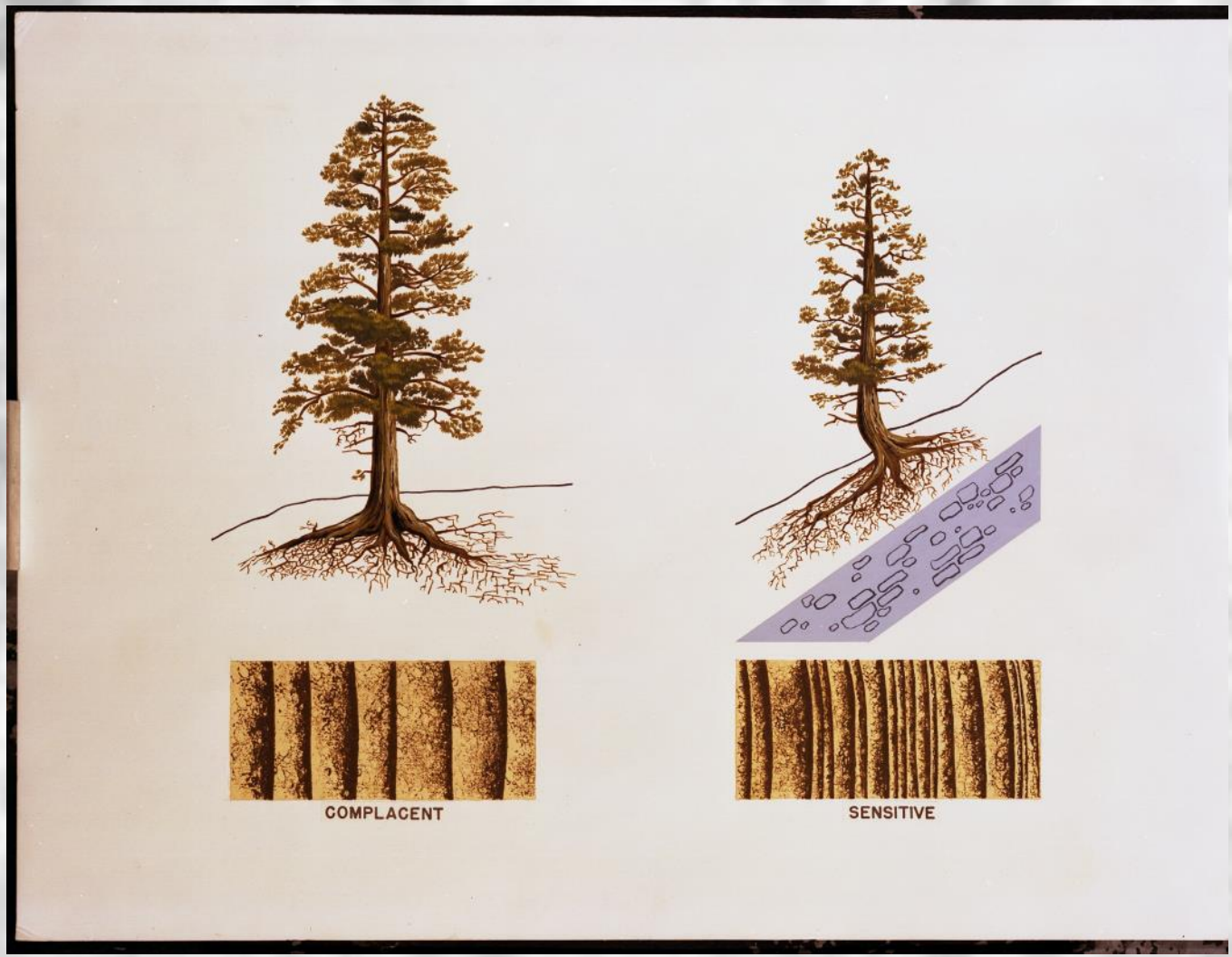
- **Near the limit** because these are usually where a single environmental factor – for example available soil moisture – controls growth, so tree rings will tend to show stronger patterns of **common variation**.
- **Not exactly at** limit, because conditions are often so stressed there that circuit uniformity is poor, and missing rings so frequent that dating is more difficult.
- Open-grown stand – reduce between-tree interactions (thus, this depends on question).

Site selection at the semiarid margin of a species' local distribution reveals moisture as limiting factor



Fritts 1965, *Ecology*

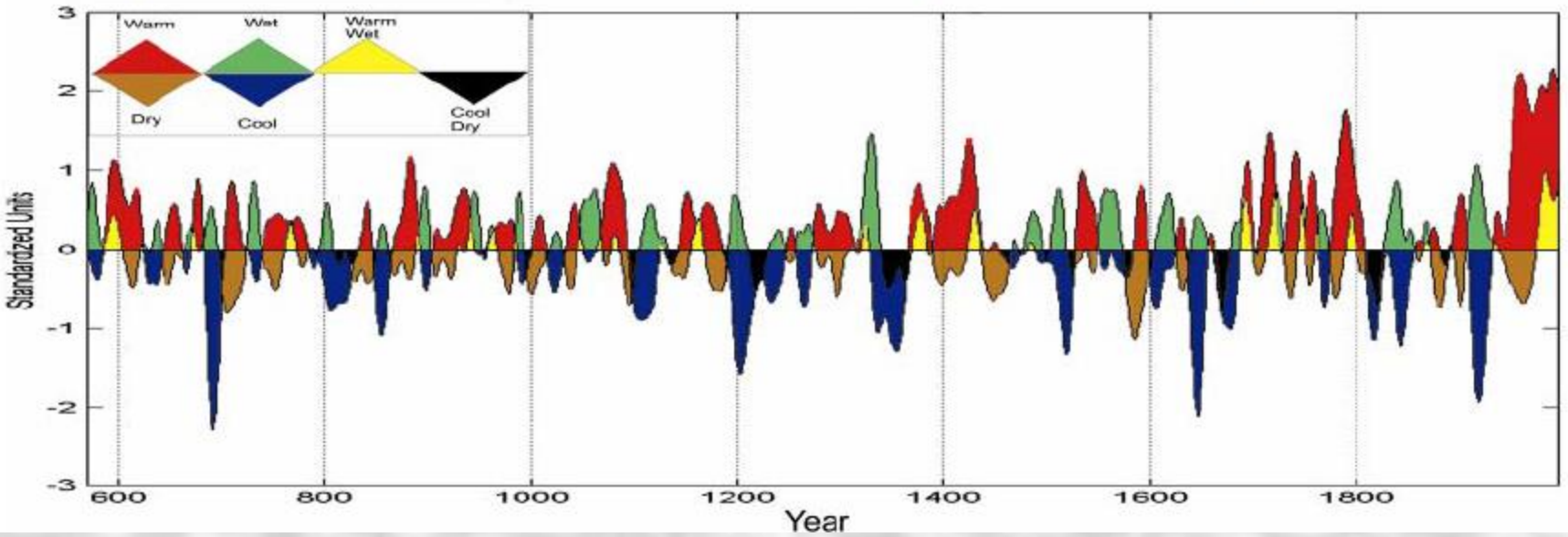
Sensitive vs Complacent Trees



Climate sensitive trees

Temperature & Precipitation reconstruction comparisons

Temperature reconstruction from upper treeline bristlecone pine (living and remnant); Precipitation reconstruction from lower treeline Douglas-fir, ponderosa, pinyon pine (living and archeological)



Salzer MW, Kipfmueller KF. 2005. Reconstructed temperature and precipitation on a millennial timescale from tree-rings in the Southern Colorado Plateau, USA. CLIMATIC CHANGE 70 (3): 465-487

Other considerations in tree and site selection

Open-grown stand, minimal tree interaction maximizes climate signal.*Pinus longaeva*, White Mts, California, about 3000 yrs old.

Photo V.C. LaMarche

Closed-canopy stand with evidence of past disturbance, substantial tree interactions, and thus more of an ecological signal in the tree-ring record.
Picea engelmannii, Abies concolor and Populus tremuloides, White Mts, Arizona

Sampling design for dendroecology may follow different logic:

- Often in dendroecology we look for growth differences among trees:
  - Growth increases in trees released from competition
  - Host/non-host differences in stands affected by a host-specific insect (e.g. defoliator)
  - Growth changes from foliar damage during fire
  - Clusters of recruitment dates reflecting climate and disturbance

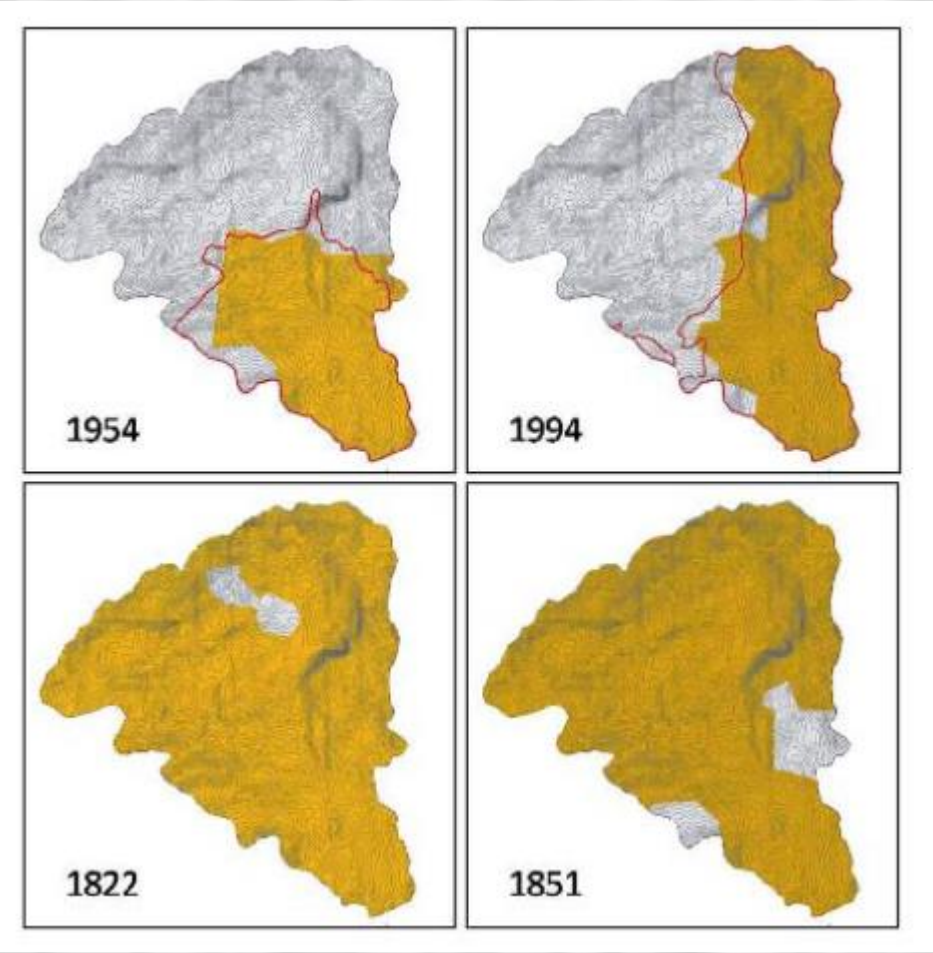
Sampling considerations in fire history

Example Research Questions:

- How does fire occurrence and extent vary with climate?
- To what extent is fire area burned governed by topography?
- What is the influence of sample area on metrics of the fire regime?

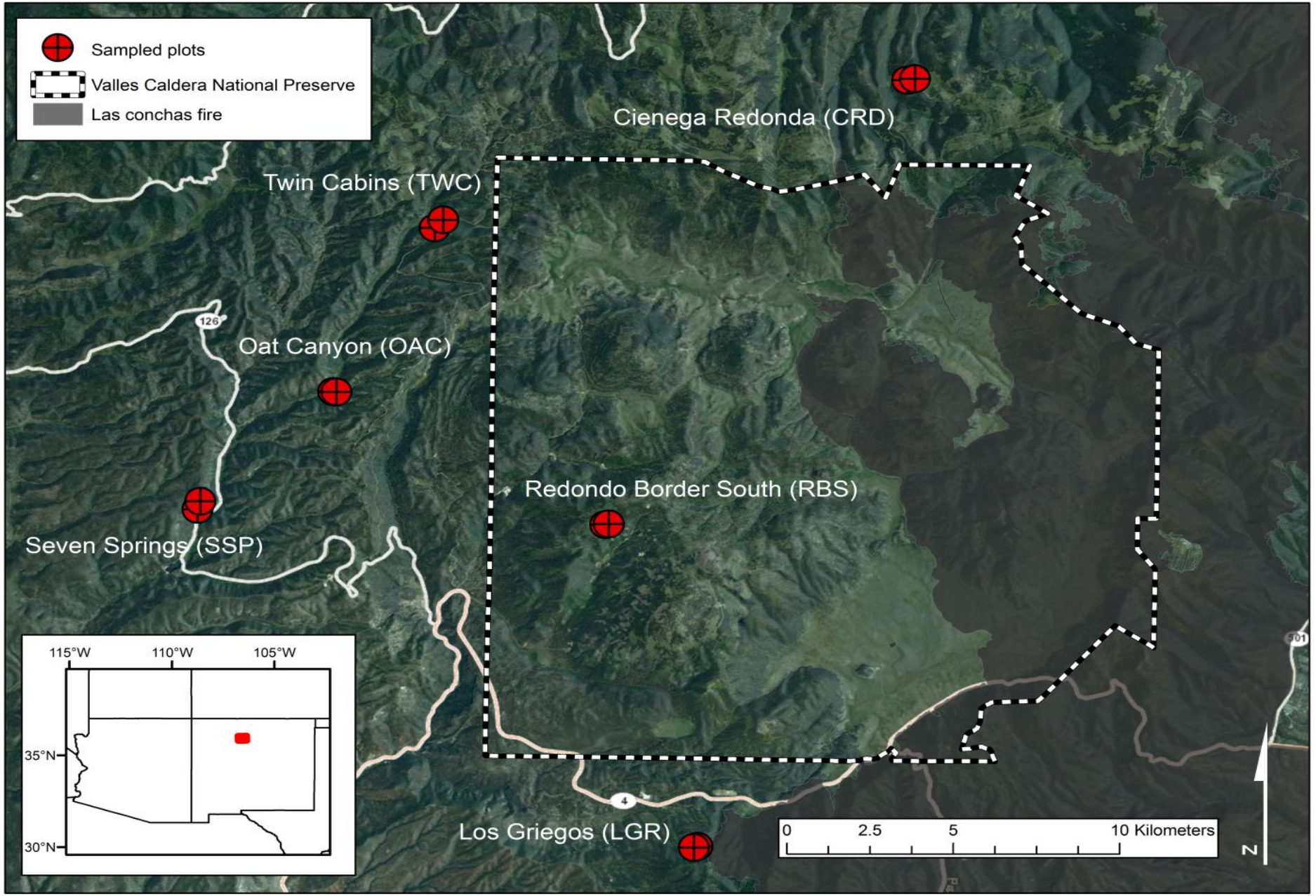
Each of these would suggest different sampling strategies

Farris et al. 2010: Objective was to compare landscape patterns of area burned reconstructed from fire scars with perimeters in fire atlases (Rincon Mts, AZ)



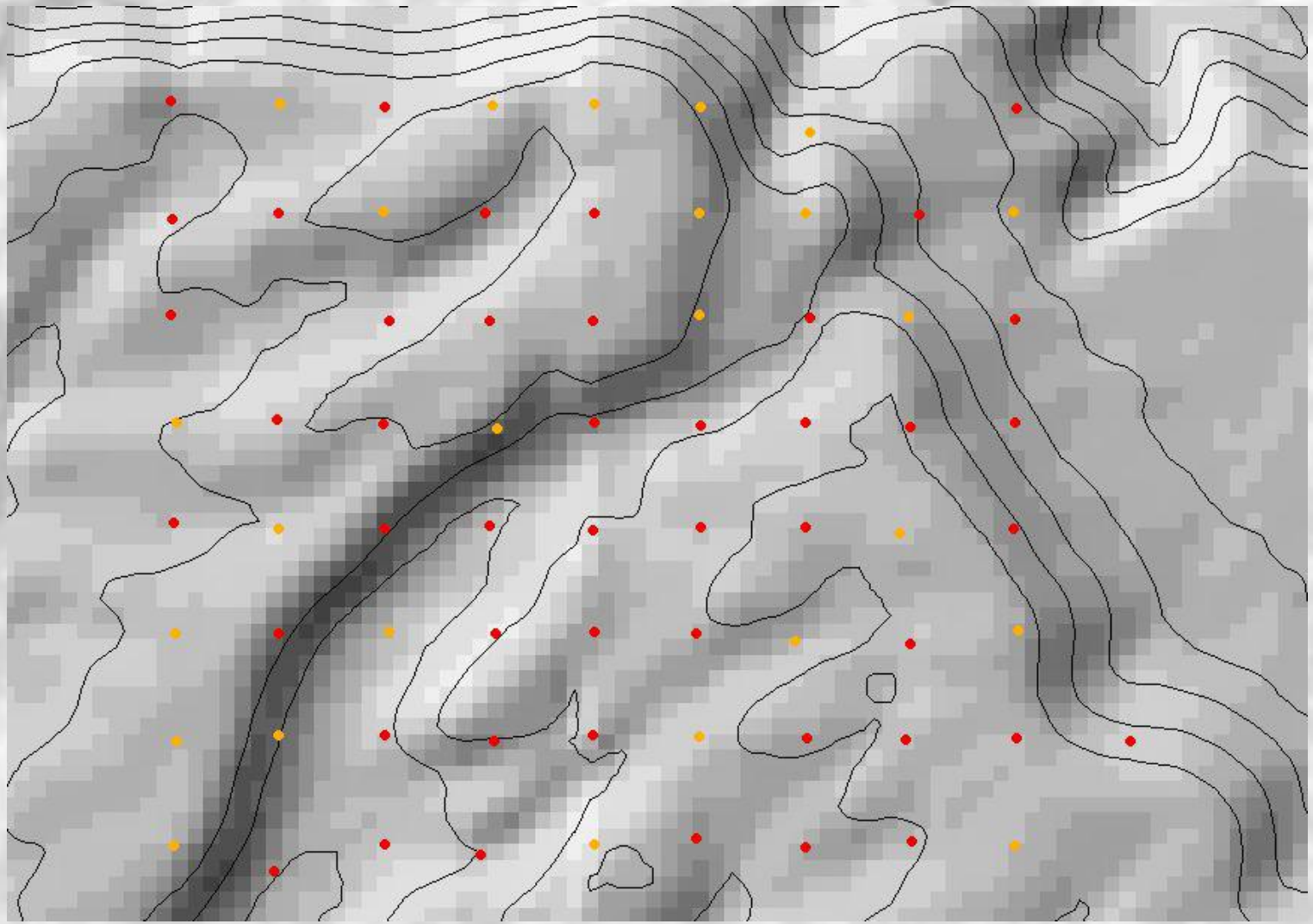
This objective required a spatially distributed, gridded sample design

“Occupied” Jemez Mountain Salamander sites



Gridded fire history at Monument Canyon RNA, NM

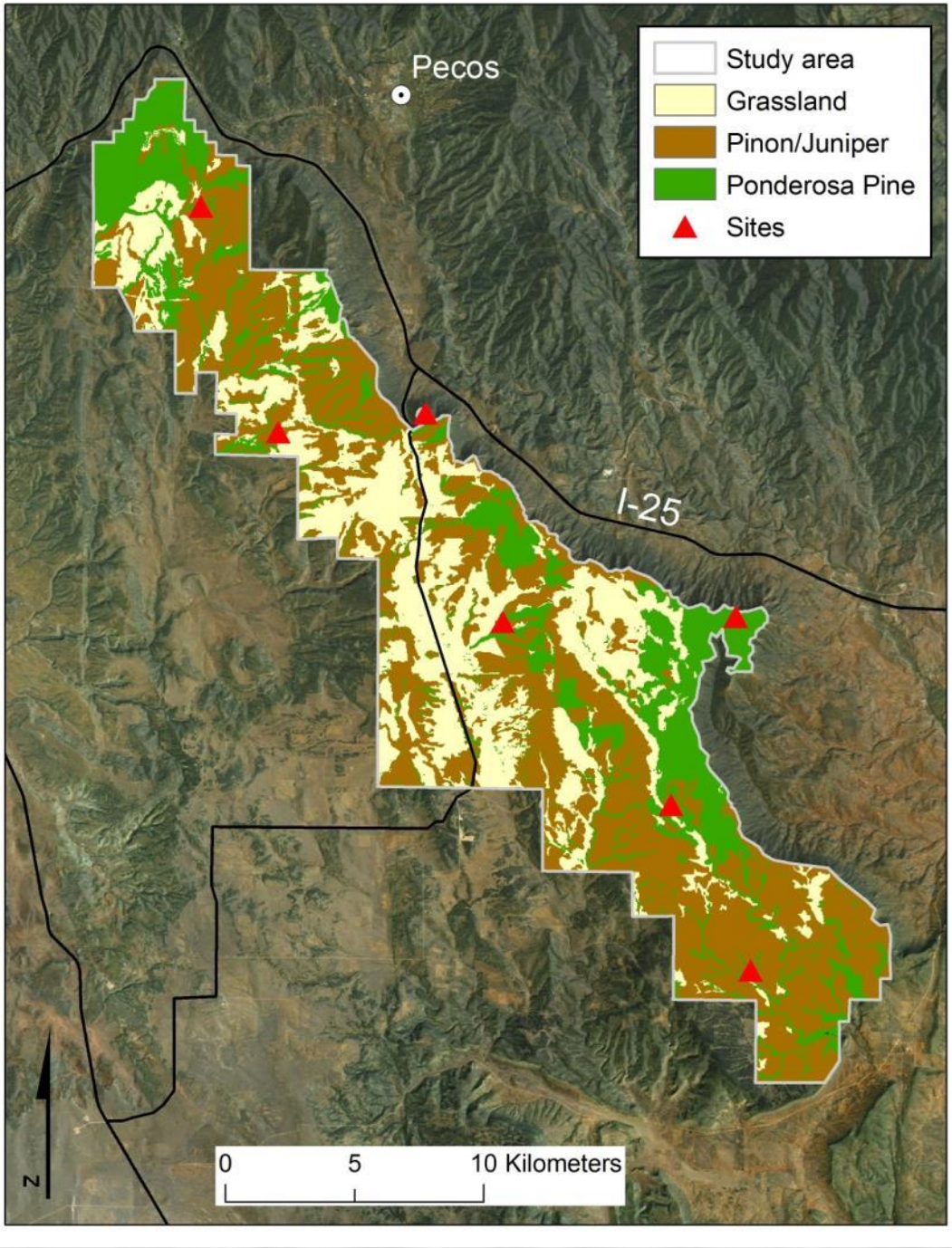
Question: Are metrics of the fire regime scale dependent?



Vegetation

(ground corrected Landfire EVT):

- **47% - Piñon-juniper** (savanna) - *Pinus edulis*, *Juniperus scopulorum*, *J. monosperma*
- **29% - Grassland** (short grass) - *Bouteloua gracilis*
- **24% - Ponderosa pine** - *Pinus ponderosa, Quercus undulata*



Margolis 2013 IJWF

Tree-ring sample collection

Increment cores:

1. tree age

2. climate reconstruction

Surface fire history


Pecos Wilderness


STIH

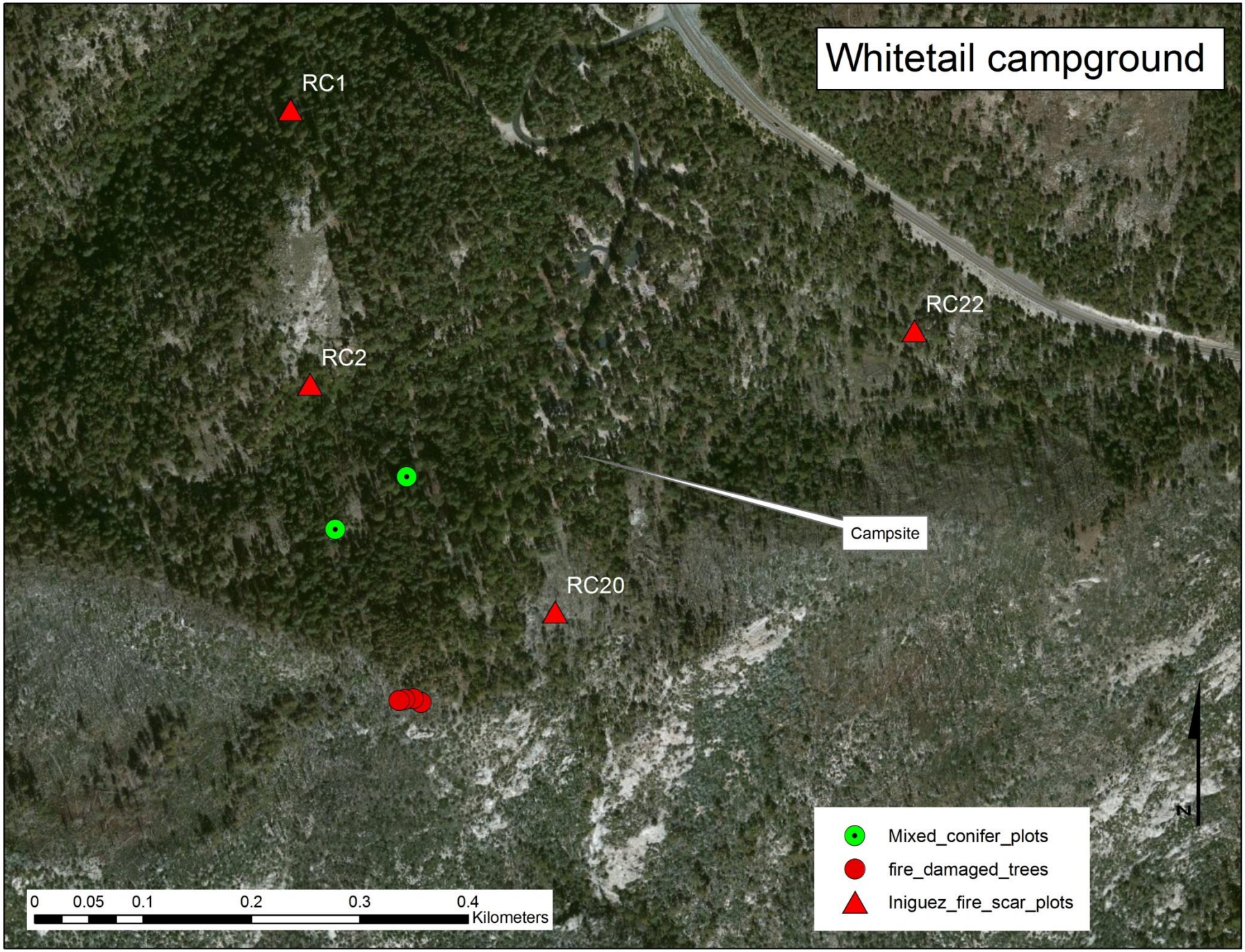
Sometimes you take anything you can find

Sampling **all** live and dead trees to reconstruct composition, age structure, and fire history in mixed conifer forests

We often “target” certain trees that have the information we seek

Fire-killed tree death dates

Class Field Trip


Whitetail campground
RC1
RC2
RC22
RC20
Campsite
0 0.05 0.1 0.2 0.3 0.4
Kilometers
N
Mixed_conifer_plots
fire_damaged_trees
Iniguez_fire_scar_plots

Research questions

1. Has fire exclusion affected tree species composition and density?

2. Is there a tree-ring response to crown damage from fire?

Species composition and density change?

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2013)

CORRESPONDENCE

Unsupported inferences of high-severity fire in historical dry forests of the western United States: response to Williams and Baker

Peter Z. Fulé[1]*, Thomas W. Swetnam[2], Peter M. Brown[3], Donald A. Falk[4,2], David L. Peterson[5], Craig

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2014)

CORRESPONDENCE

High-severity fire corroborated in historical dry forests of the western United States: response to Fulé *et al.*

Mark A. Williams and William L. Baker*

OPEN ACCESS Freely available online

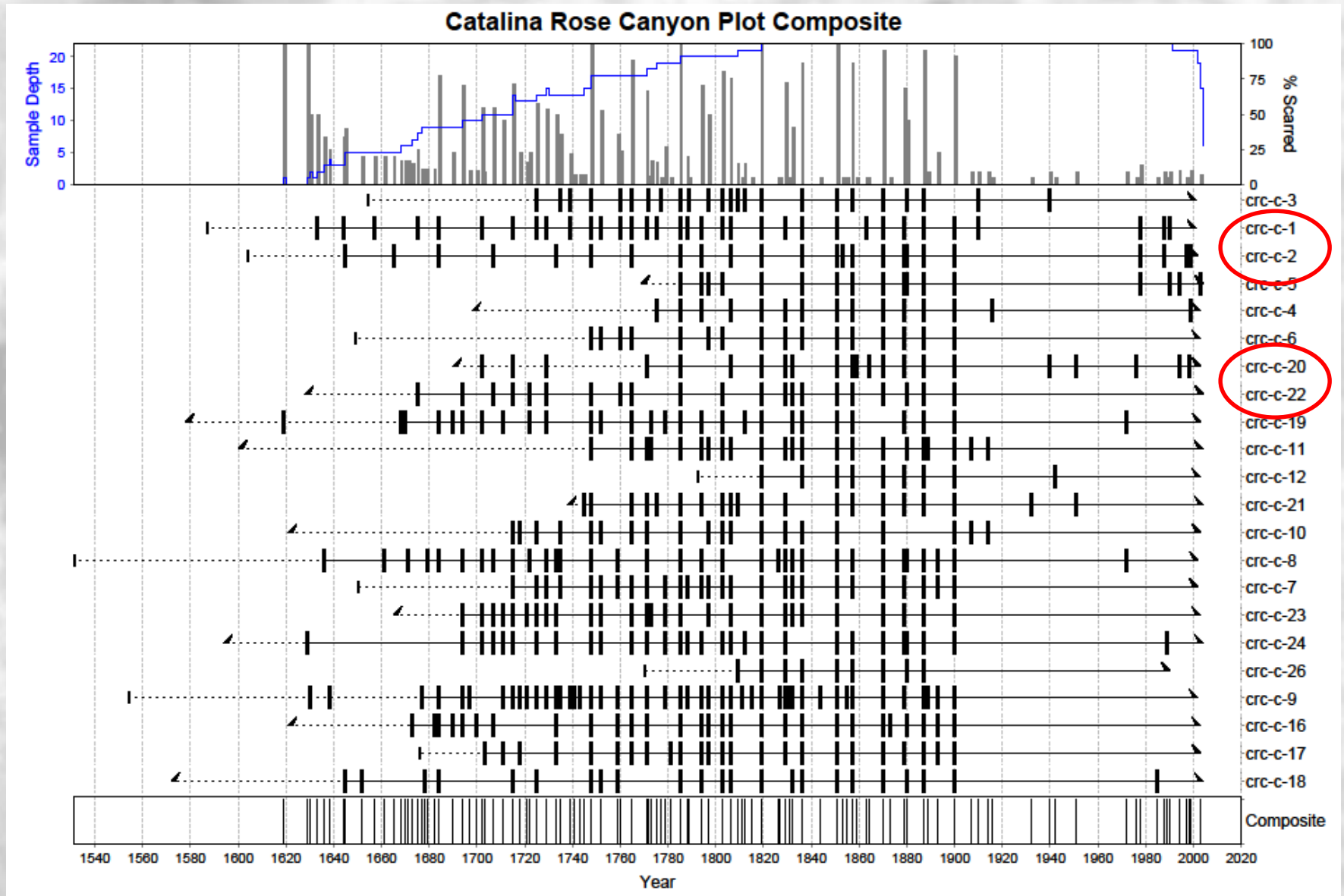
PLOS ONE

Examining Historical and Current Mixed-Severity Fire Regimes in Ponderosa Pine and Mixed-Conifer Forests of Western North America

Dennis C. Odion[1,2]*, Chad T. Hanson[3], André Arsenault[4], William L. Baker[5], Dominick A. DellaSala[6], Richard L. Hutto[7], Walt Klenner[8], Max A. Moritz[9], Rosemary L. Sherriff[10], Thomas T. Veblen[11], Mark A. Williams[12]

"current attempts to ''restore'' forests to open, low-severity fire conditions may not align with historical reference conditions in most ponderosa pine and mixed-conifer forests of western North America."

Last widespread fire in 1899



Were these sites mixed conifer when there was frequent fire?

Sample design

- 2 n-tree plots in mixed conifer forest
- Core 30 trees in each plot to determine whether they pre- or post-date the last widespread fire (1899)?

Research questions

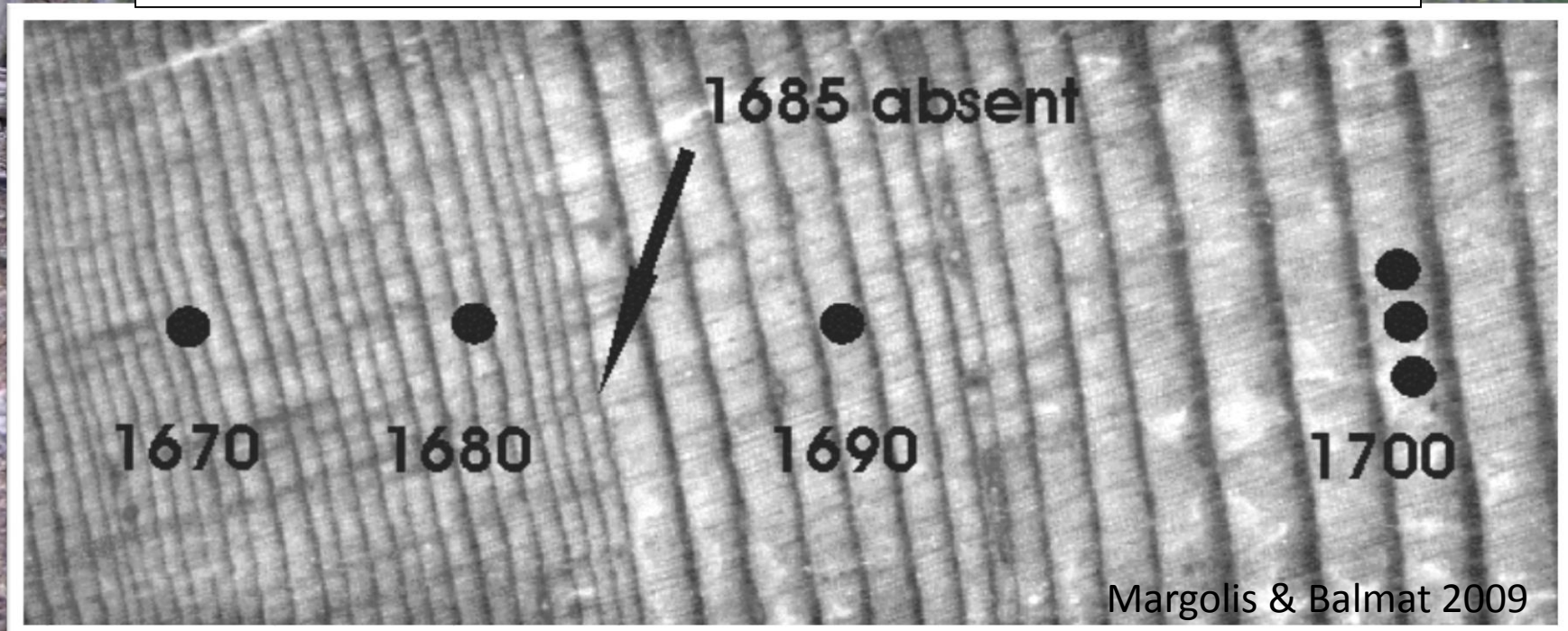
1. Has fire exclusion affected tree species composition and density?

2. Is there a tree-ring response to crown damage from fire?

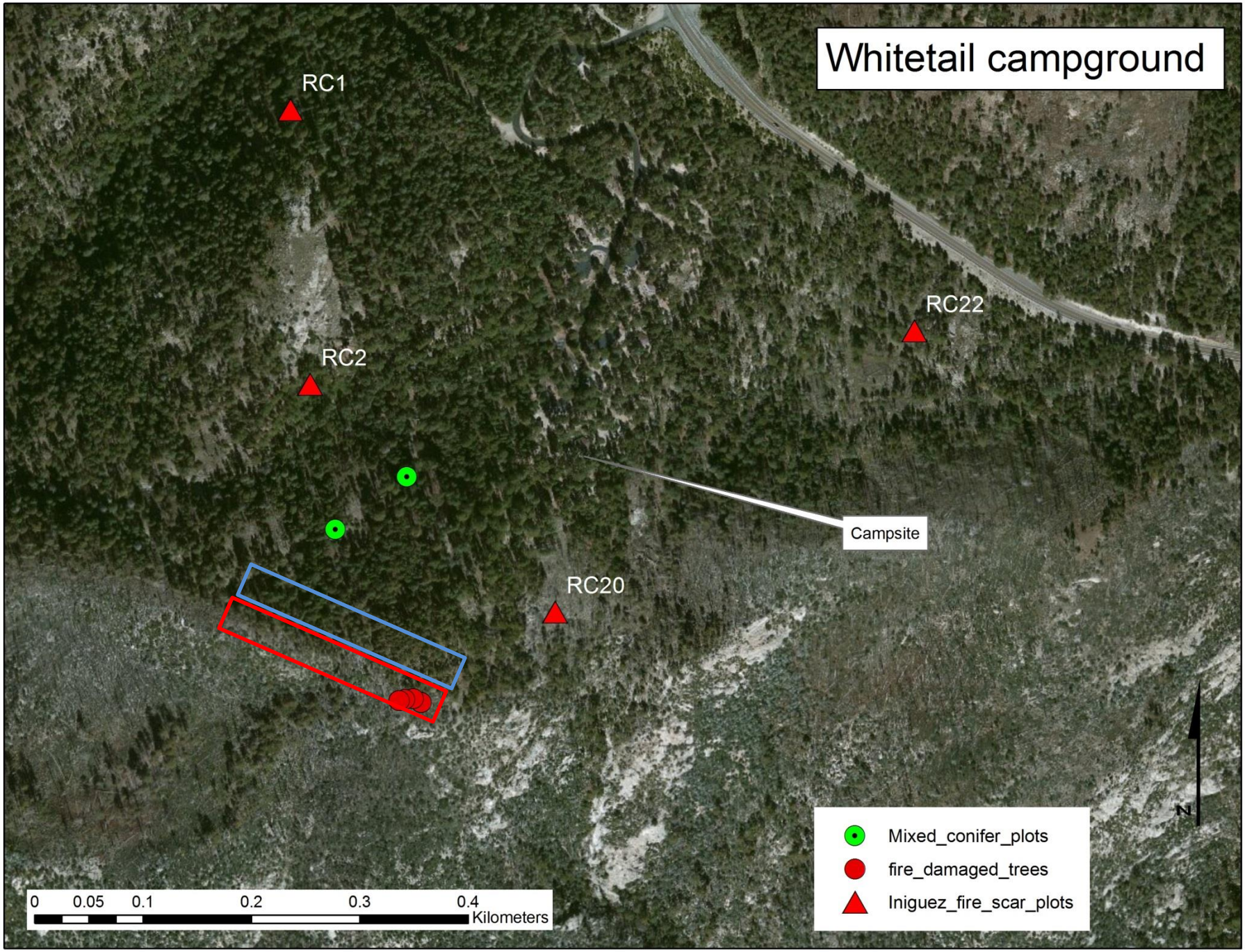
Injured fire-survivors (growth changes/resin ducts)

Fire-survivors

Missing ring, then release after fire



Growth suppression following crown damage from fire


Whitetail campground
RC1
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0 0.05 0.1 0.2 0.3 0.4
Kilometers
N
Mixed_conifer_plots
fire_damaged_trees
Iniguez_fire_scar_plots

Tree-ring response to crown damage from fire