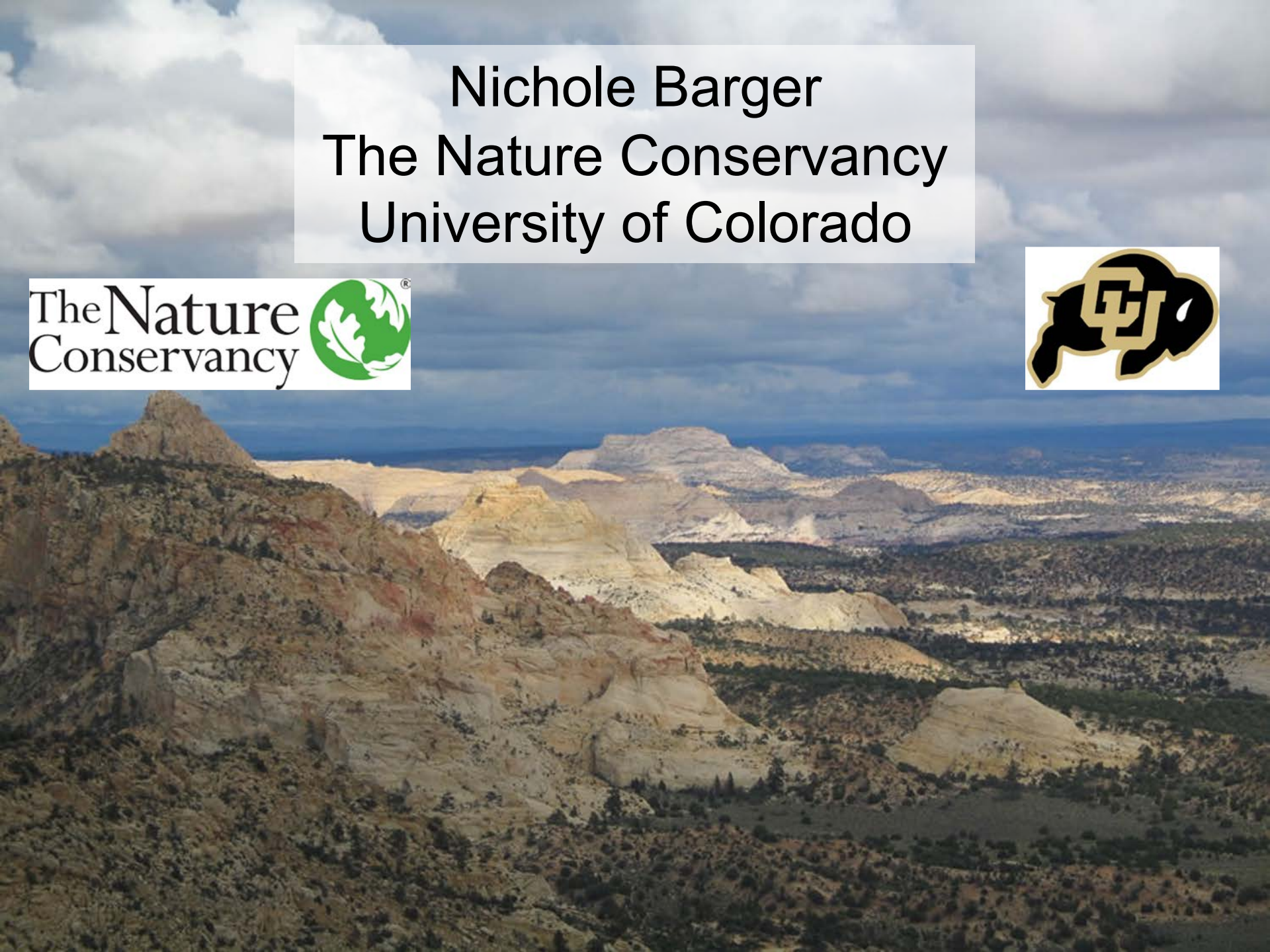
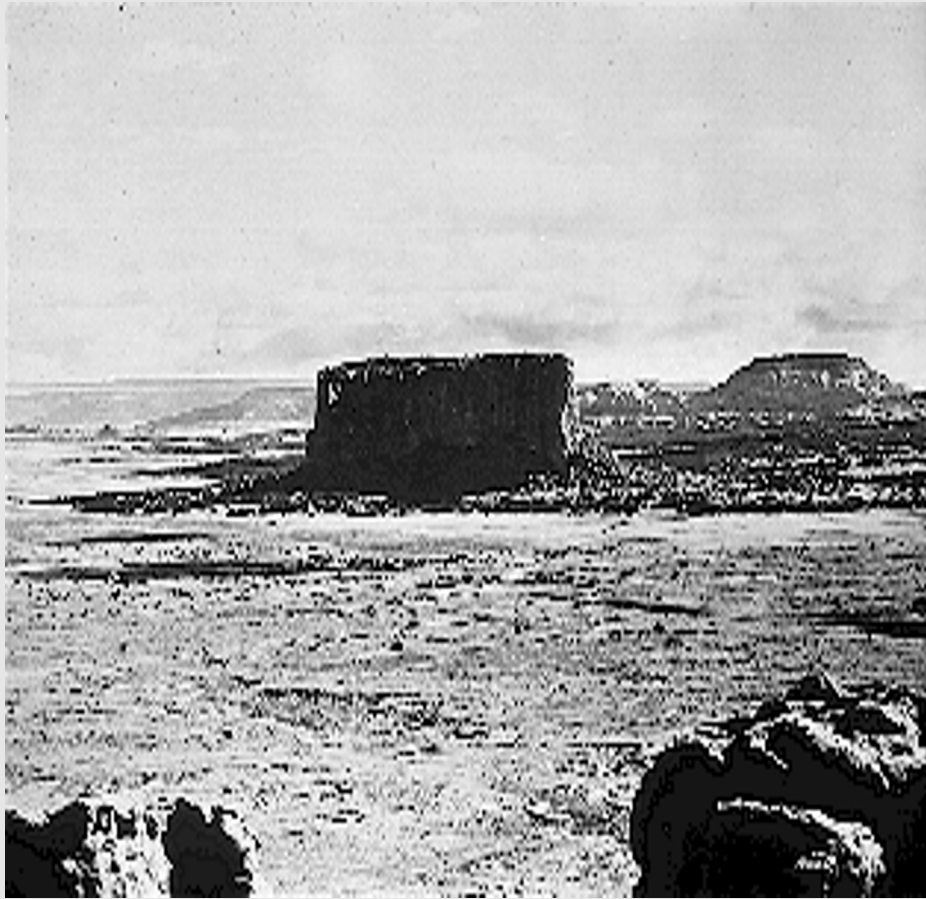


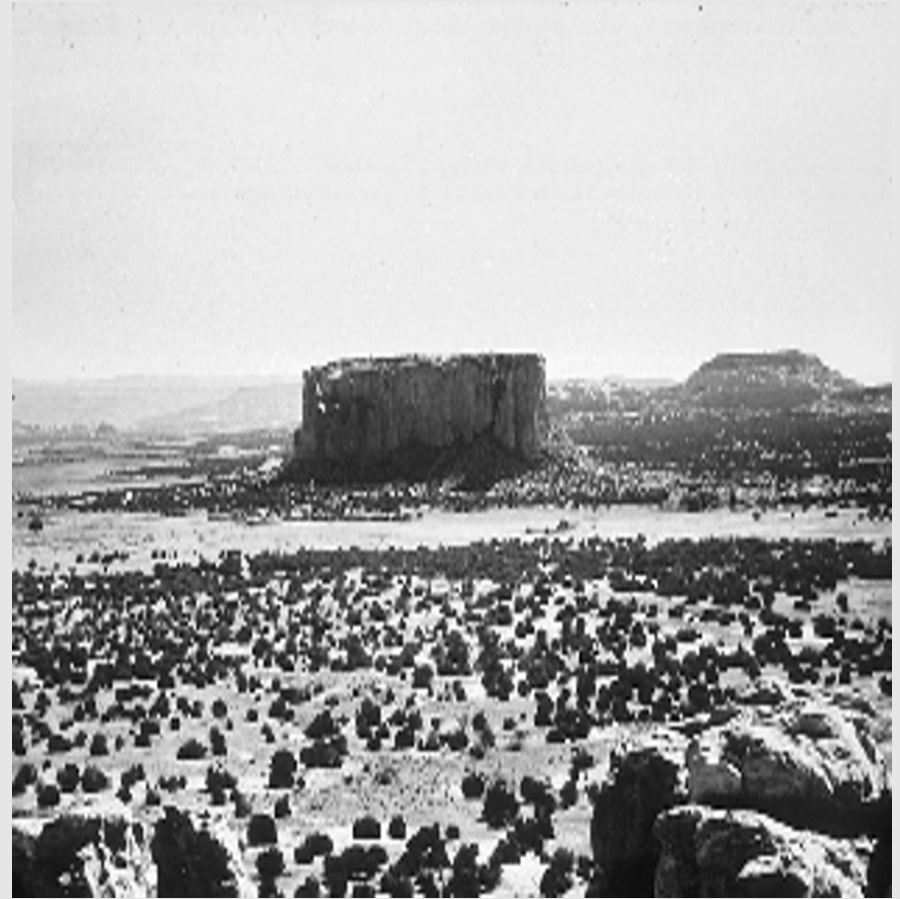
Nichole Barger
The Nature Conservancy
University of Colorado



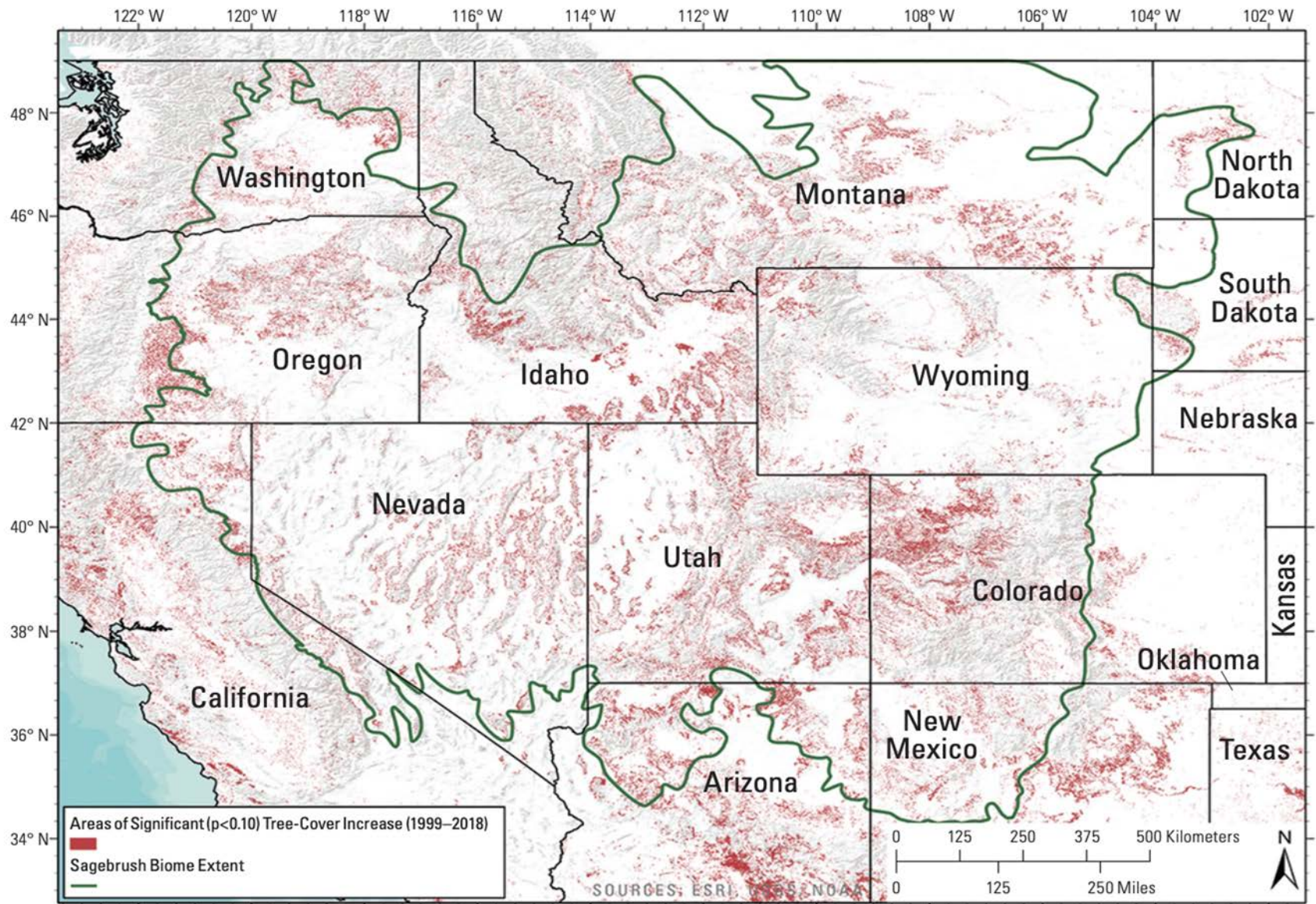
1899



1977



Views from Acoma Pueblo to Enchanted Mesa, west of Albuquerque, NM, taken by William Henry Jackson in 1899 and H.E. Malde in 1977. Note expansion of junipers into surrounding grassland. Source: C. Allen, J. Betancourt, and T. Swetnam, USGS Biological Resources Division Southwestern U.S. LUHNA pilot project, 1997 <http://biology.usgs.gov/luhna/chap9.html>.



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Pinyon-Juniper Distribution

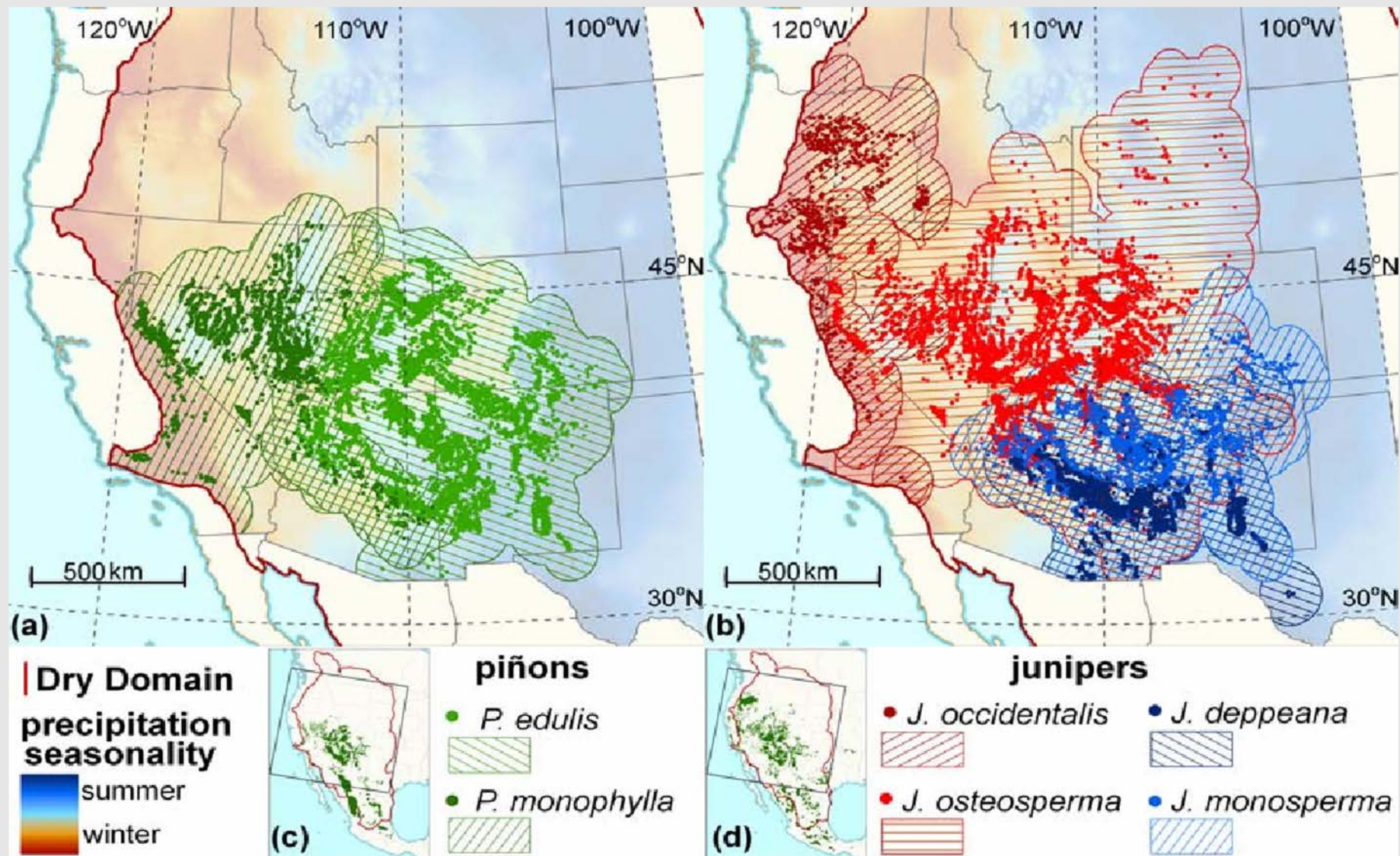
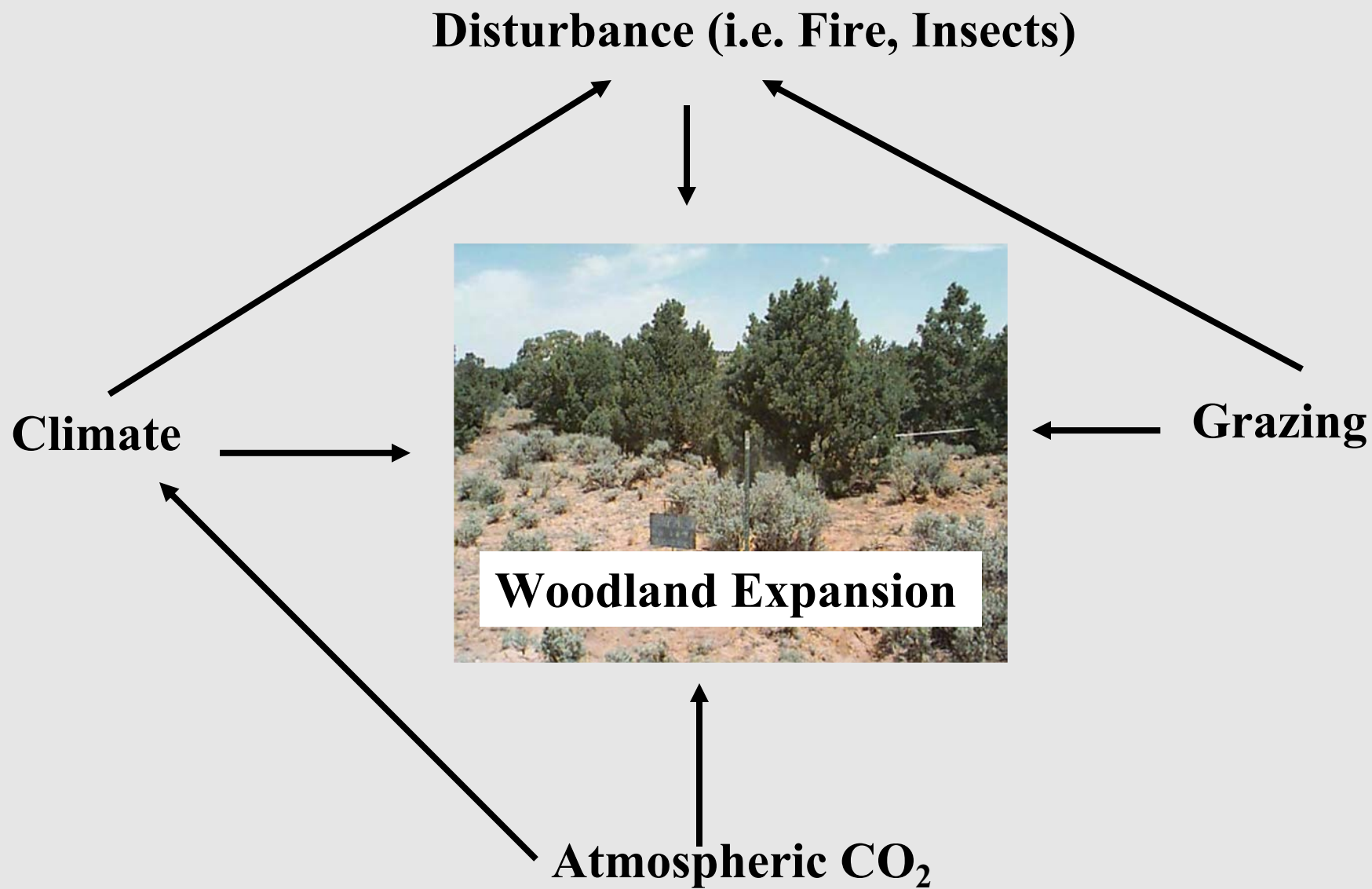


Fig. 1. Distribution of FIA observations for study piñons (a) and junipers (b) within their

What is causing the expansion of pinyon-juniper woodlands?

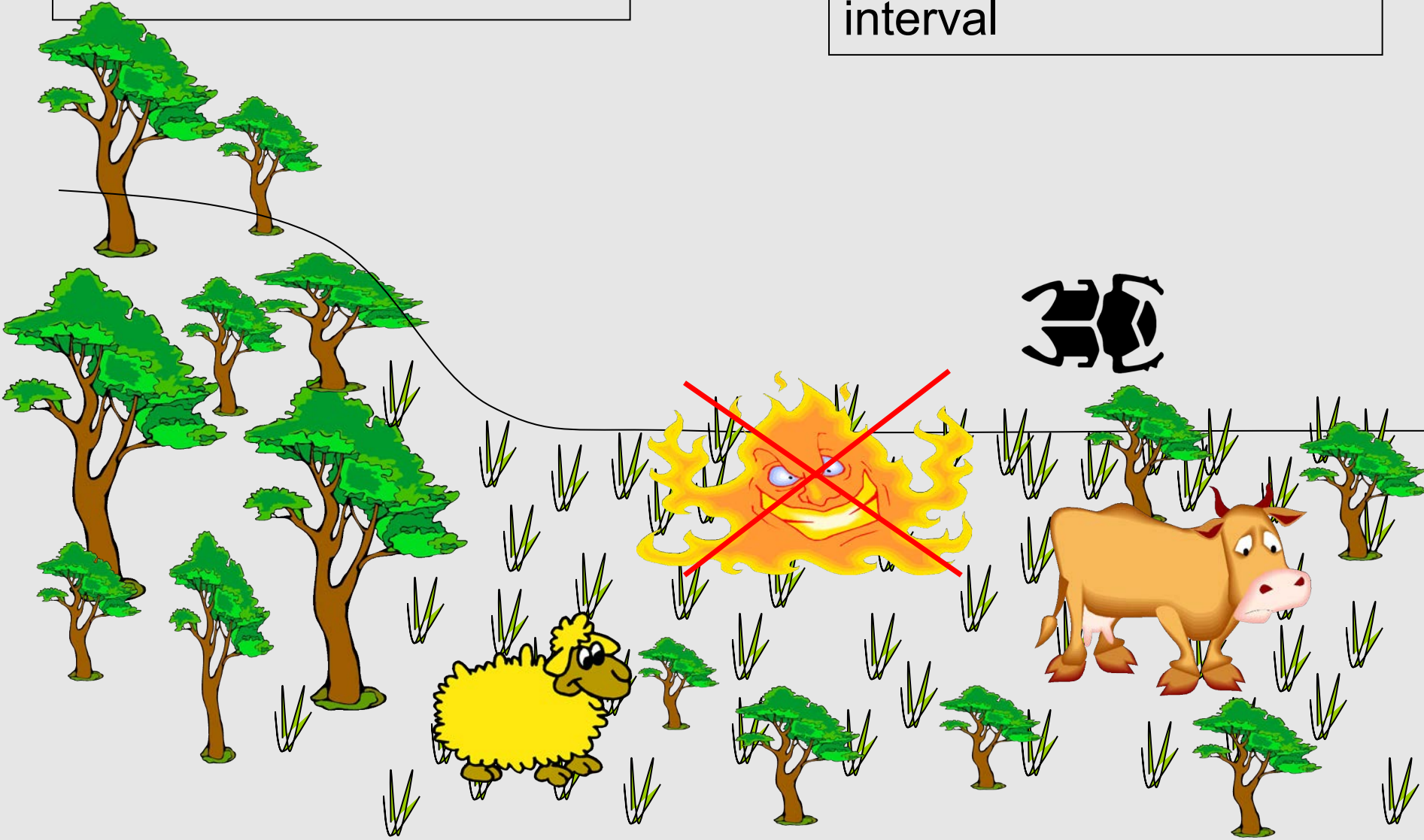
Take 2 minutes to write down your answer

Factors Regulating Pinyon-Juniper Distribution



Pinyon-juniper woodland
Low fire return interval

Grassland/Shrubland
Higher fire return interval



Historical Evidence of Expansion Under Different Land Uses

Canyon Country, Utah

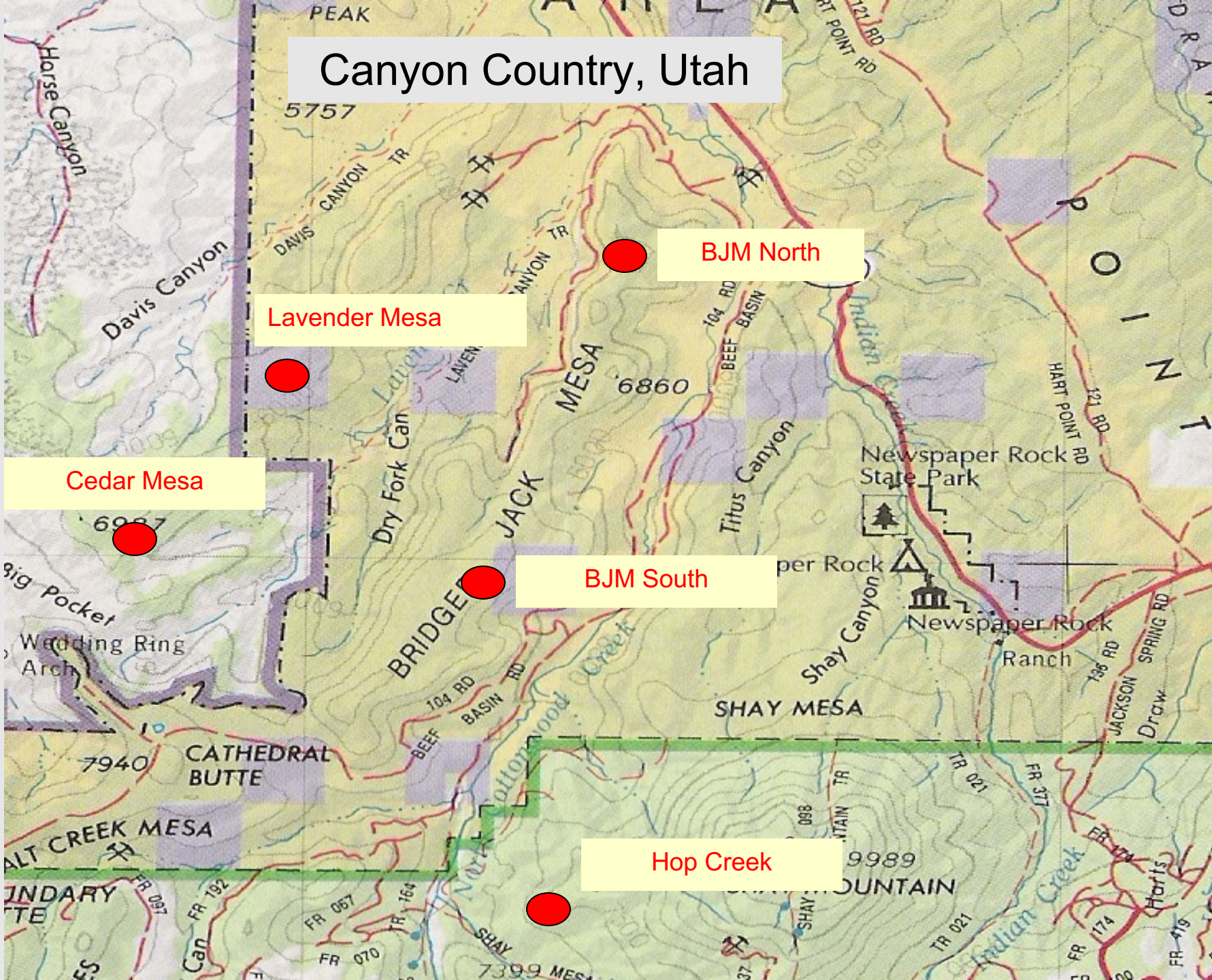
BJM North

Lavender Mesa

Cedar Mesa

BJM South

Hop Creek



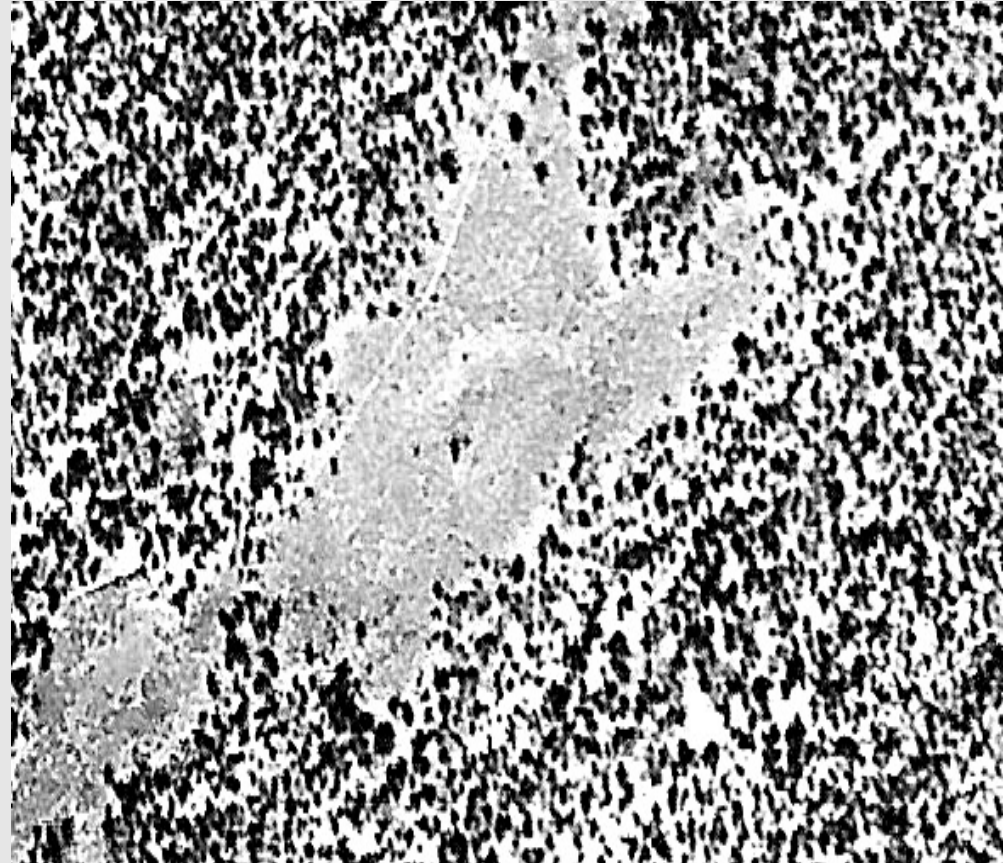
Cedar Mesa

No livestock grazing

1966



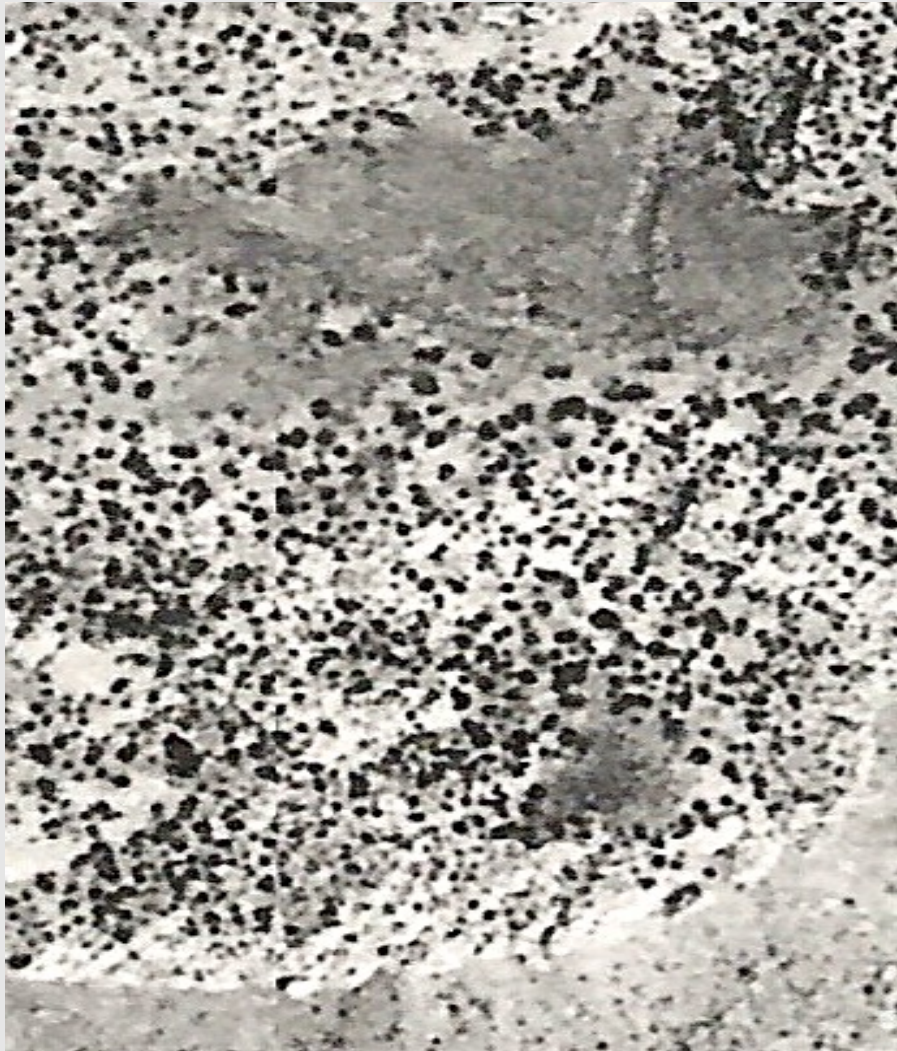
2001



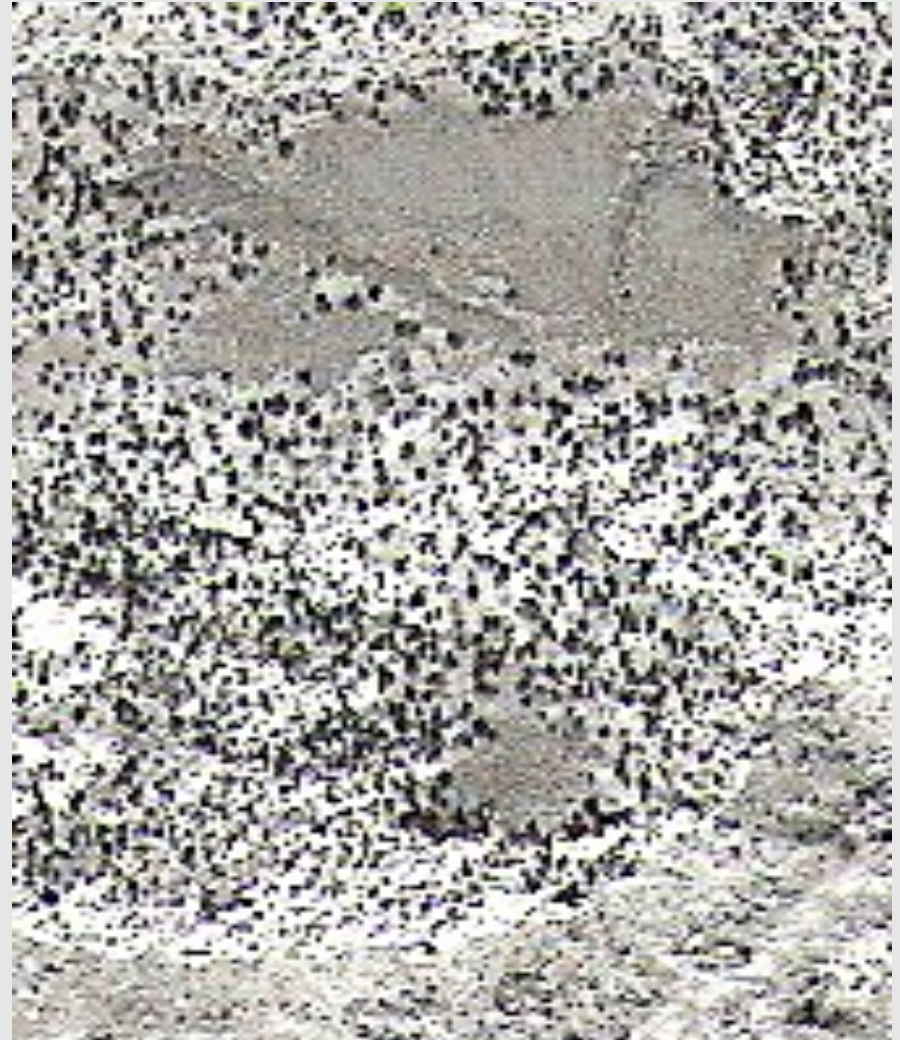
Lavender Mesa

No livestock grazing

1937



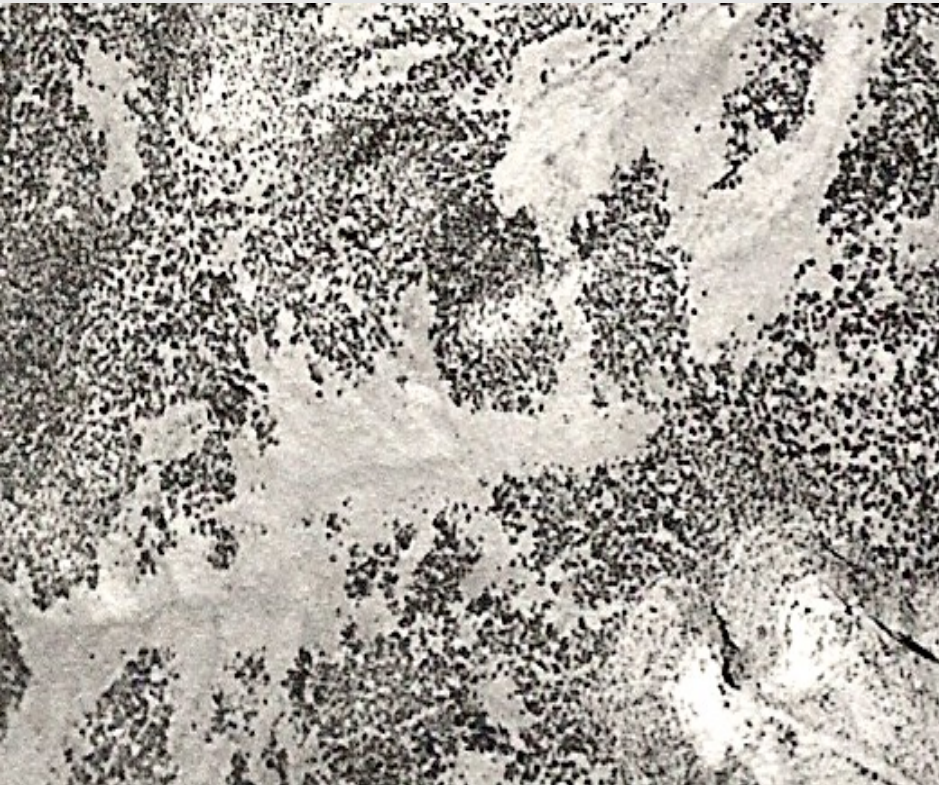
2001



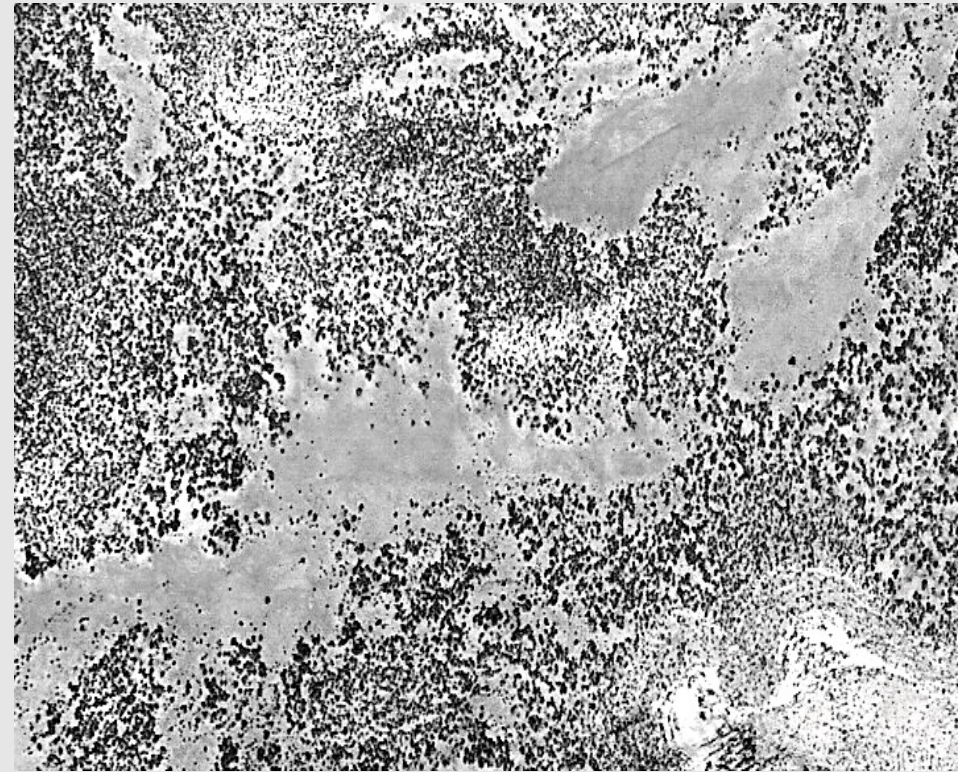
Bridger Jack Mesa North

Herbivores
Possibly some livestock

1937



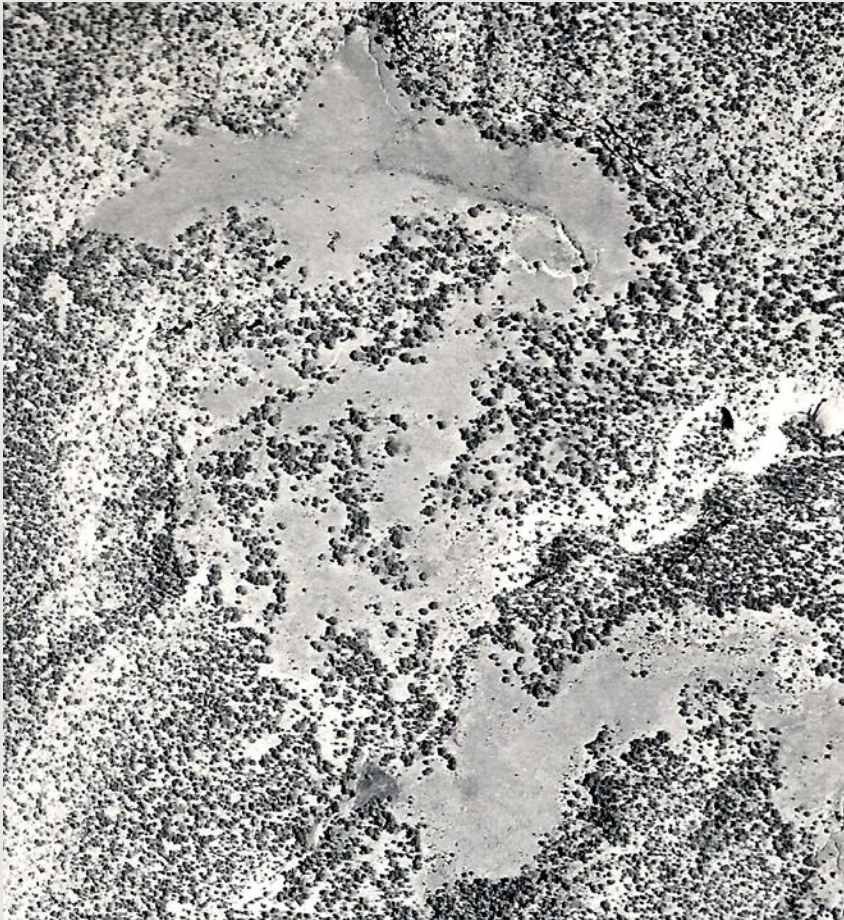
2001



Bridger Jack Mesa South

Some horse grazing in 1940s and elk grazing

1966



2001



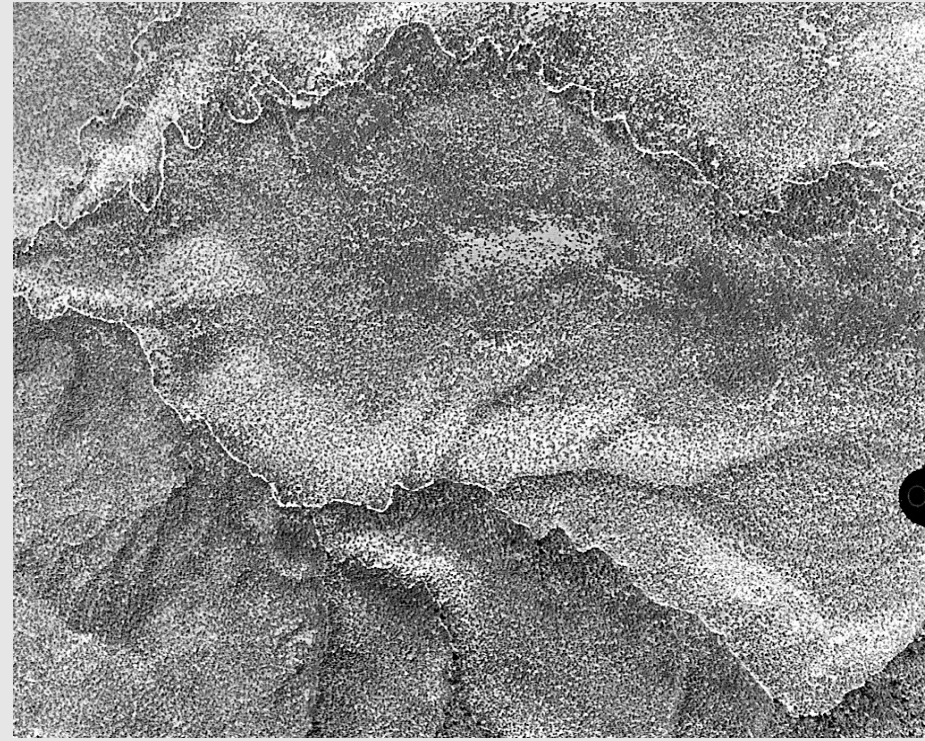
Hop Creek

Historical livestock grazing

1937

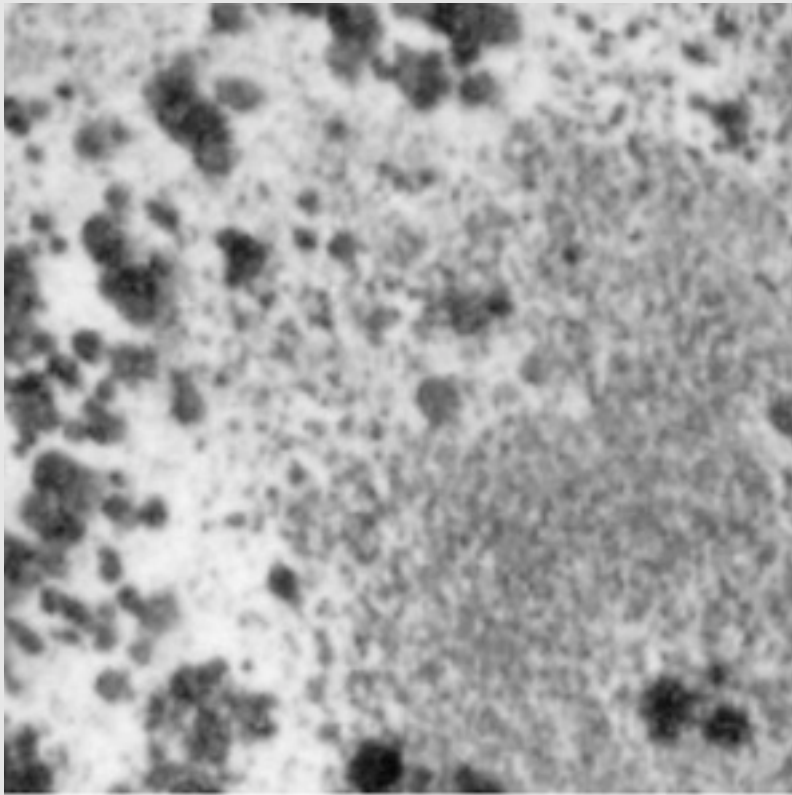


2001

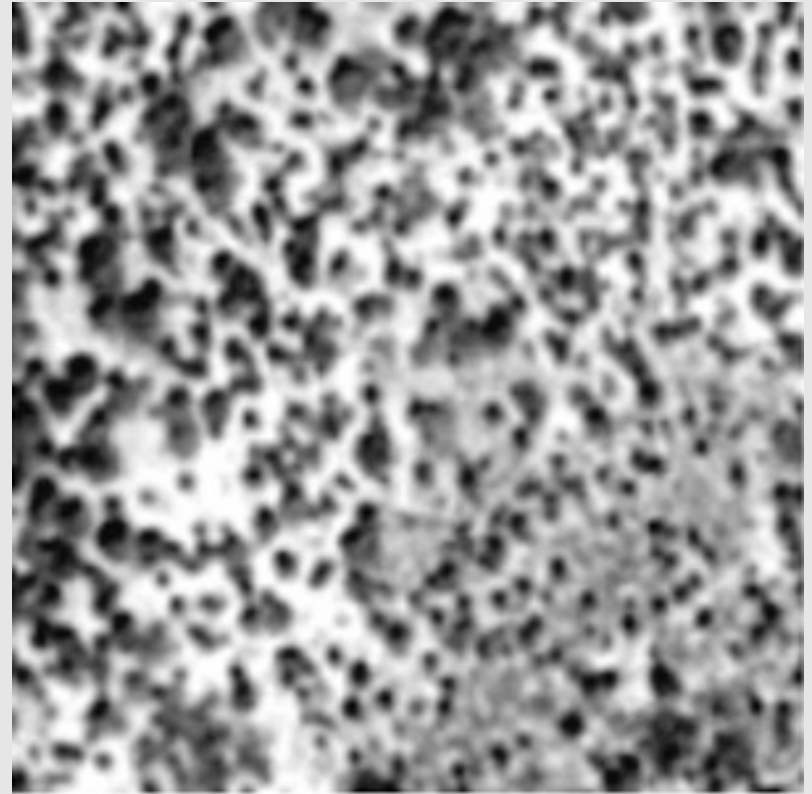


Grand Staircase Escalante

No historical livestock grazing



1948



1999

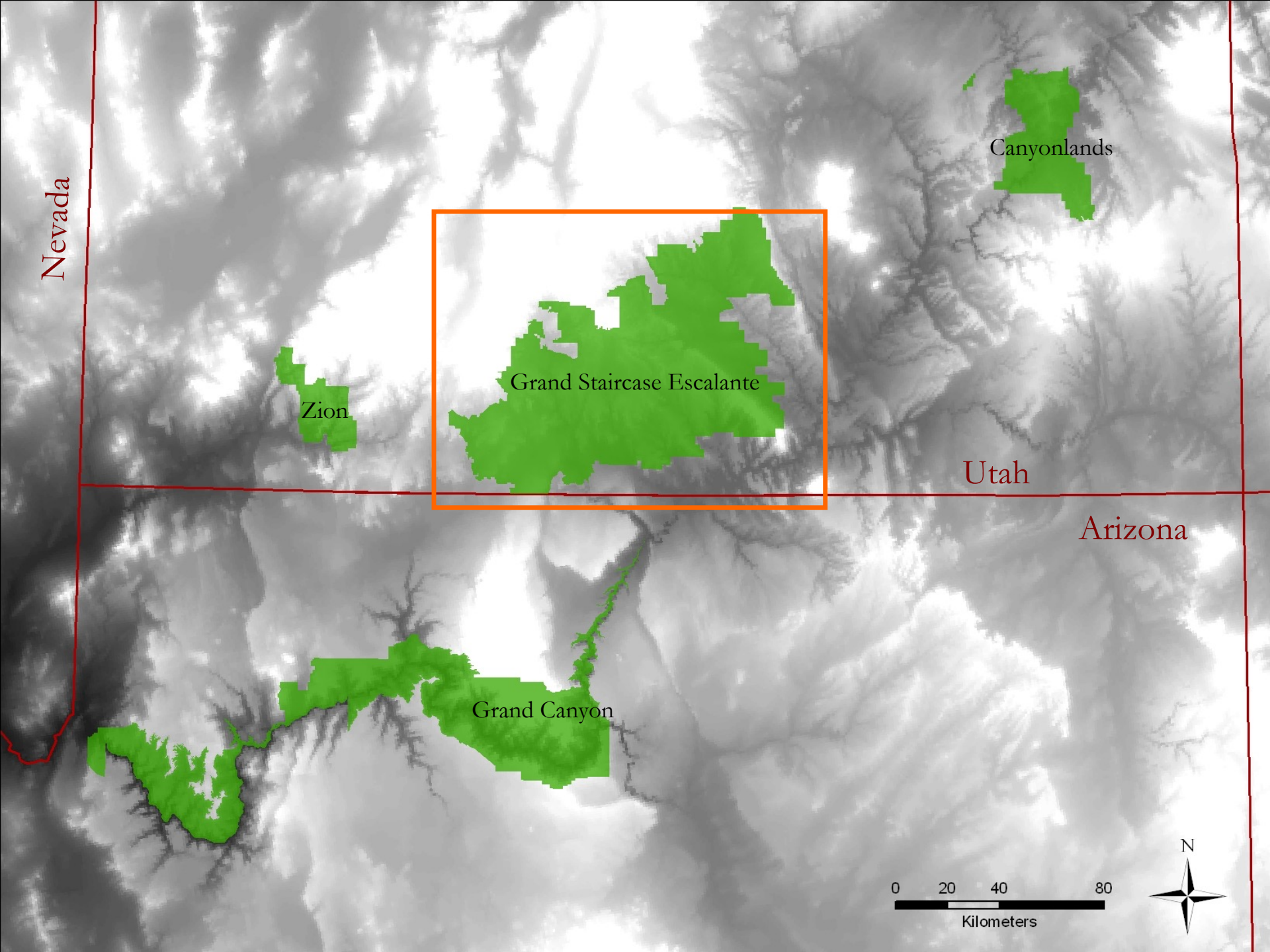
Some insights from Historical Aerial Photos

Northern Sites (Canyon Country)

Relict sites (ie. Lavender and Cedar Mesa) show very little change over the last 40-70 yrs, whereas the grazed (Hop Creek) and near-relict sites (Bridger Jack) show woodland expansion in previously open areas.

Southern Utah Sites (Grand Staircase-Escalante)

Pinyon-juniper woodland expansion has occurred in the absence of historical livestock grazing



Nevada

Canyonlands

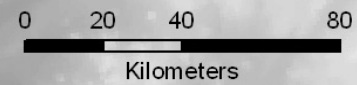
Zion

Grand Staircase Escalante

Utah

Arizona

Grand Canyon



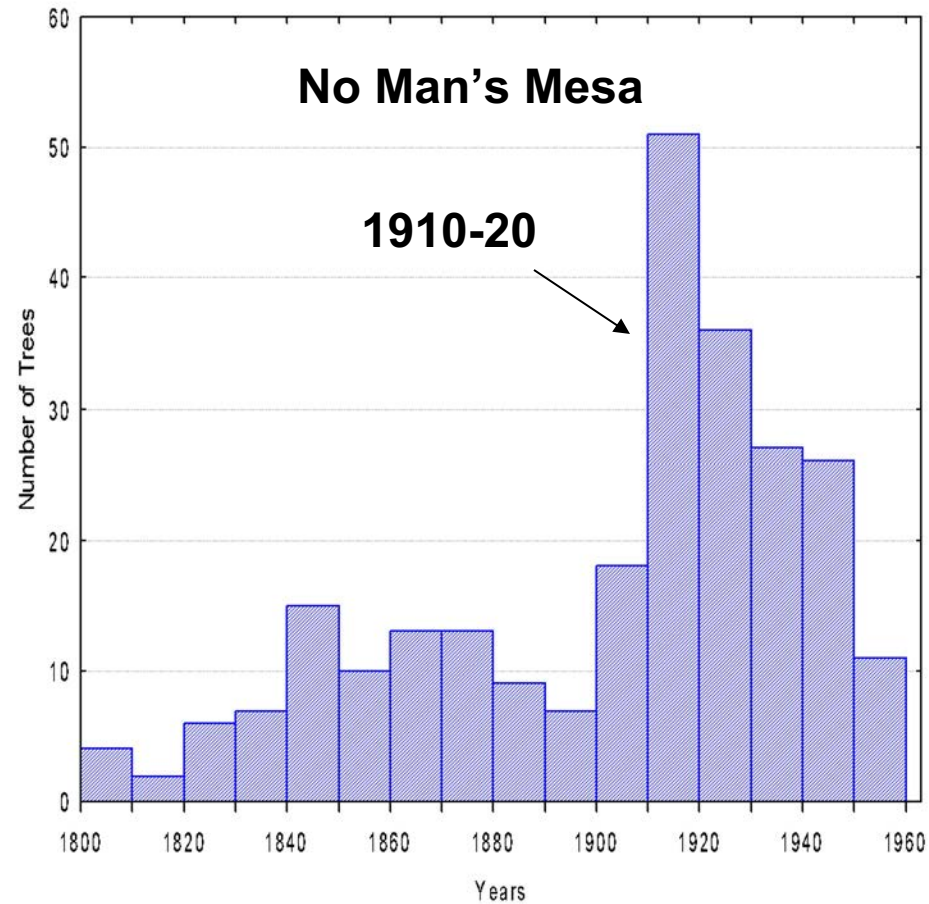
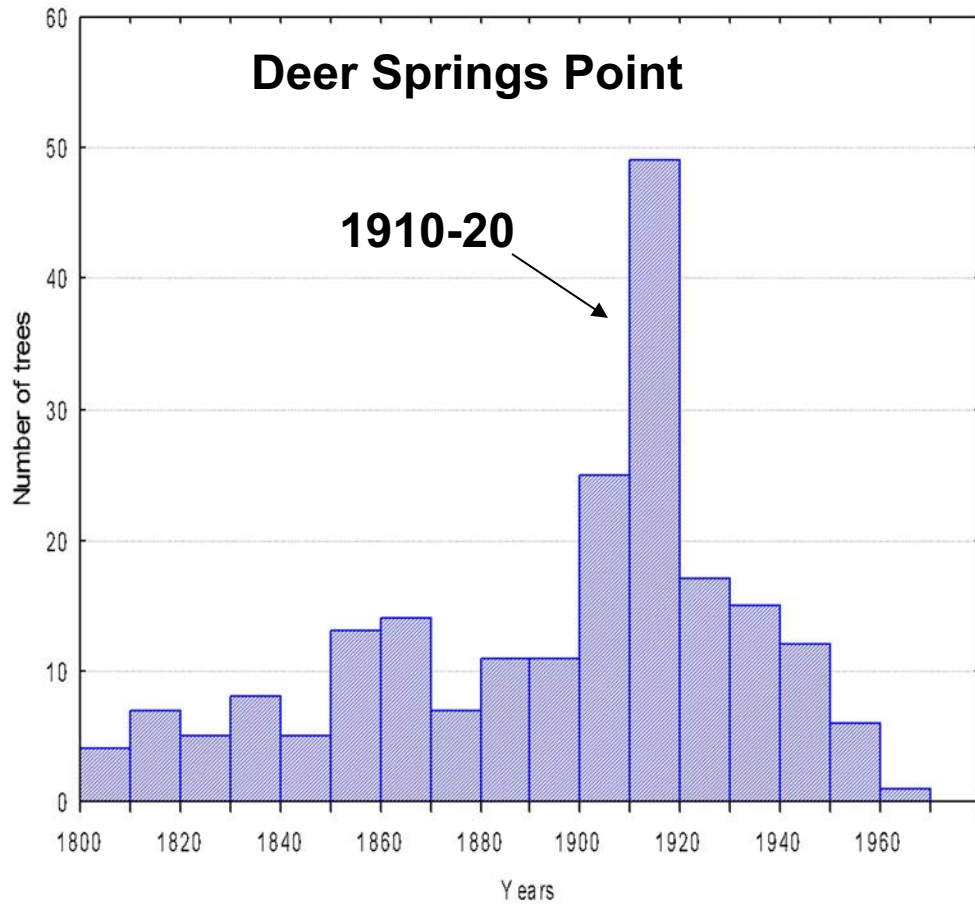


Site Description

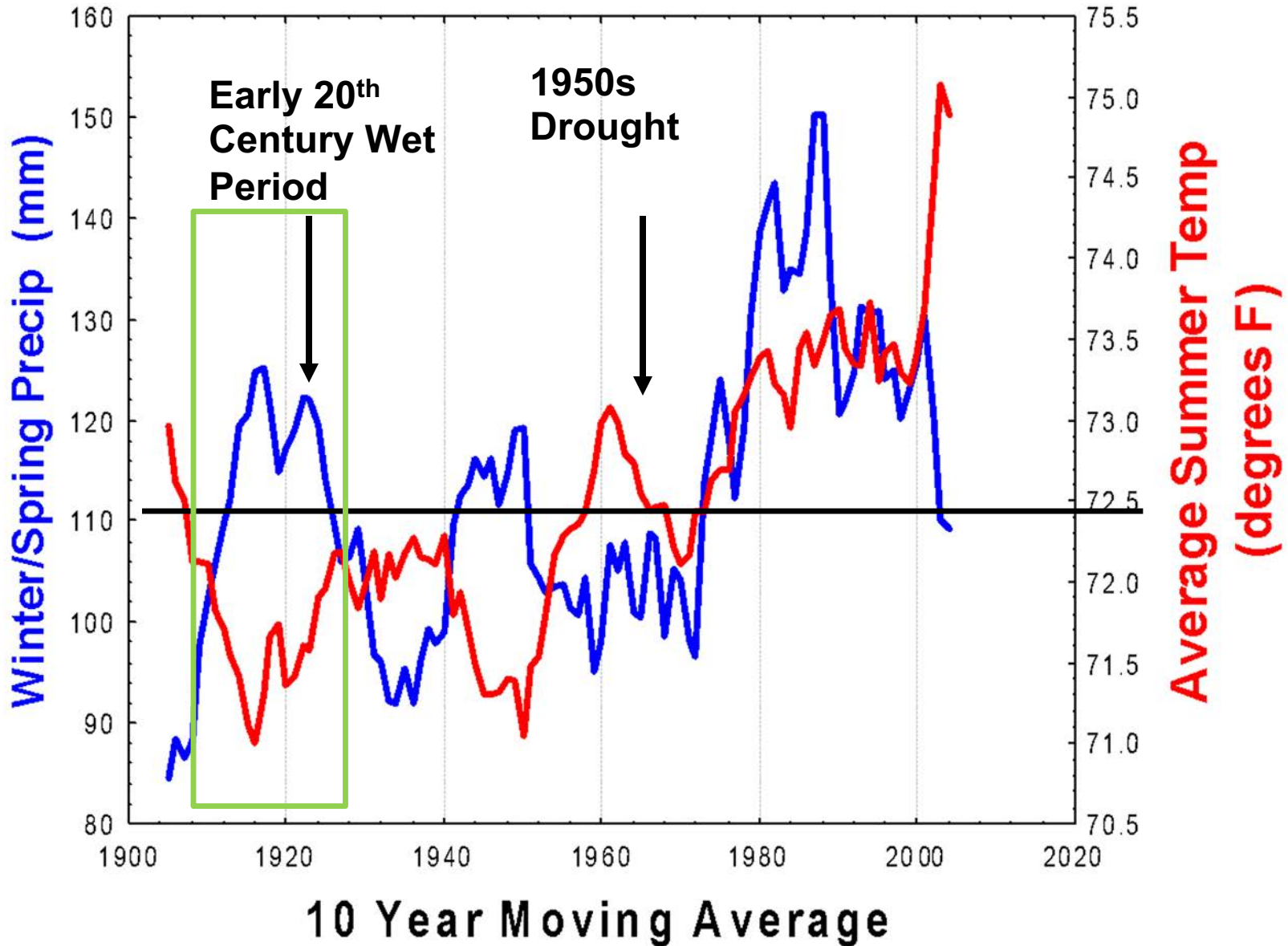
	Deer Springs Point	No Mans Mesa
Geologic substrate	Navajo sandstone capped by Carmel Formation	Navajo sandstone capped by Carmel Formation
Land use history	Summer grazed by horses since 1880s	No cattle grazing, some sheep grazing in 1927-1928
Elevation (m)	2107-2182	2153-2185

Grand Staircase Escalante Pinyon Age Structure

18% of pinyons recruited in this one decade



Past Century Climate



Regional Pinyon Mortality



Multi-year drought across the Colorado Plateau resulted in widespread pinyon pine mortality (1996-2003)

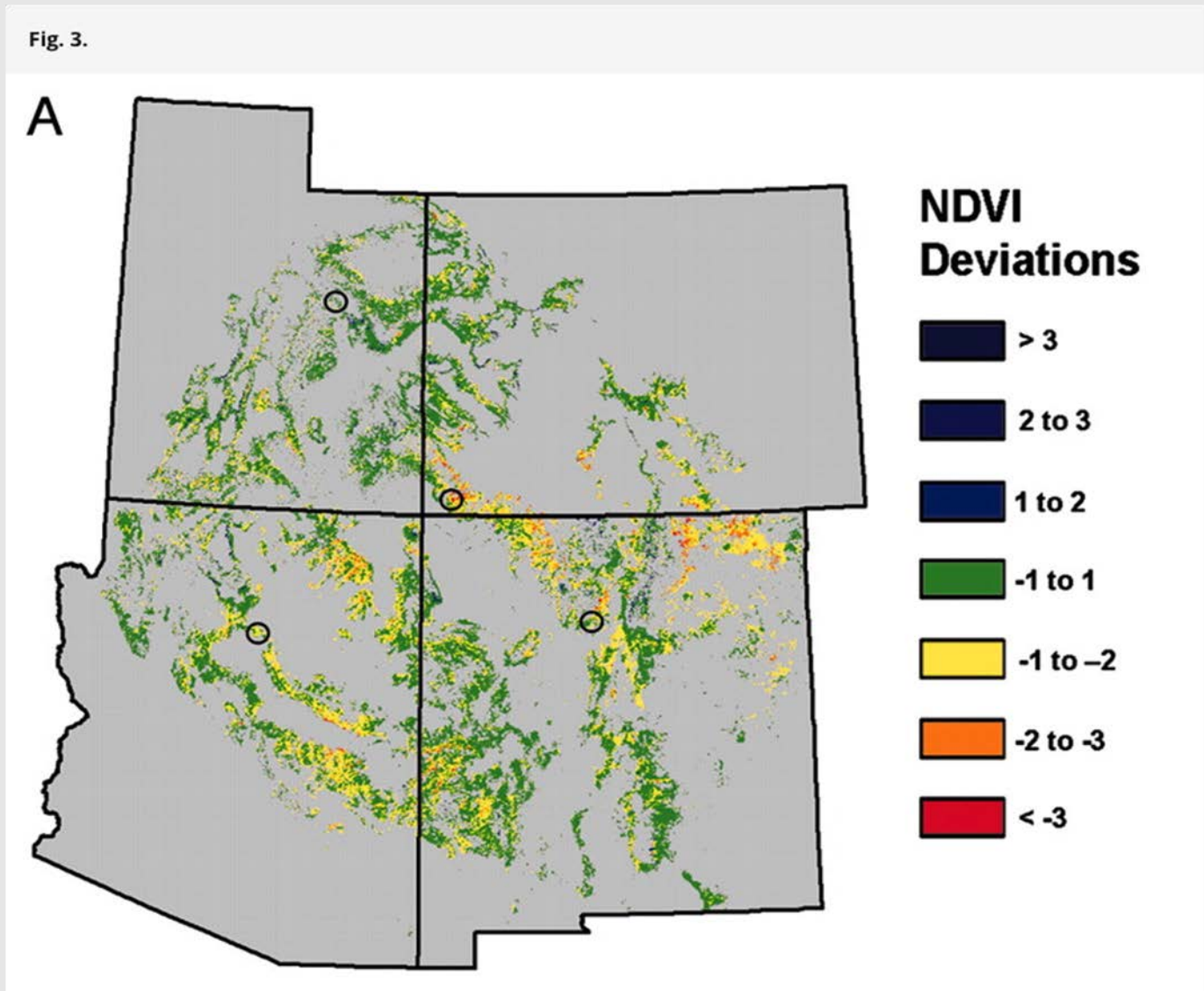
Regional mortality events as a result of drought have occurred several times over the last century (early 1900s, 1950s) but evidence suggests that pinyon mortality in the early 2000s drought was of a greater magnitude as compared to the 1950s



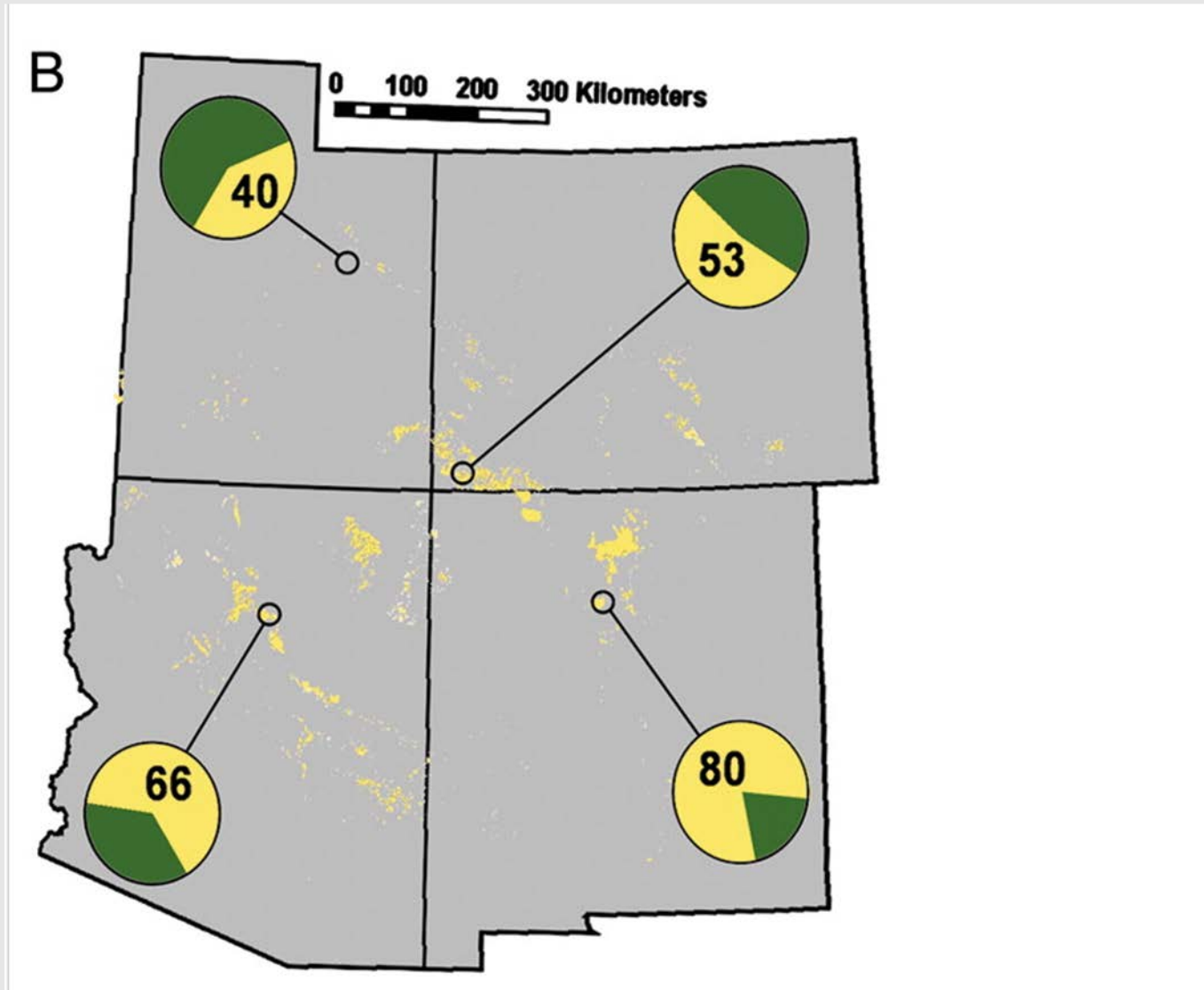
UGA1274018

Mesa Verde National Park 2004
Photo Credit: William Ciesla

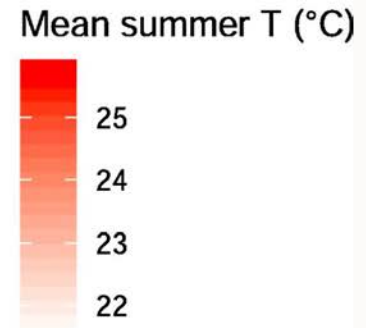
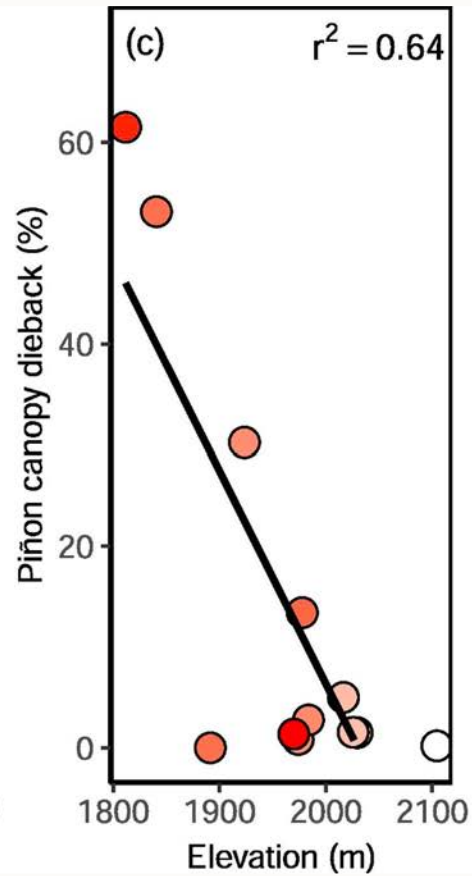
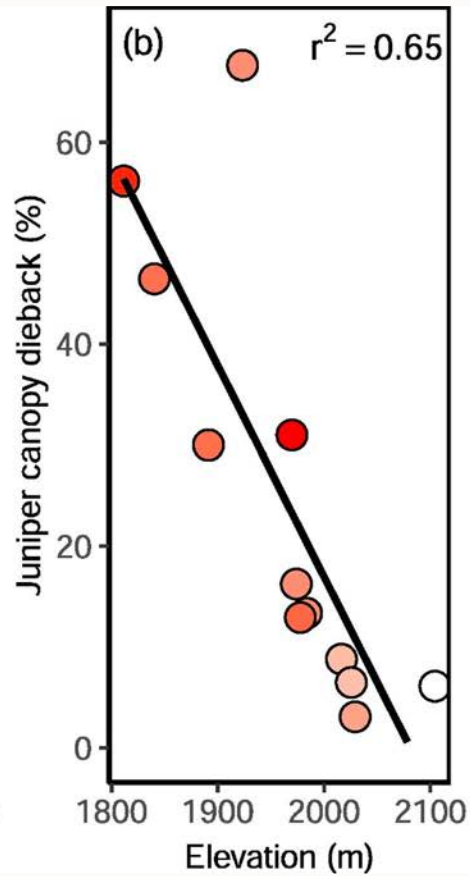
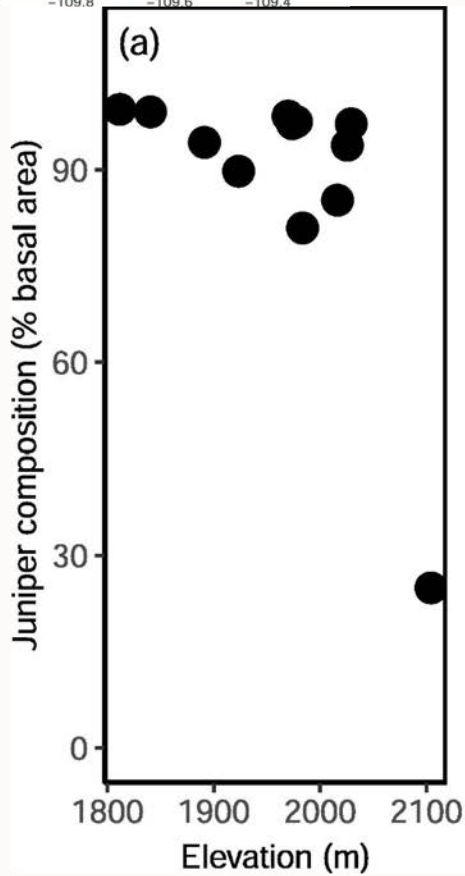
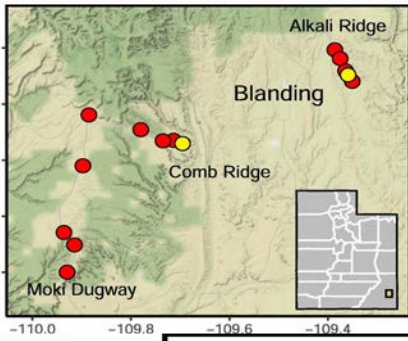
Mortality Across P-J Woodlands



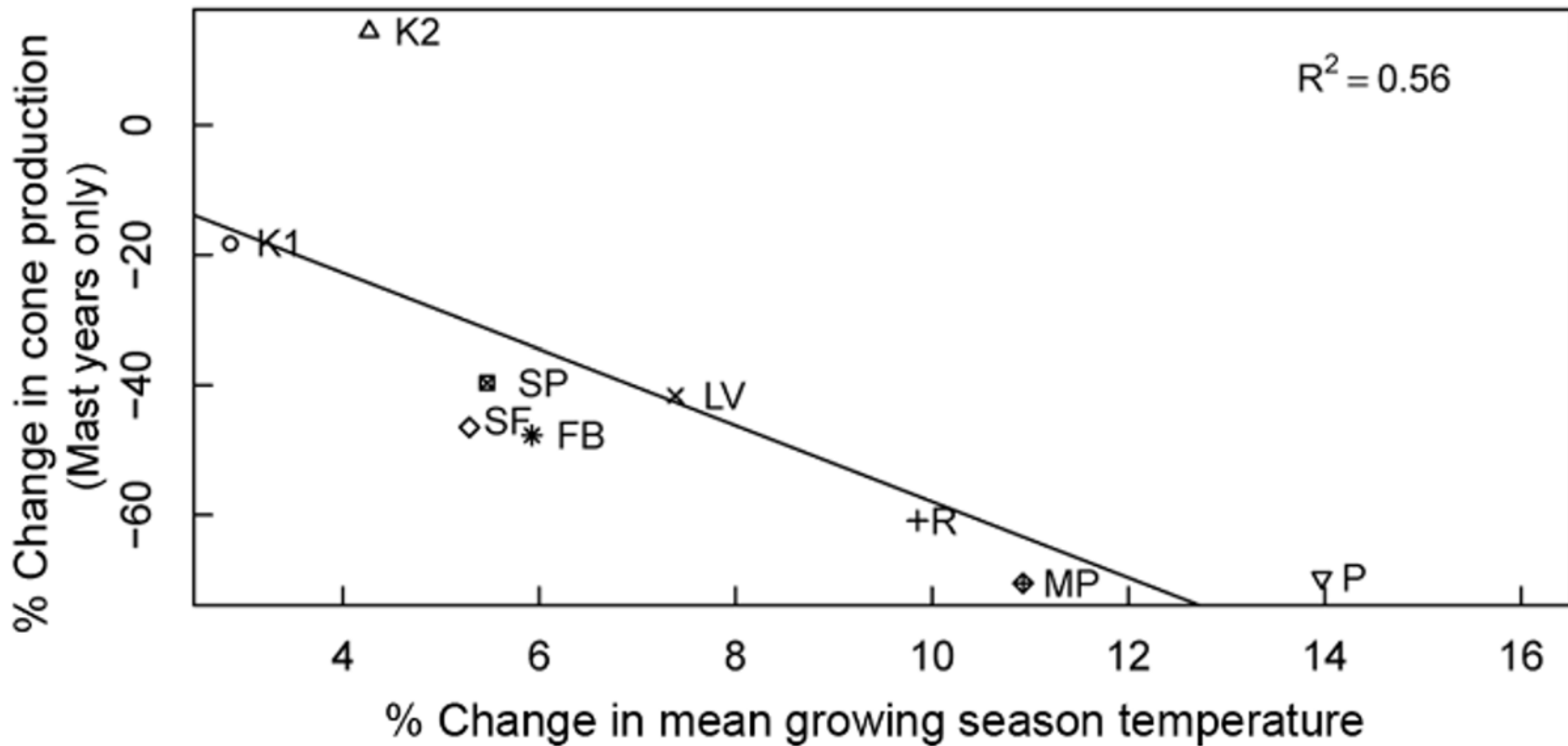
Mortality Across P-J Woodlands

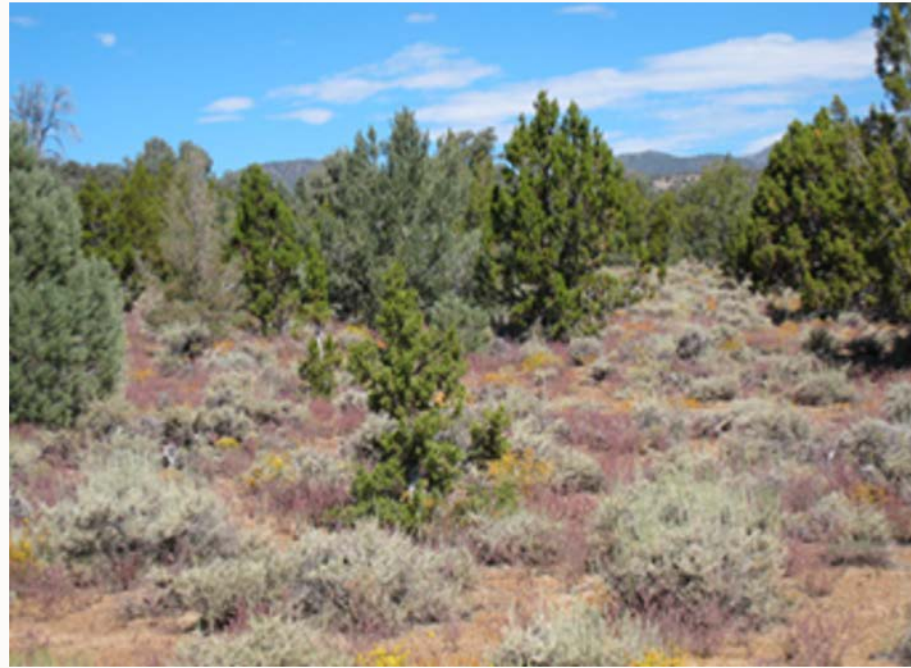


Juniper Dieback



Pinyon cone production decline with increasing temperature

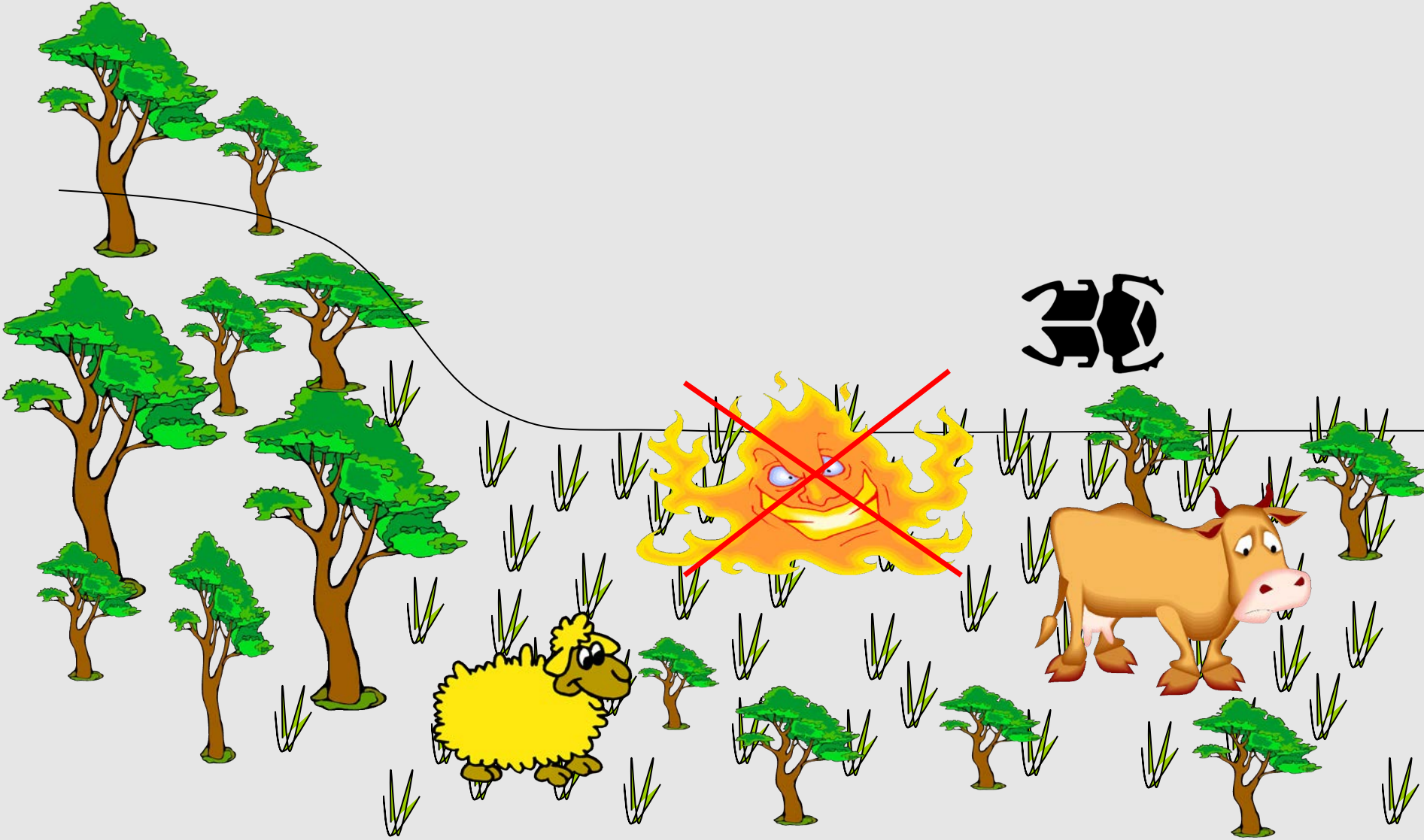






Pinyon-juniper woodland

Grassland/Shrubland



Early vs. Late Century Growth Per Unit of Precipitation

