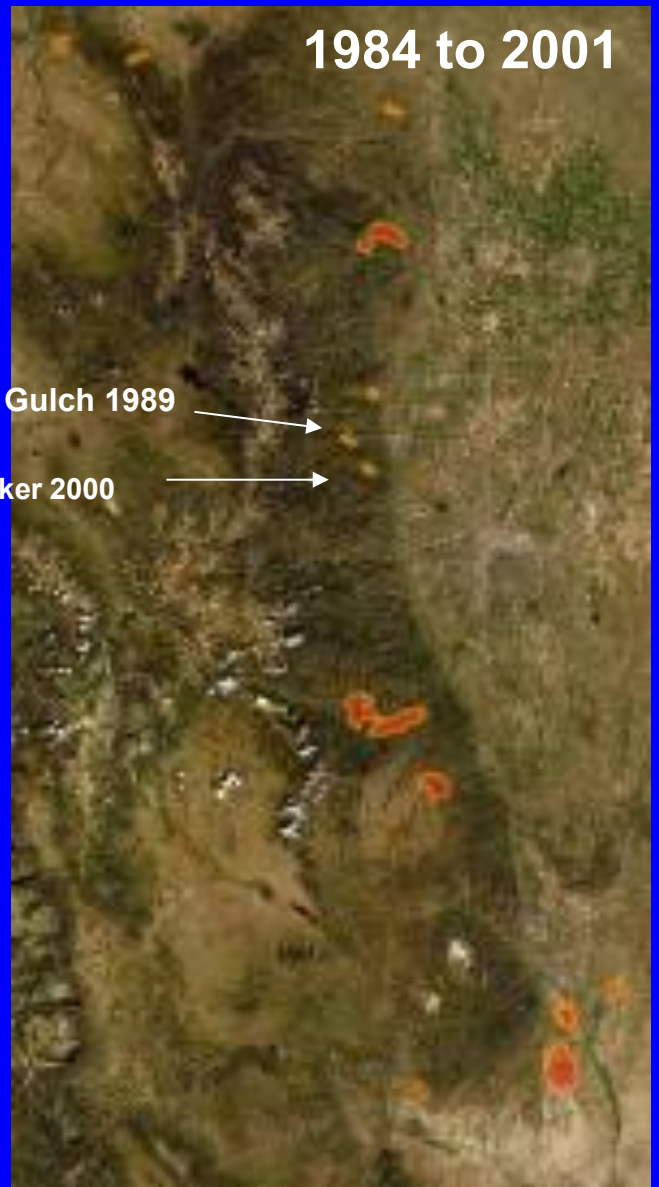
Guide for a field trip on climate and forest changes led by Tom Veblen and Karl Ford, June 10, 2026

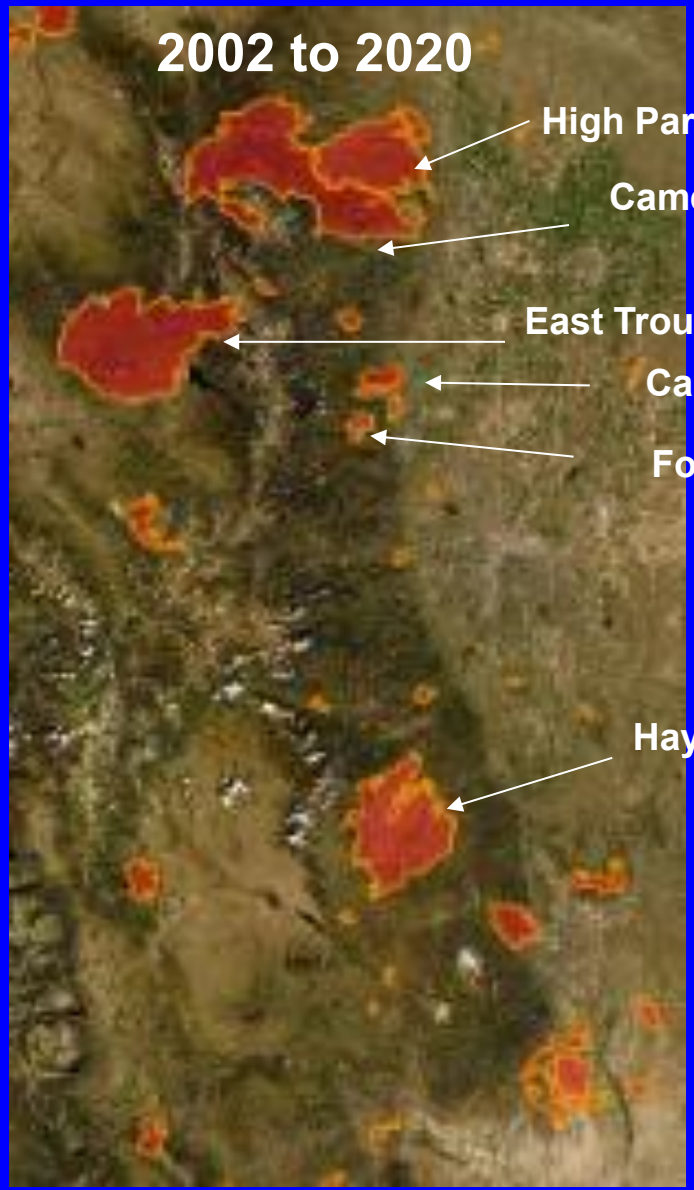
Sponsored by the Boulder County Nature Associaton

- Buckingham Park: Review of fire history and vegetation changes in the Lower Montane zone and the Upper Montane Zone, illustrated with repeat photography.
- Camp Frances: Discussion of fire history near the Peak to Peak Highway and of repeat photos showing widespread burning of forests by the 1890s on the lower slopes of Niwot Mountain
- C1 and MRS8: introduction to the forest permanent plot network; fire history derived from mapping post-fire cohorts; J. Sibold's fire history study of Rocky Mountain National Park.
- S-curve and plot MRS-4: spruce-fir coexistence/tree demography; warming impacts on tree radial growth, tree mortality, and tree establishment.

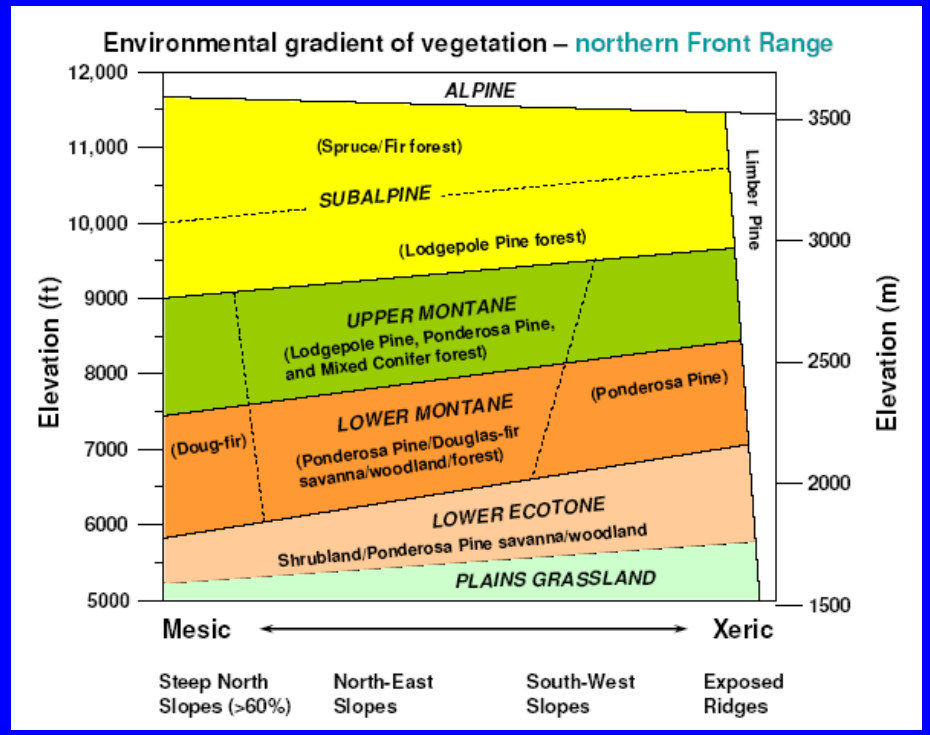
Climate Change: Increased Fire

Colorado Front Range Wildfires > 1000 acres (Data: MTBS)





Forest Setting

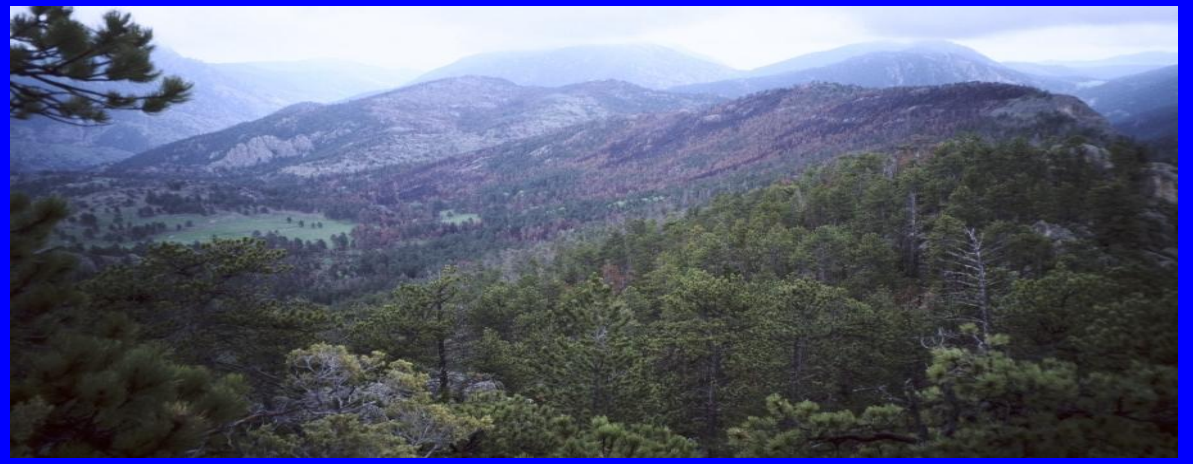


From: Historical Fire Regimes in Ponderosa Pine Forests of the Colorado Front Range, and Recommendations for Ecological Restoration and Fuels Management.

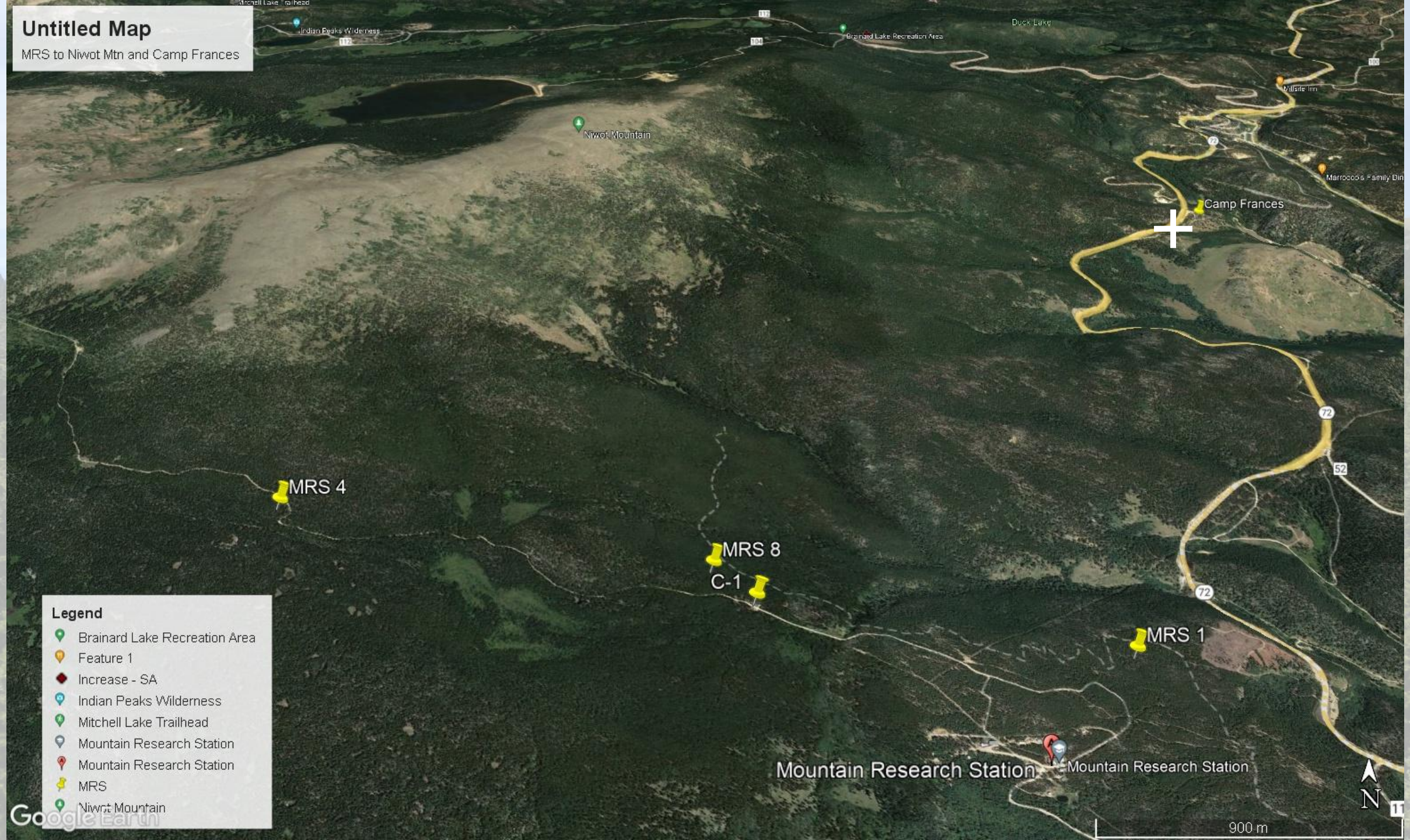
Kaufmann, Veblen, Romme. 2006 CFRI Report

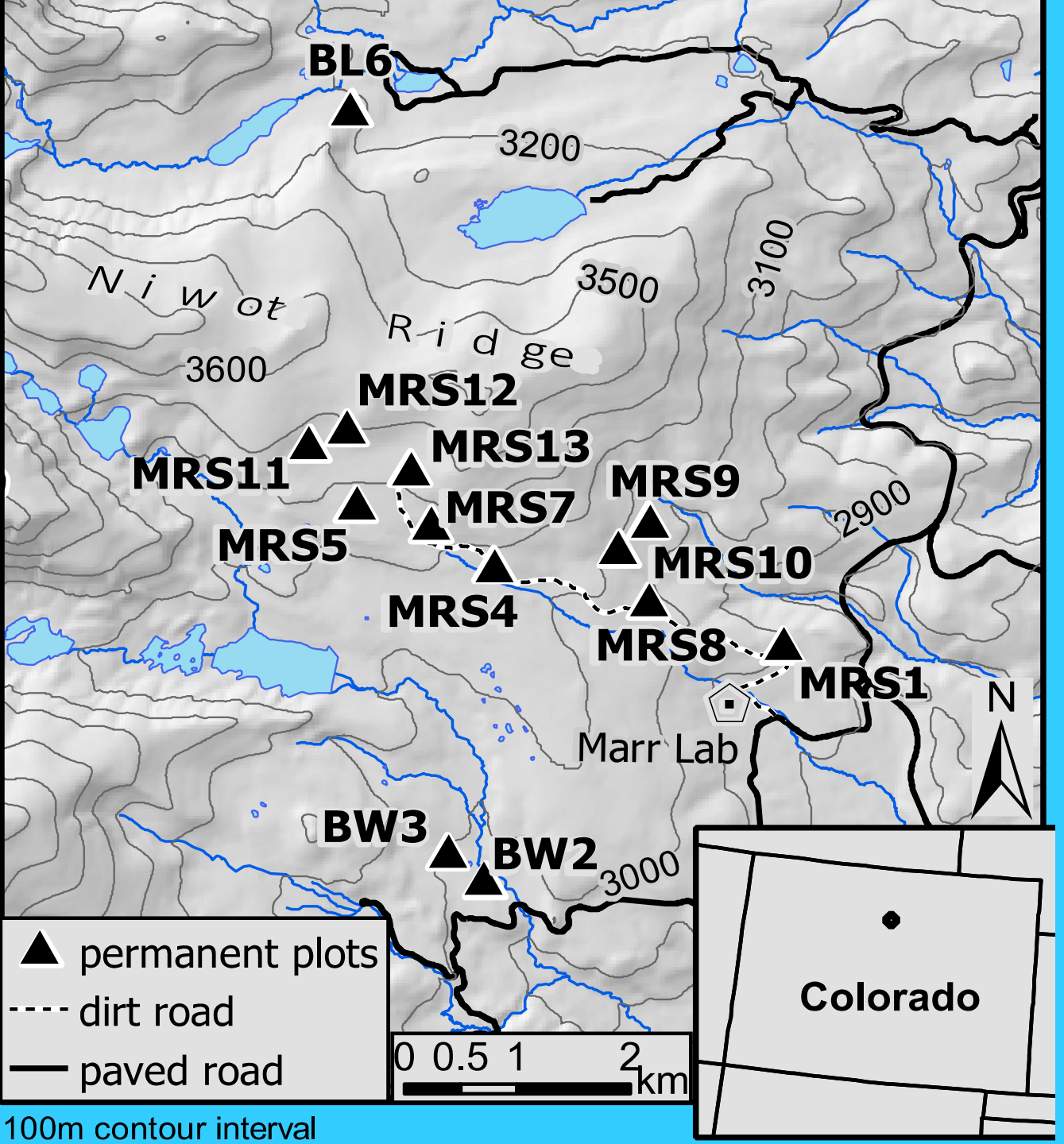
Subalpine
≈ 9300-11000 ft

Upper montane
≈ 7700-9100 ft



Lower montane
≈ 5900-7400 ft


Untitled Map
MRS to Niwot Mtn and Camp Frances
Indian Peaks Wilderness
Brainard Lake Recreation Area
Duck Lake
Niwot Mountain
Camp Frances
Marrocco's Family Din
MRS 4
MRS 8
C-1
MRS 1
Mountain Research Station
Mountain Research Station
Legend
Brainard Lake Recreation Area
Feature 1
Increase - SA
Indian Peaks Wilderness
Mitchell Lake Trailhead
Mountain Research Station
Mountain Research Station
MRS
Niwot Mountain
Google Earth
N
900 m

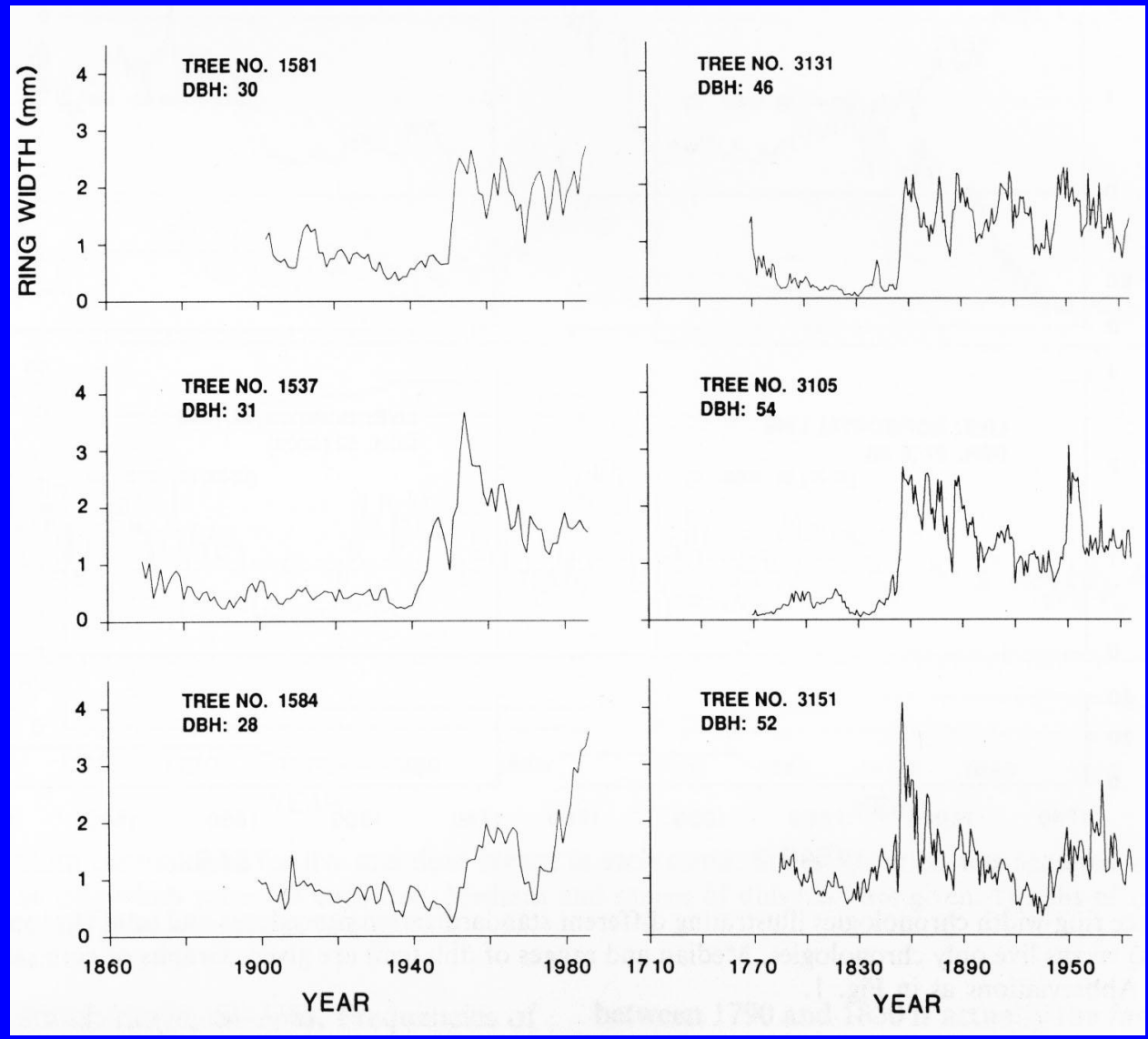


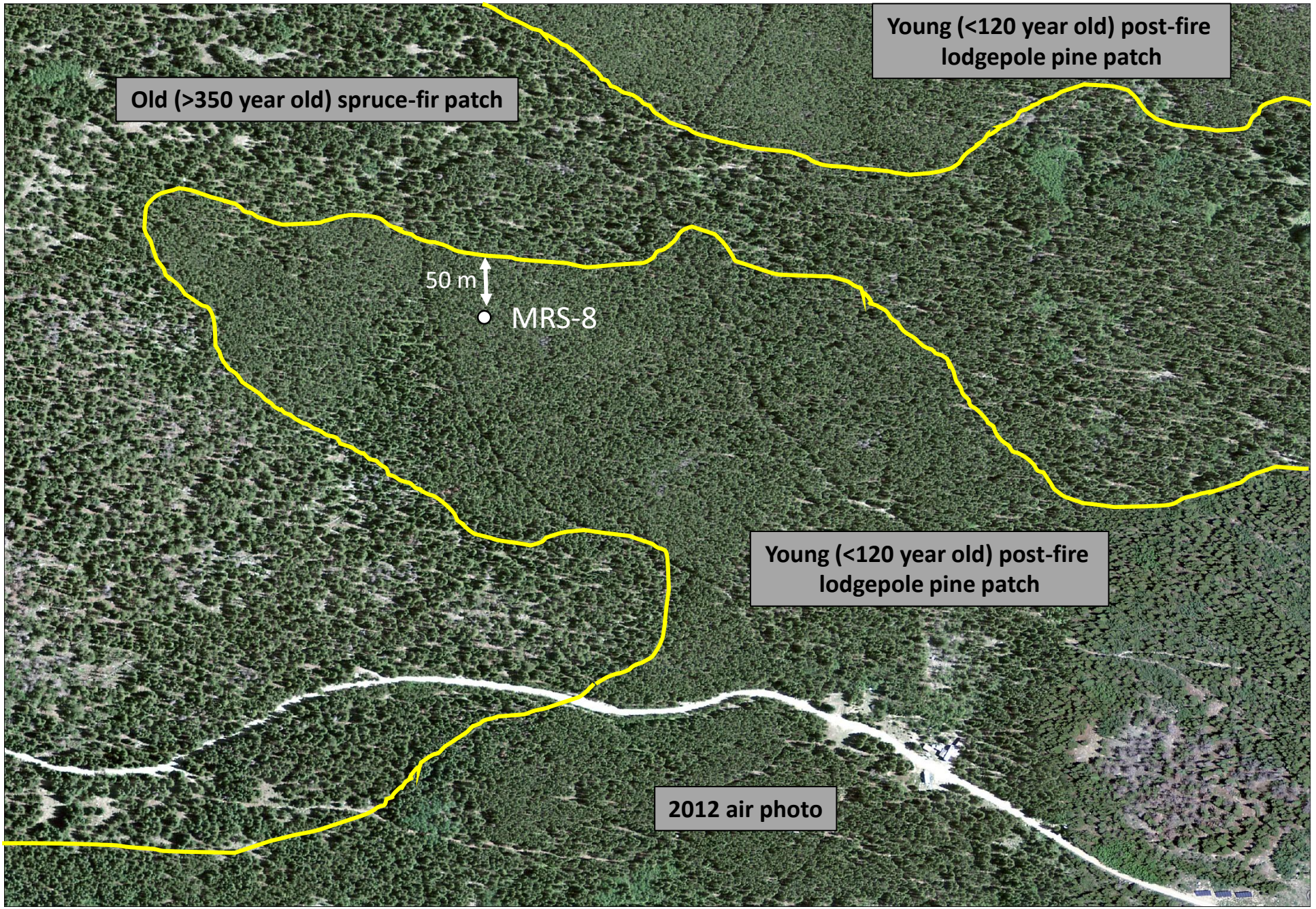
- 13 large plots (1134 – 2916m^2)
- 30 smaller "gap" plots (c. 49 – 336m^2)
- > 5000 live trees (> 4cm dbh) tagged
- > 1900 standing dead trees tagged
- Fallen trees measured and mapped
- **All trees cored for ages in most plots**
- All seedlings (<1.3m) and saplings (> 1.3m) counted and mapped
- Subsample of saplings and seedlings tagged in 2008 for height growth measurement
- Plots installed in 2008 for dead and fallen fuel sizes plus regeneration
- Tree mortality censused in 1985, 1988, 1991, 1994, 2007, 2010, 2013, 2016, 2019, 2022, 2025.
- In 2007, 2016, 2020 complete tree remeasurements (dbhs) & in-growth into sapling and tree size classes.

Plot	Year installed	Plot size (m^2)	Date stand initiated	Elevation (m)	Aspect	Slope (%)	Site moisture classification
Young postfire stands							
MRS1	1982	1134	1880	2900	E	6	xeric
$MRS1_{CSP}$	1983	340	1880	2920	N-NE	10	xeric
MRS8	1986	648	1902	3020	NE	12	mesic
MRS9	1986	324	1893	3090	SE	11	xeric
MRS10	1986	432	1893	3090	SE	9	xeric
MRS13	2016	1764	1905	3340	SW	10	xeric
Old seral postfire stands							
BW2	1982	2592	1748	2980	E	2	xeric
BW3	1982	810	1748	2975	NE	3	mesic
MRS4	1982	1944	1660	3170	S	7	mesic
$MRS4_{CSP}$	1983	1732	1660	3190	SE-S	6	mesic
MRS7	1983	2916	1640	3250	S	14	xeric
Old Picea-Abies stands (not post-fire cohorts)							
MRS5	1982	2916	1461	3285	S	4	hydric
BL6	1982	1944	1553	3220	NE	4	mesic
$BL6_{CSP}$	1983	1289	1553	3220	N-NW	5	mesic
MRS11	2016	1764	1417	3350	SE	5	mesic
MRS12	2016	1764	1775	3380	SW	10	xeric

Growth releases to detect past spruce beetle, White River NF

Veblen et al. 1991. Methods of detecting past spruce beetle outbreaks in Rocky Mountain subalpine forests. Can. J. For. Res.




Young (<120 year old) post-fire lodgepole pine patch
Old (>350 year old) spruce-fir patch
50 m
MRS-8
Young (<120 year old) post-fire lodgepole pine patch
2012 air photo

Dates of burns and cutting from establishment dates and growth releases. (Kienast & Schweingruber 1986)

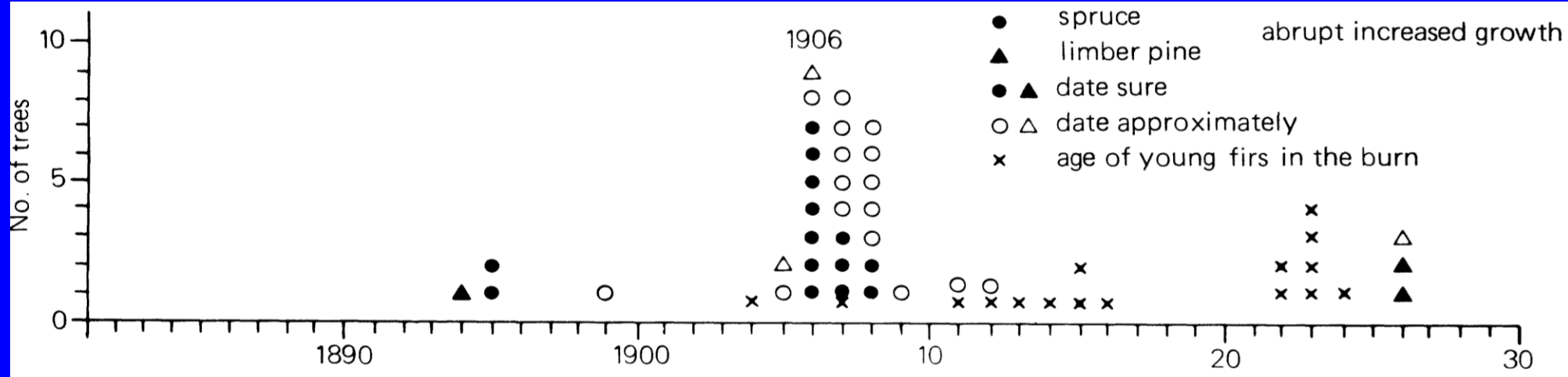


FIGURE 7. Abrupt growth release in *Picea engelmannii* and *Pinus flexilis* near the upper treeline on Niwot Ridge. The trees surround the site of a fire which occurred in approximately 1905.

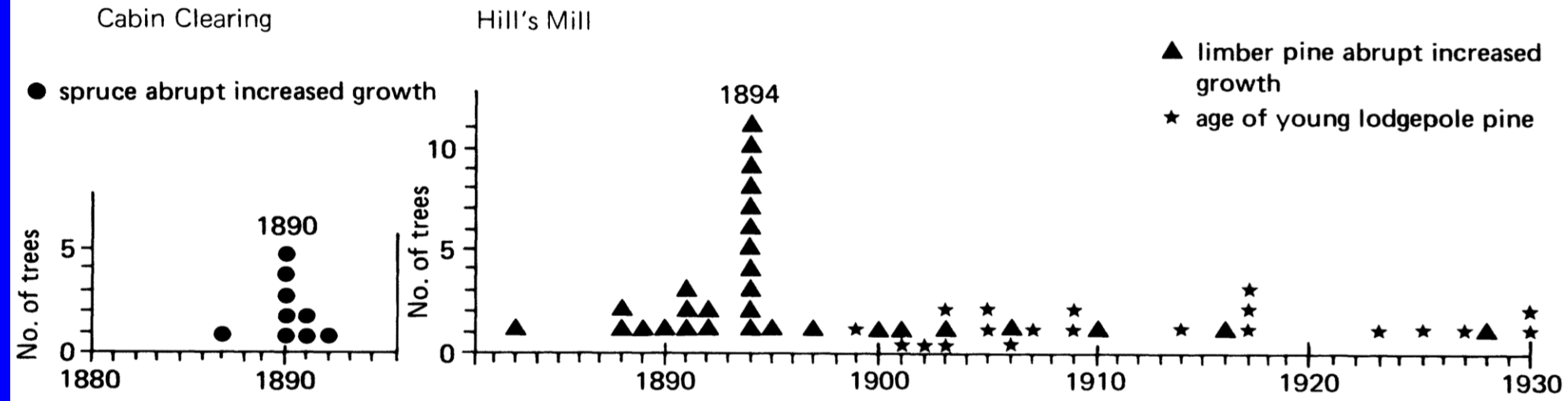
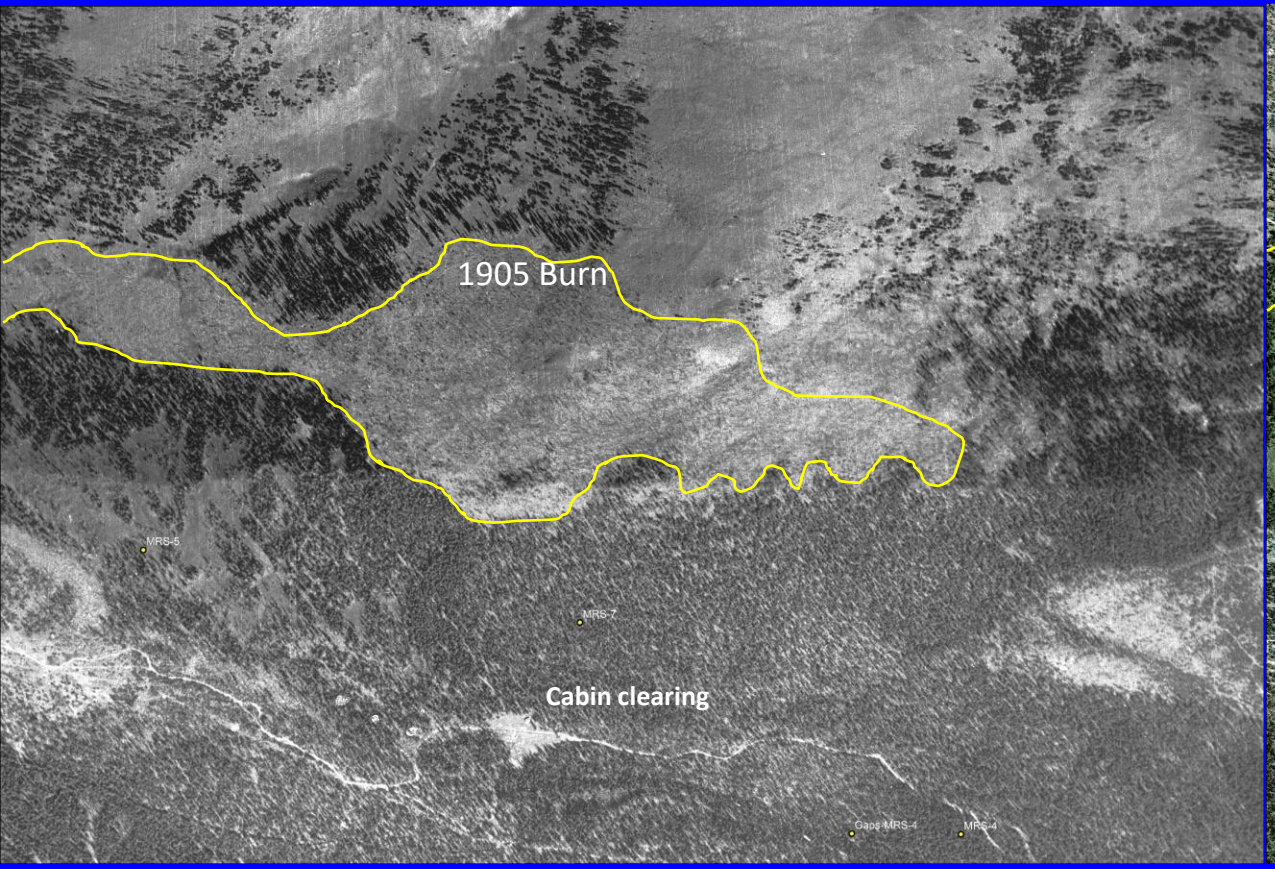
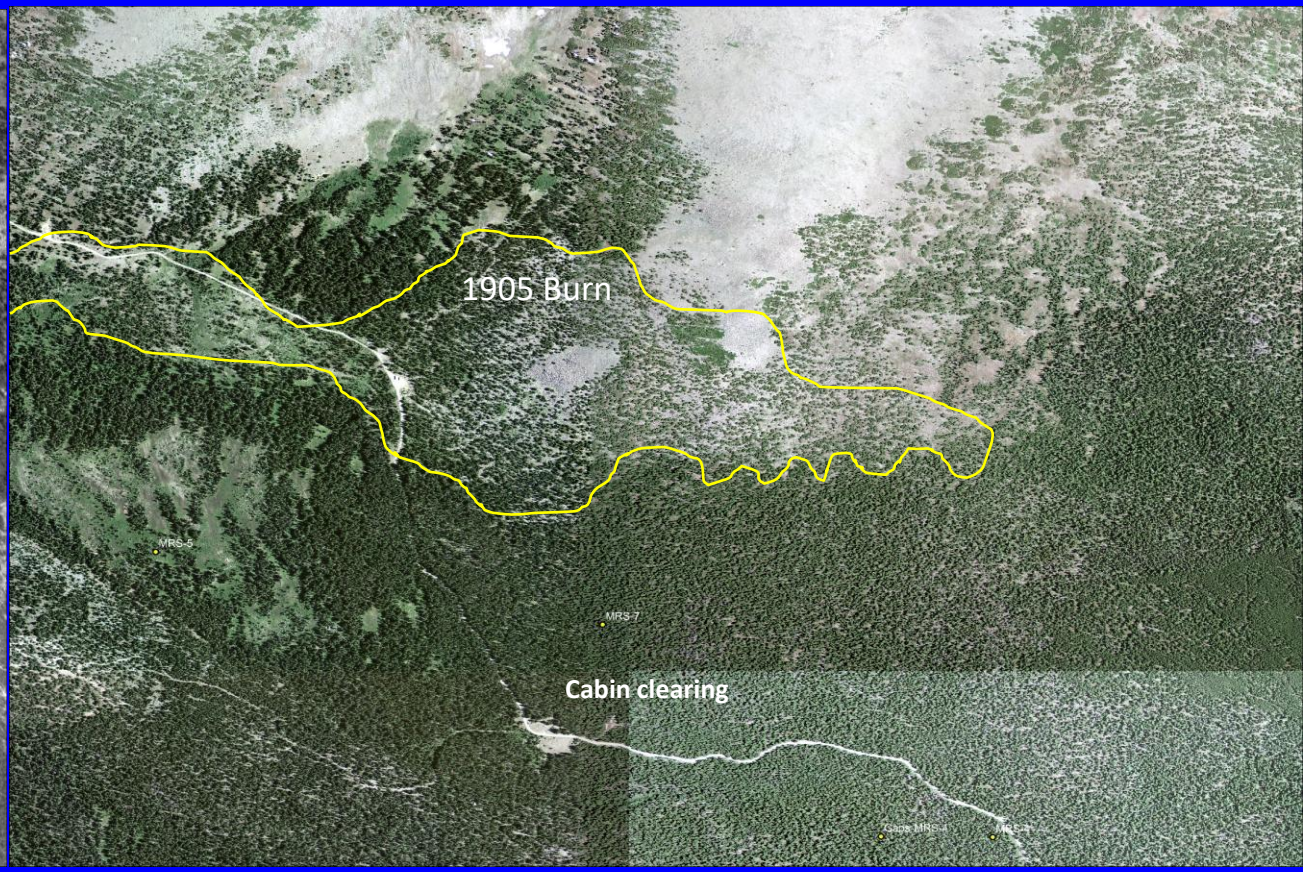


FIGURE 8. Abrupt growth release in trees at Cabin Clearing and Hill's Mill, near the University of Colorado Mountain Research Station. The trees register release around 1890 and in 1894. At Cabin Clearing the main felling took place around 1889, at Hill's Mill around 1893.

1938

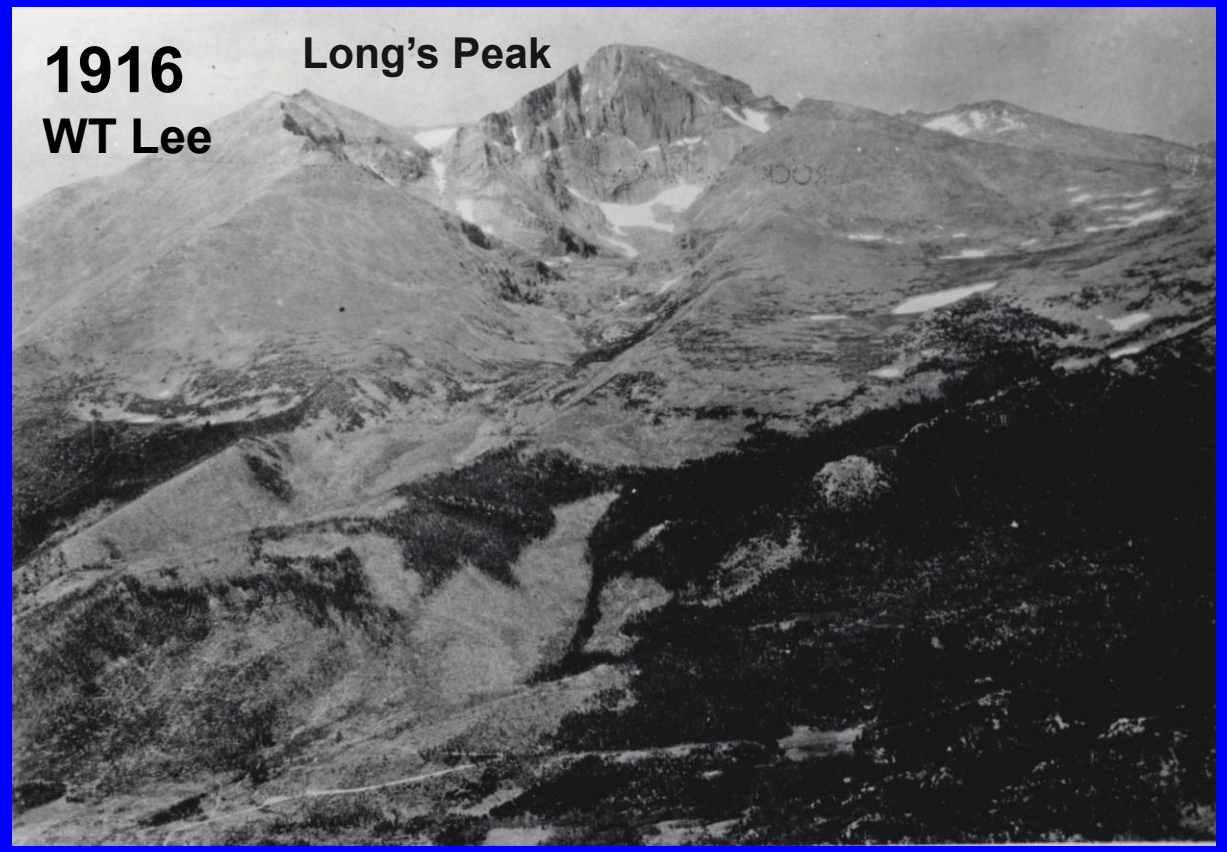
2012

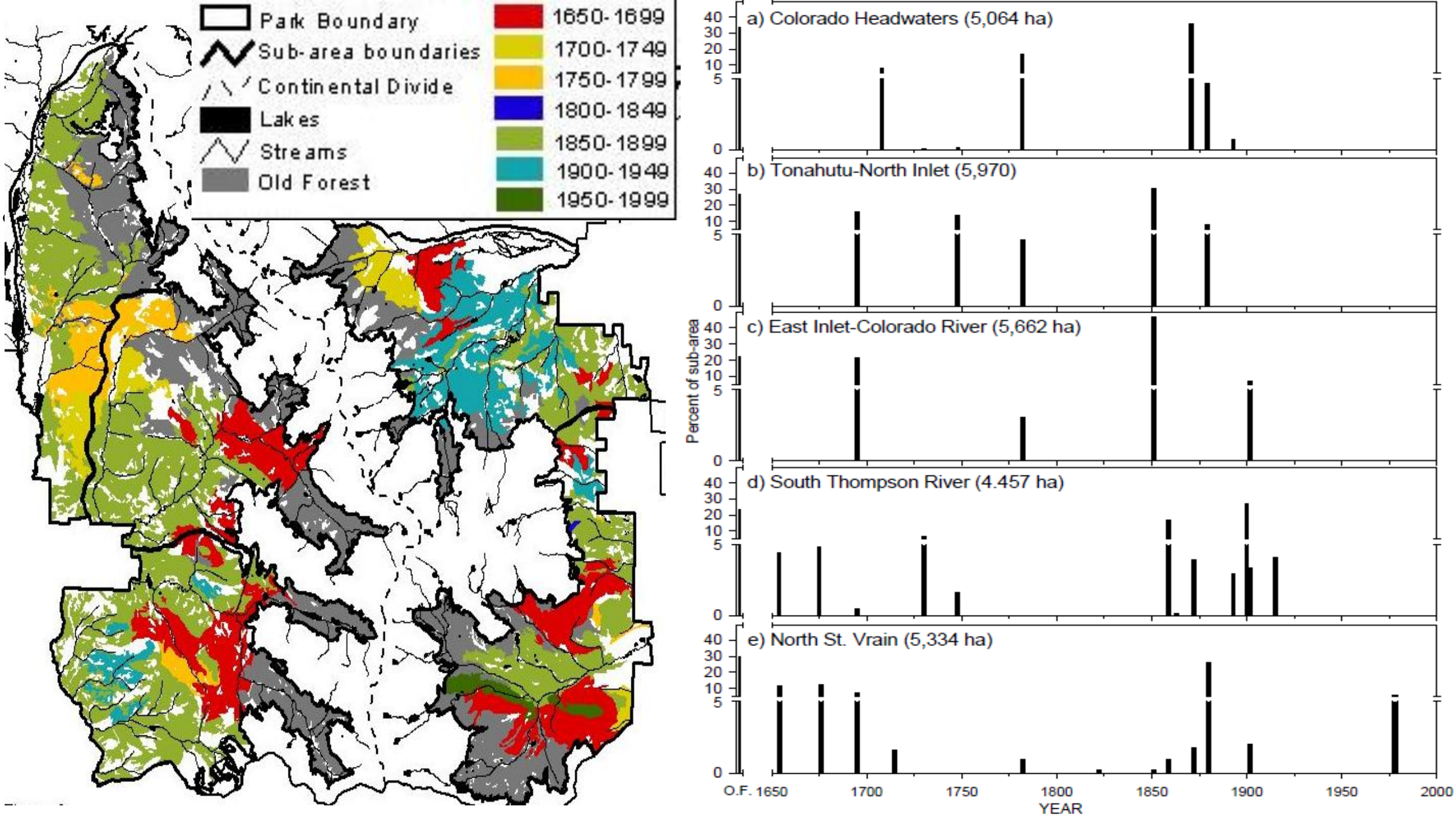

1905 Burn
MRS-5
MRS-7
Cabin clearing
Gaps MRS-4
MRS-4


1905 Burn
MRS-5
MRS-7
Cabin clearing
Gaps MRS-4

Subalpine: High-Severity Fire Regime

- Infrequent, severe stand-replacing fires
- Driven by extreme drought (correlated to La Niña & AMO)
- Limited by weather, not by fuel amounts
- Long natural fire return intervals (> 100 >> 300 years)




Park Boundary
Sub-area boundaries
Continental Divide
Lakes
Streams
Old Forest
1650-1699
1700-1749
1750-1799
1800-1849
1850-1899
1900-1949
1950-1999
a) Colorado Headwaters (5,064 ha)
b) Tonahutu-North Inlet (5,970)
c) East Inlet-Colorado River (5,662 ha)
d) South Thompson River (4.457 ha)
e) North St. Vrain (5,334 ha)
Percent of sub-area
0
5
10
20
30
40
O.F.
1650
1700
1750
1800
1850
1900
1950
2000
YEAR

Warming and provenance limit tree recruitment across and beyond the elevation range of subalpine forest—Kueppers et al. 2016 GCB

- Heated and watered Pien & Pifl above treeline, in krummholz, in forest; sowed high/low elevation seed; cohorts observed for 1-4 years.
- Warming reduced Pien recruitment at all 3 sites. Less so with watering.
- Initial recruitment better for low elevation provenances.
- Lower recruitment with warming + lower quality high-provenance seed, portends range contraction for Pien.
- Lower sensitivity of Pifl to warming suggests potential future advantage

Old seral post-fire stands

BW2, xeric, fire in ~1748

BW3, mesic, fire in ~1748

Old seral post-fire stands

MRS4, mesic, fire ~1660

MRS7, xeric, fire in ~1640

Old spruce-fir

(no fire > 500 years) **BL6 Mesic**

MRS5 Hydric

Old spruce-fir, timberline

(no fire > 500 years)

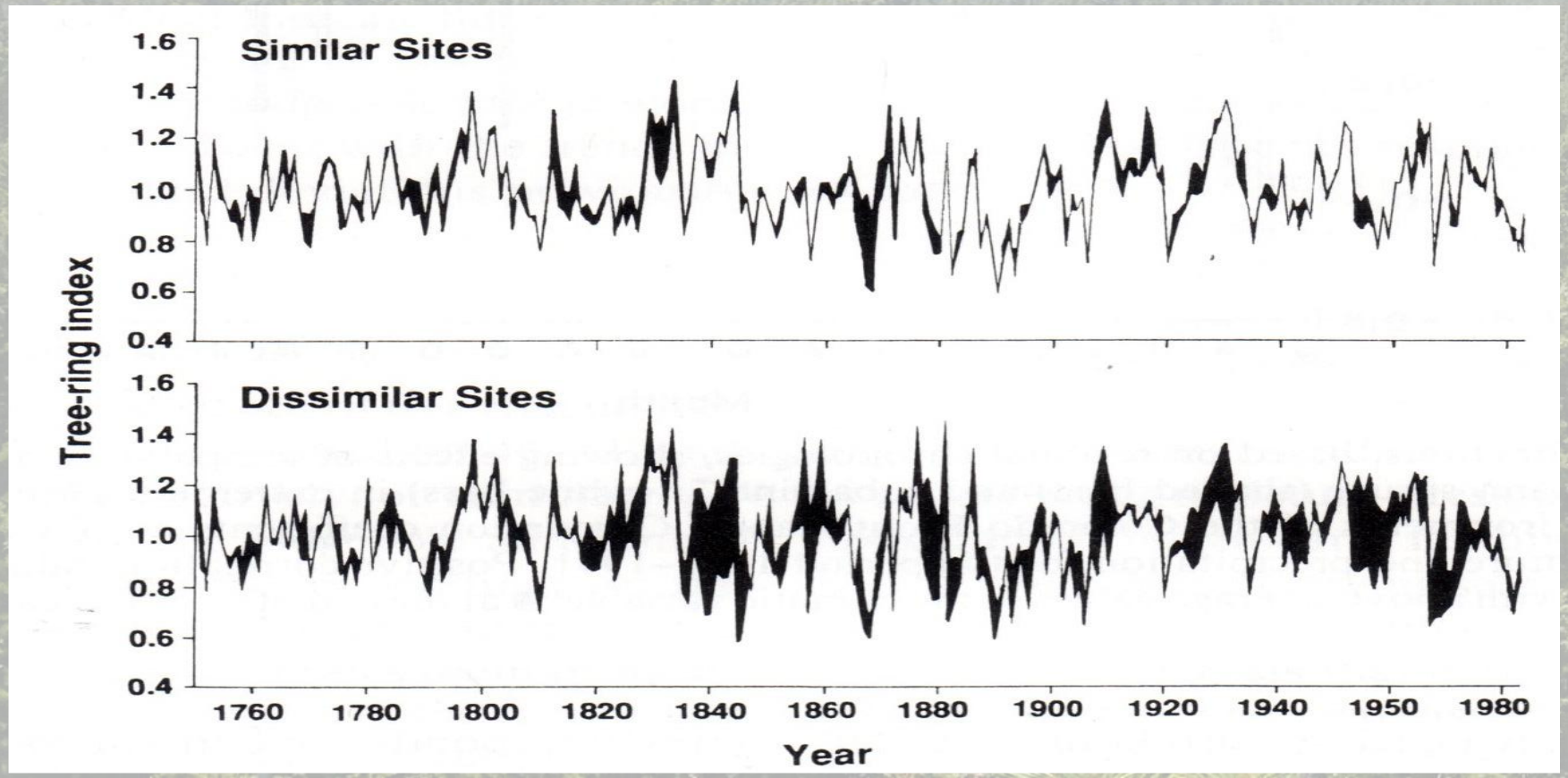
MRS 11

Post-fire (1905) near treeline

MRS13

Tree radial growth: 1750-1990

- 25 chronologies, 4 species, 12 sites (including 5 perm plots)
  - Higher temperature/reduced moisture availability reduces growth at most sites
  - Longer growing season favorable for Pico and Pifl but not Pien and Abla
  - Strong influence of topographic factors on growth



Difference (black) in spruce growth response to interannual climate variability for MRS4/MRS7 and MRS7/MRS5

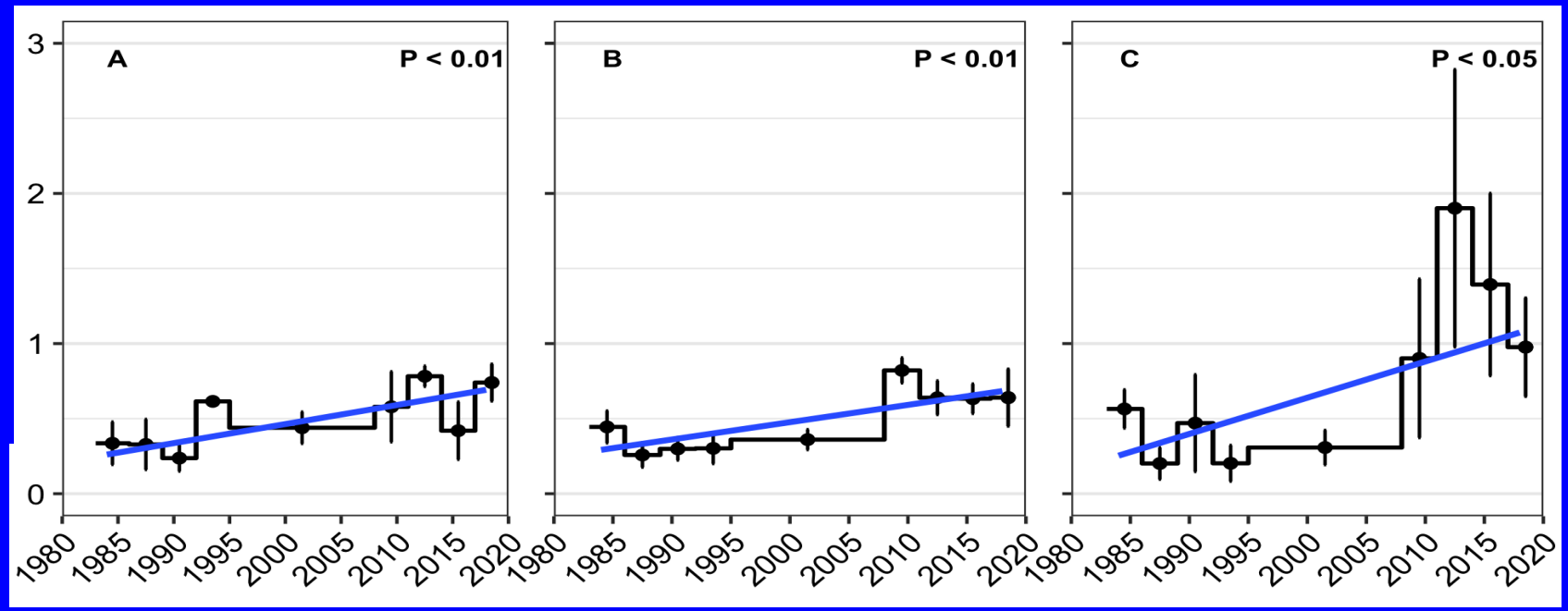
Climatic influences on the growth of subalpine trees in the Colorado Front Range. *Ecology* 1994. Villalba, Veblen, Ogden.

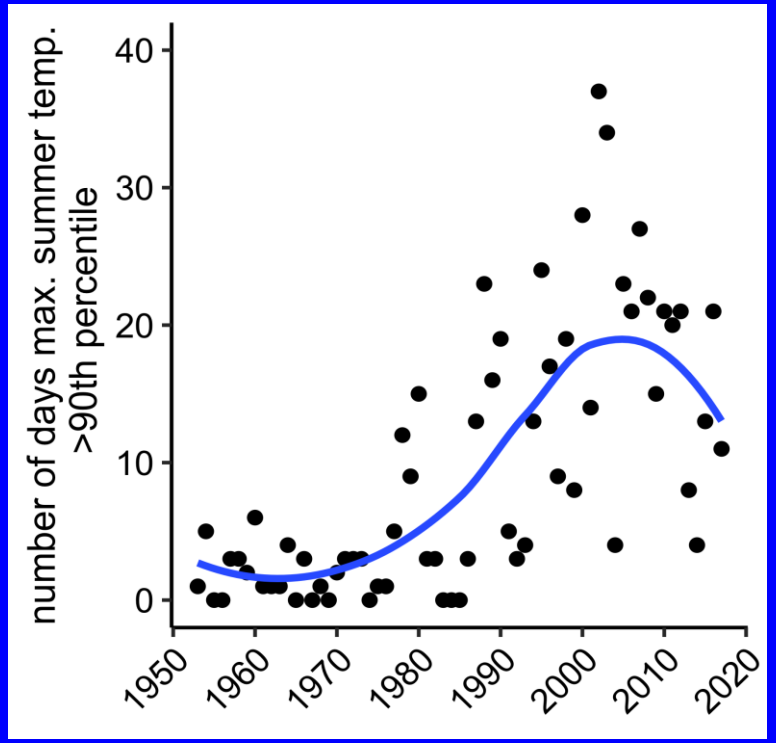
Climate Change Impacts: Drought and increased tree mortality (Andrus et al. 2021)

Post-fire lodgepole—130 yr old stands

Spruce-fir-lodgepole—250 to 400 yr old stands

Spruce-fir 400 to > 600 yr old stands

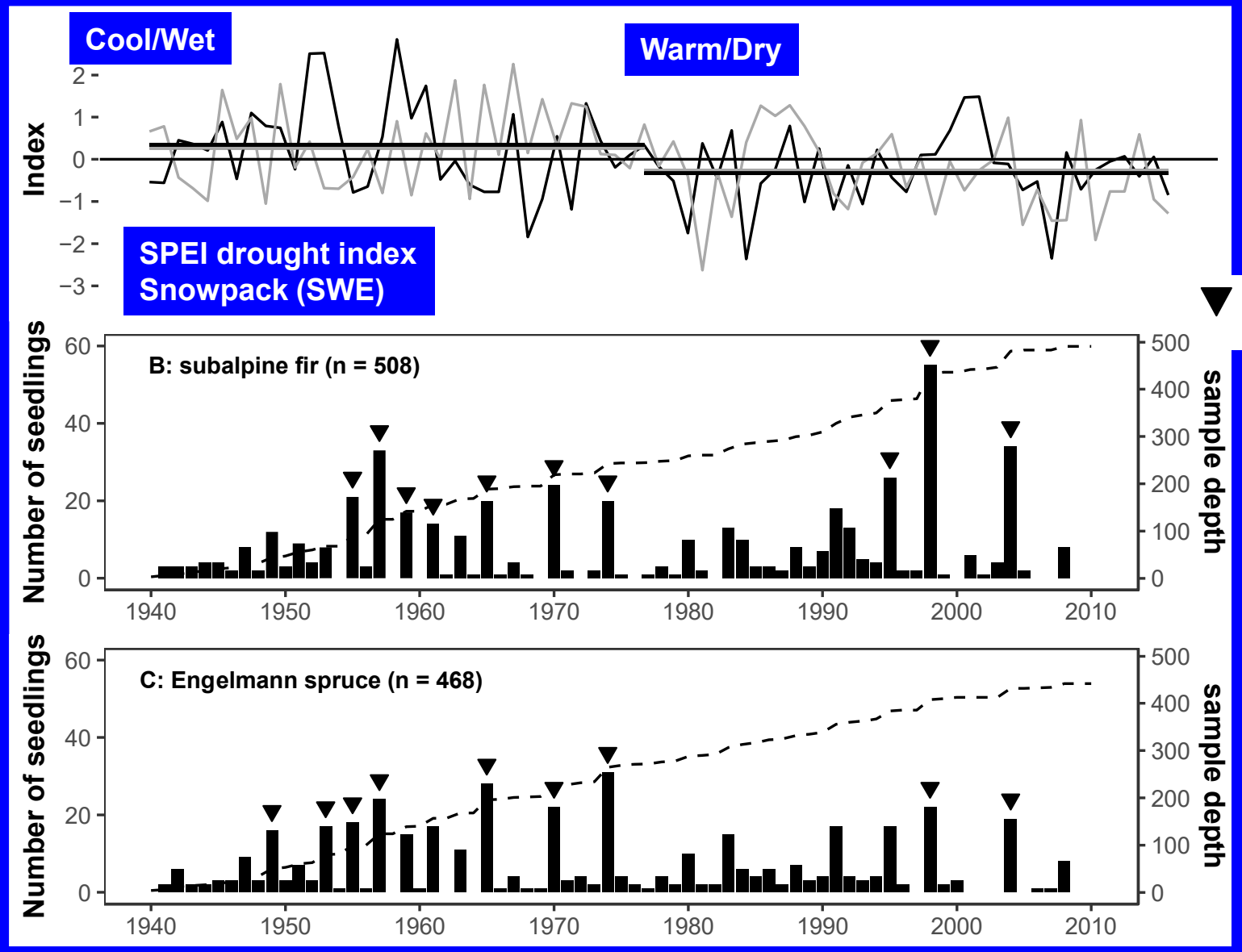




Higher tree mortality best predicted by warmer max summer temp, greater summer moisture deficits, and La Niña

Drought impact on tree regeneration in unburned forests

(Andrus et al. 2018. Ecology).



10 sites

c. 1000 trees

Modeling syntheses of forest changes*

- Pifl and Pien: warming-driven (1.2 to 3.9^{o} C) declines in recruitment led to rapid modelled population declines at the low-elevation, ‘warm edge’ of subalpine forest and slow emergence of populations beyond the high-elevation, ‘cool edge’.
- Range contraction for both Pifl and Pien, but lower sensitivity of Pifl to warming may facilitate persistence.
- Seeds of Pico from low elevation provenance had three-fold greater recruitment.
- Heating without watering halted any upslope range expansion of Pico.

*Conlisk et al. 2017 Journal Ecology, and Conlisk et al. 2017 Global Change Biology

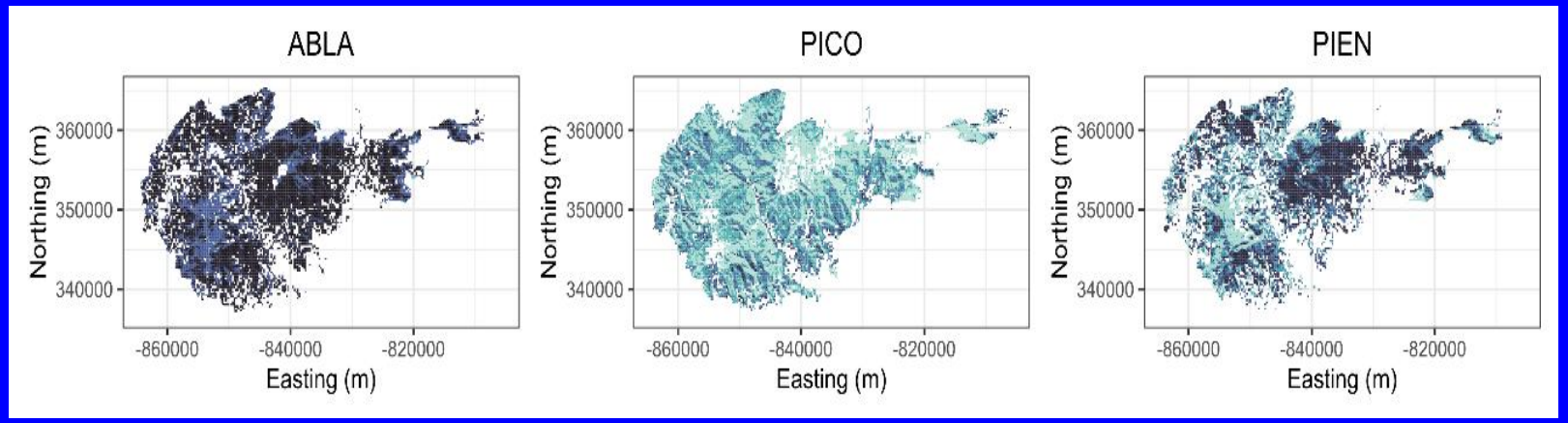
Post-fire subalpine tree regeneration: early warning signs

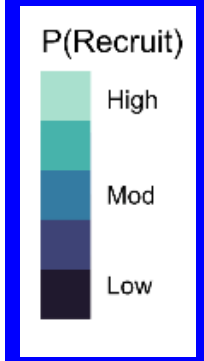
- Infrequent years of climate suitable for seedling survival (Andrus et al. 2018)
- Warming experiments show regeneration failures
- Sparse Pico regeneration after fires in early 2000s compared to pre-2000 fires

2002 Big Fish Creek fire seen in 2018

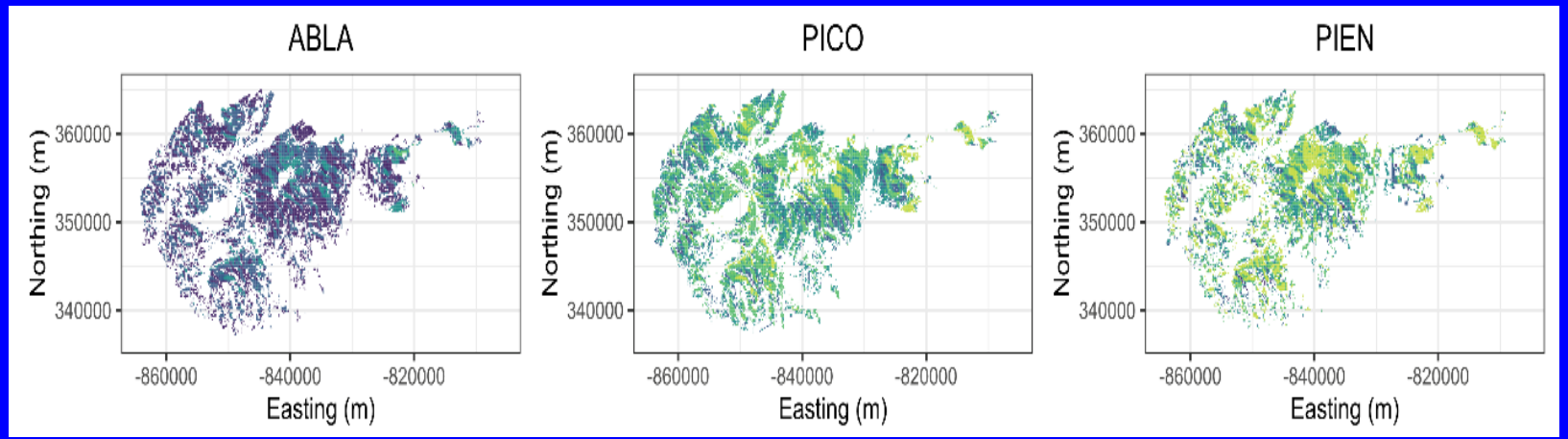
The 2020 subalpine fire events: ET, Cameron Pk, Mullen

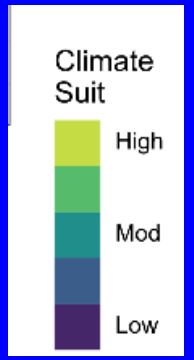
East Troublesome Fire





Probabilities of natural recruitment (seed dispersal)

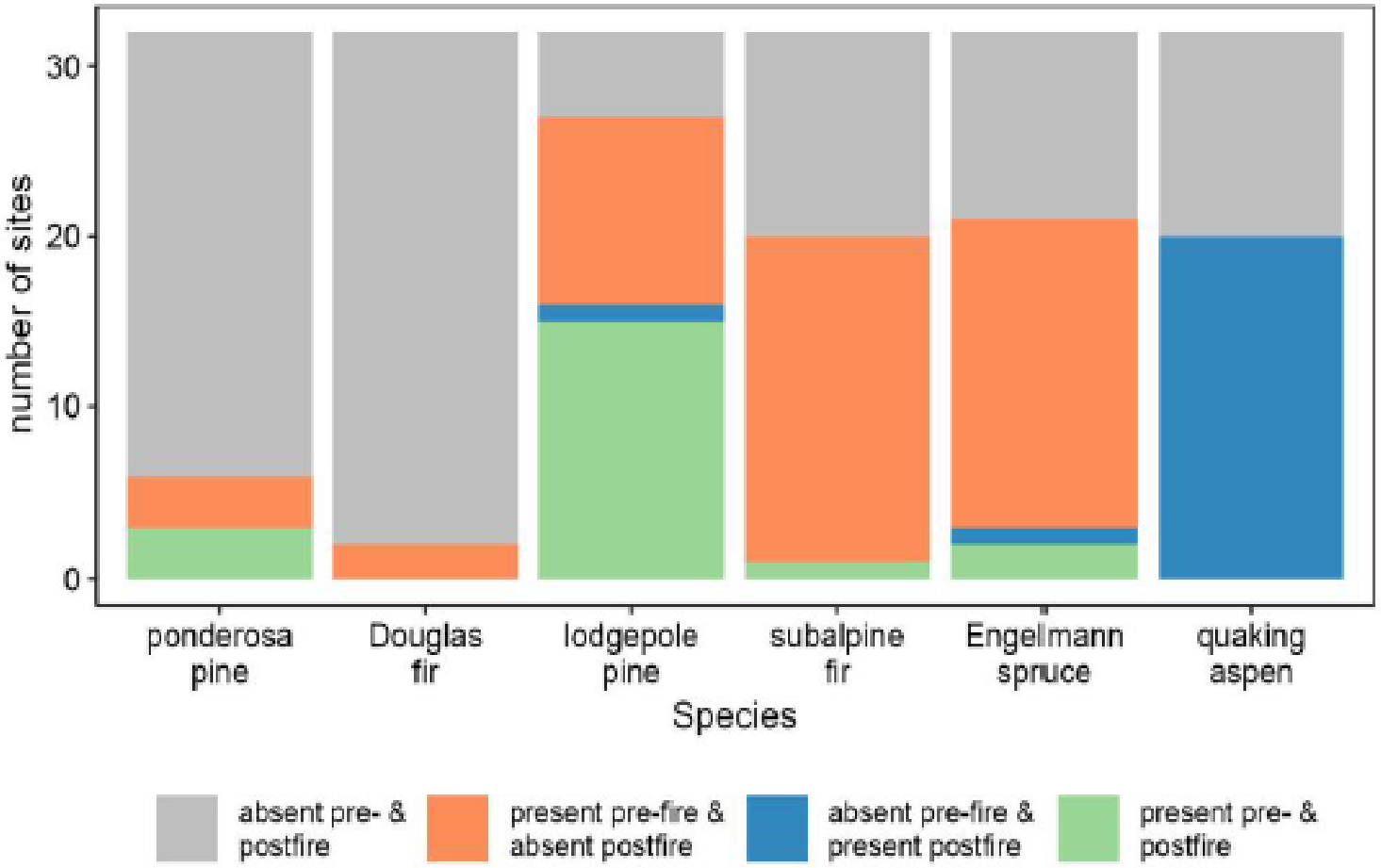




Probabilities of suitable current climate

The Historic 2020 Fire Year in Colorado and Wyoming: A Landscape Assessment to Inform Post-Fire Management Strategies. SWERI Report. Rodman, Kyle C. Rodman, Kimberley T. Davis, Marin E. Chambers, Teresa B. Chapman, Paula J. Fornwalt, Sarah J. Hart, Laura A.E. Marshall, Charles C. Rhoades, Catherine A. Schloegel, Camille S. Stevens-Rumann, and Thomas T. Veblen

Cameron Peak Fire



East Troublesome and Mullen Fires: Lodgepole pine seedling recruitment (Rhoades et al. 2025)

- 70% stands are unstocked (< 370 seedlings per hectare)
- Lowest stocking in recently harvested units
- Highest stocking in older stands
- More cone consumption on beetle-killed trees
- Declining seed viability with time since early 2000s beetle outbreak

Limited conifer regeneration but widespread regeneration of aspen seedlings following the Cameron Peak fire, northwestern Colorado. Fire Ecology. 2026. S.V. Carter & S. Hart.

Links to public outreach coverage of research discussed on the educational hikes:

Forests scorched by wildfire unlikely to recover, may convert to grasslands | CU Boulder Today | University of Colorado Boulder

Extreme heat, dry summers main cause of tree death in Colorado's subalpine forests | CU Boulder Today | University of Colorado Boulder

Drier conditions could doom Colorado spruce and fir trees | CU Boulder Today | University of Colorado Boulder

Colorado's wildfire-stricken forests showing limited recovery | CU Boulder Today | University of Colorado Boulder

Fire severity in southwestern Colorado unaffected by spruce beetle outbreak, CU-Boulder study finds | CU Boulder Today | University of Colorado Boulder

Study: Western forests decimated by pine beetles not more likely to burn | CU Boulder Today | University of Colorado Boulder

Seed availability hampers forest recovery after wildfires | CU Boulder Today | University of Colorado Boulder

Colorado's Front Range fire severity today not much different than in past, says CU-Boulder study | CU Boulder Today | University of Colorado Boulder

Massive spruce beetle outbreak in Colorado tied to drought, according to new CU study | CU Boulder Today | University of Colorado Boulder

New Study Links Western Tree Mortality to Warming Temperatures, Water Stress | CU Boulder Today | University of Colorado Boulder

New Study Links Western U.S. Wildfires To Atlantic Ocean Surface Temperatures | CU Boulder Today | University of Colorado Boulder

Adapting to a future of increasing wildfire

Extreme fire spread events and area burned under recent and future climate in the western USA

Jonathan D. Coop[1] | Sean A. Parks[2] | Camille S. Stevens-Rumann[3] | Scott M. Ritter[4] | Chad M. Hoffman[3]

Glob Ecol Biogeog 2022

"Exceptional fire seasons like 2020 will become more likely, and wildfire activity under future extremes is predicted to exceed anything yet witnessed."

- "We know humans cannot stop a fire during 100 mph winds or a fire that moves 20 miles in an hour and crosses the Continental Divide. There is no forest management project that will "protect" our communities from wildfire in those conditions…" USDA FS Boulder District Ranger, Comment Scoping Letter, SVFH Project, 2022.
- **Public Engagement** on Forest Management must insist on the precautionary principle of "first, do no harm". Demand evidence that pro-active management will yield greater benefits than protecting forests from logging.
- **Adopt** *"Living with Wildfire"* strategies – localized (CWPP) collaborative strategies focus on public safety, structure protection, reducing ignition risks, securing fire-fighting water supplies, early fire detection and alerts, home hardening, defensible space on or adjacent to private property, evacuation planning, increased/improved egress routes, undergrounding power lines, engineering solutions for hardening of waterworks . **Shift public funding from back country fuels treatments to home hardening/defensible space (currently estimated at >95% vs < 5%, respectively).**
- **Invest** more in reforestation (including assisted migration) following fires to allow recovery of ecosystem services, especially the buffering capacity of forests against CO2 emissions.