Fire Ecology for the Eastern Sierra

- Fire in California
- Fire and Fuel Fundamentals
- Eastern Sierra Fire Regimes
- Forest Treatments

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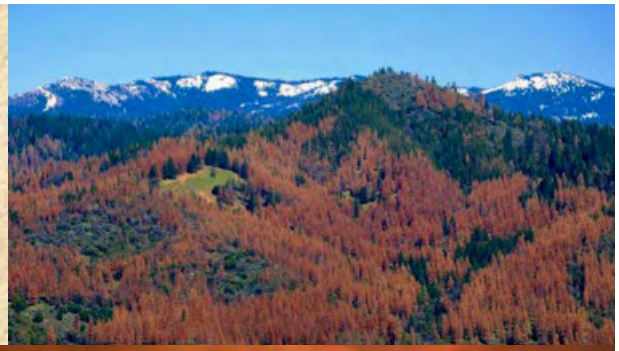
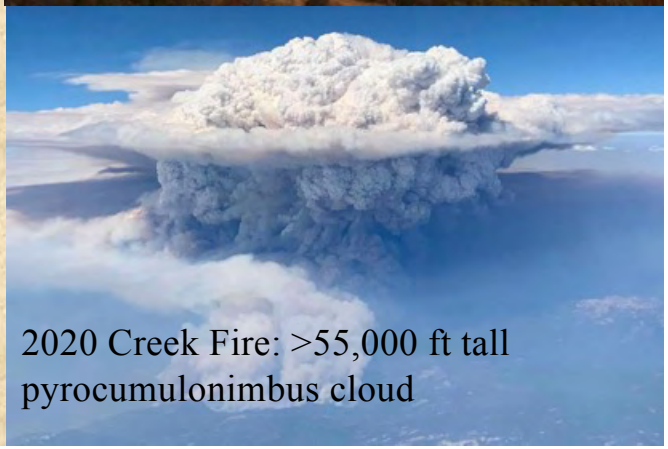
California's Current Fire Problem:

- 17% of California's 40 million ac of forests burned in the last 21 months
- >18% of the world's mature ('monarch') giant sequoia were killed in 2020 and 2021 wildfires
- Fire suppression has left too many 'straws in the ground' and a 2012-2016 CA drought resulted in >150 M dead trees in the Sierra Nevada
- This produced such high fuel loads, that fire behavior in the 2020 Creek Fire was beyond any current models
- This compounding of disturbances is likely to increase with climate change and more severe wildfires





2020 Creek Fire: >55,000 ft tall pyrocumulonimbus cloud

How much of California burned each year before European settlement?


2008 wildfire

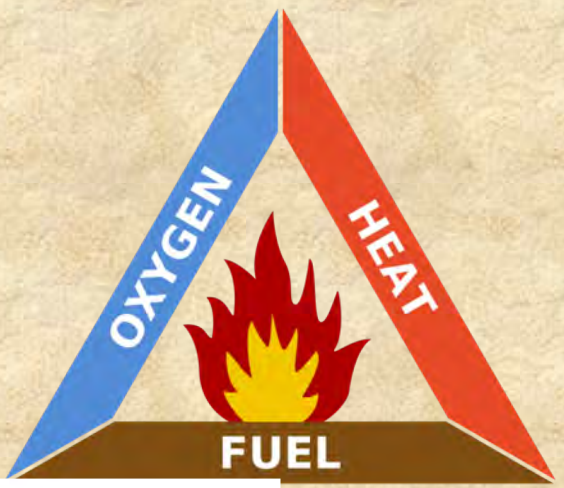
Sept. 22 1900 fire plume in the San Gabriel Mountains, Los Angeles County (taken 25 miles from the fire).

- In CA before 1800, an estimated total of 4,500,000 ac/yr
- For 1950-1999 average total burned by wildfire was 250,000 ac/yr
- In 2021, 2,600,000 ac burned and in 2020 4,300,000 ac burned

Source: Stephens et al. 2007. Forest Ecol. & Man. 251: 205–216

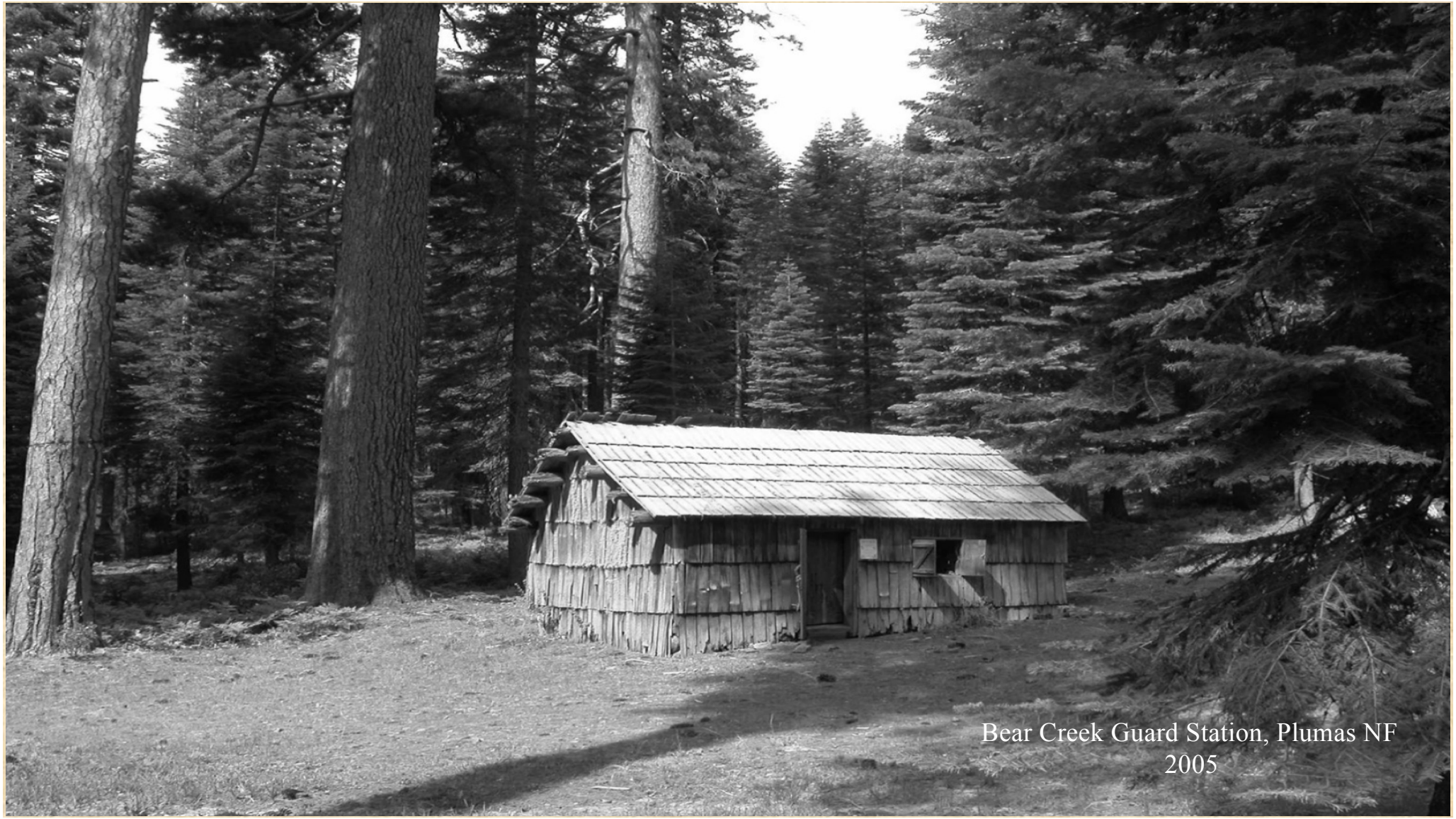
The Fire Triangle: Weather, Topography, and Fuels

Fire Triangle:
Fundamentals of an exothermic chemical reaction



Forest Fire Triangle:
Influences on Wildfire Behavior

Bear Creek Guard Station, Plumas NF
1910's



Bear Creek Guard Station, Plumas NF
2005

Dry western forests, hands off management is **not** an option

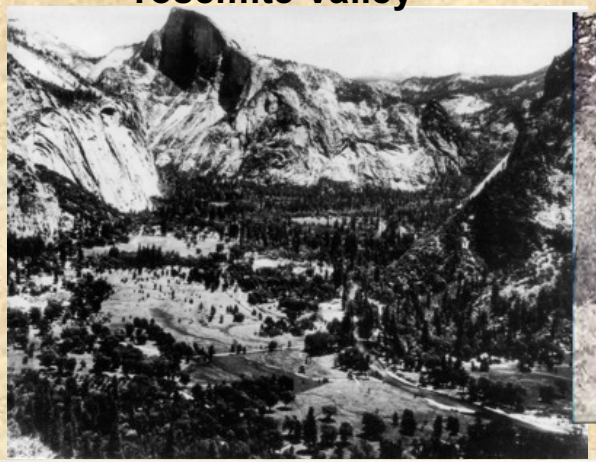
Historic and Current Forest Conditions and Fire Severity

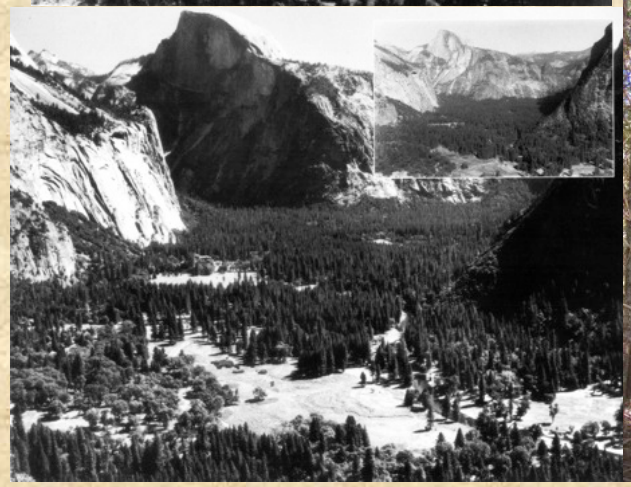
Yosemite Valley

Time Period

Historic (pre 1870)

Modern (after 1970)





Current wildfires burn differently: mostly high-intensity crown fires that kill most trees even the large and old.

Three main types of forest fuels

Surface fuels:
Litter, twigs, branches
60% of fire behavior

Ladder fuels:
Small to intermediate size trees that transfer surface to crown fire **30%**

Canopy fuels:
Tree crowns burn and rapidly transmit fire**:**
10%

Fire's Ecological Role in Sierra Neveda Forests

"The most potent factor in shaping the forest of the region has been, and still is, fire. The general character of the forest, ... in fact almost every phase of its condition has been determined by ... fire."

J. B. Leiberg 1902. *Forest conditions in the northern Sierra Nevada, California.* Professional Paper 8, Series H, Forestry, 5. US Geological Survey, GPO, Washington, D.C.

Fuels reduction

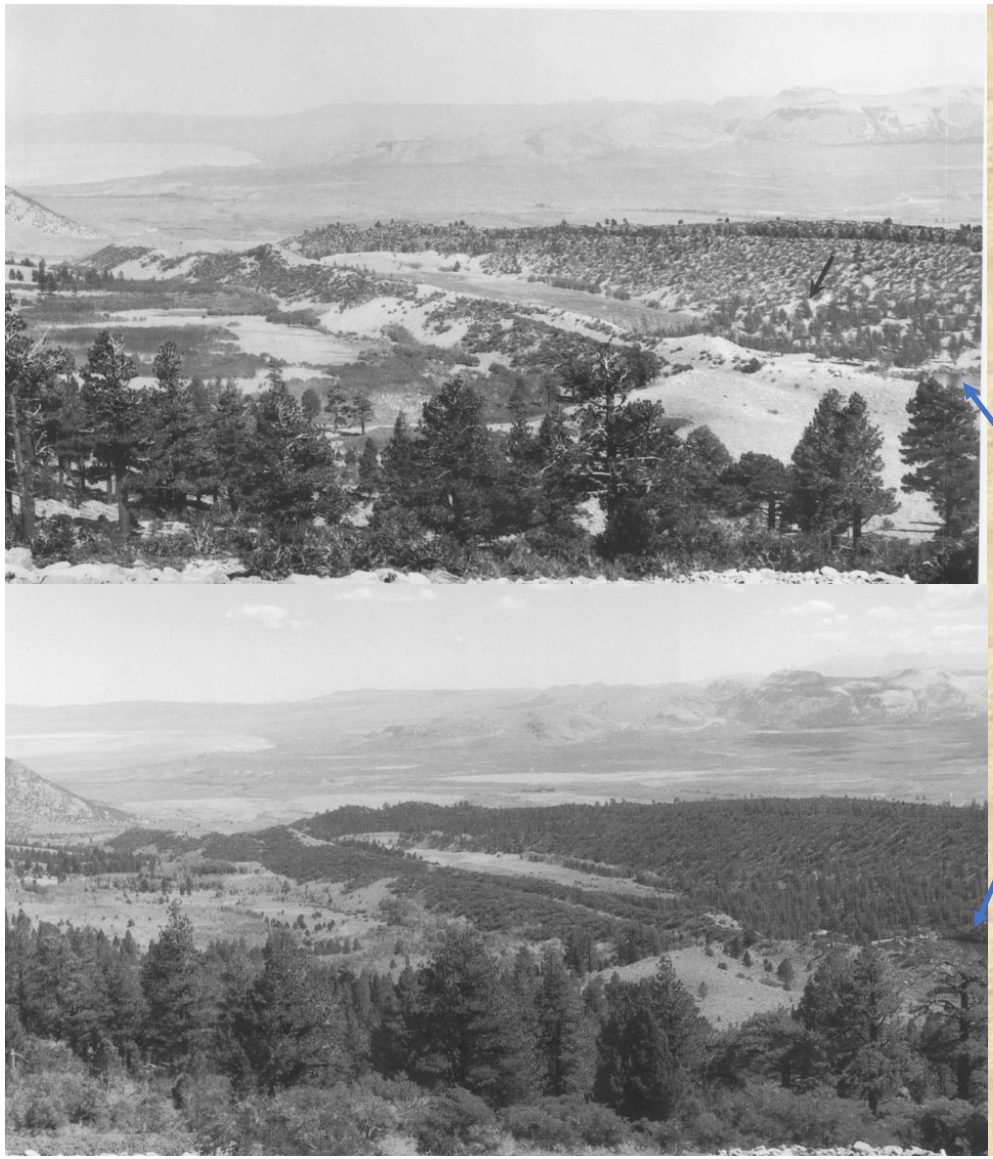
Reduces tree density—essential for drought resilience

Without fire, many ecosystem processes stall (decomposition, nutrient cycling, etc.)

Maintains a tree clump and opening pattern that makes the forest more fire resilient

That spatial pattern also creates greater microclimate and habitat variability, supporting biodiversity

Fire is required to fully restore these forest ecosystems



Changes in Eastern Sierra Forests:

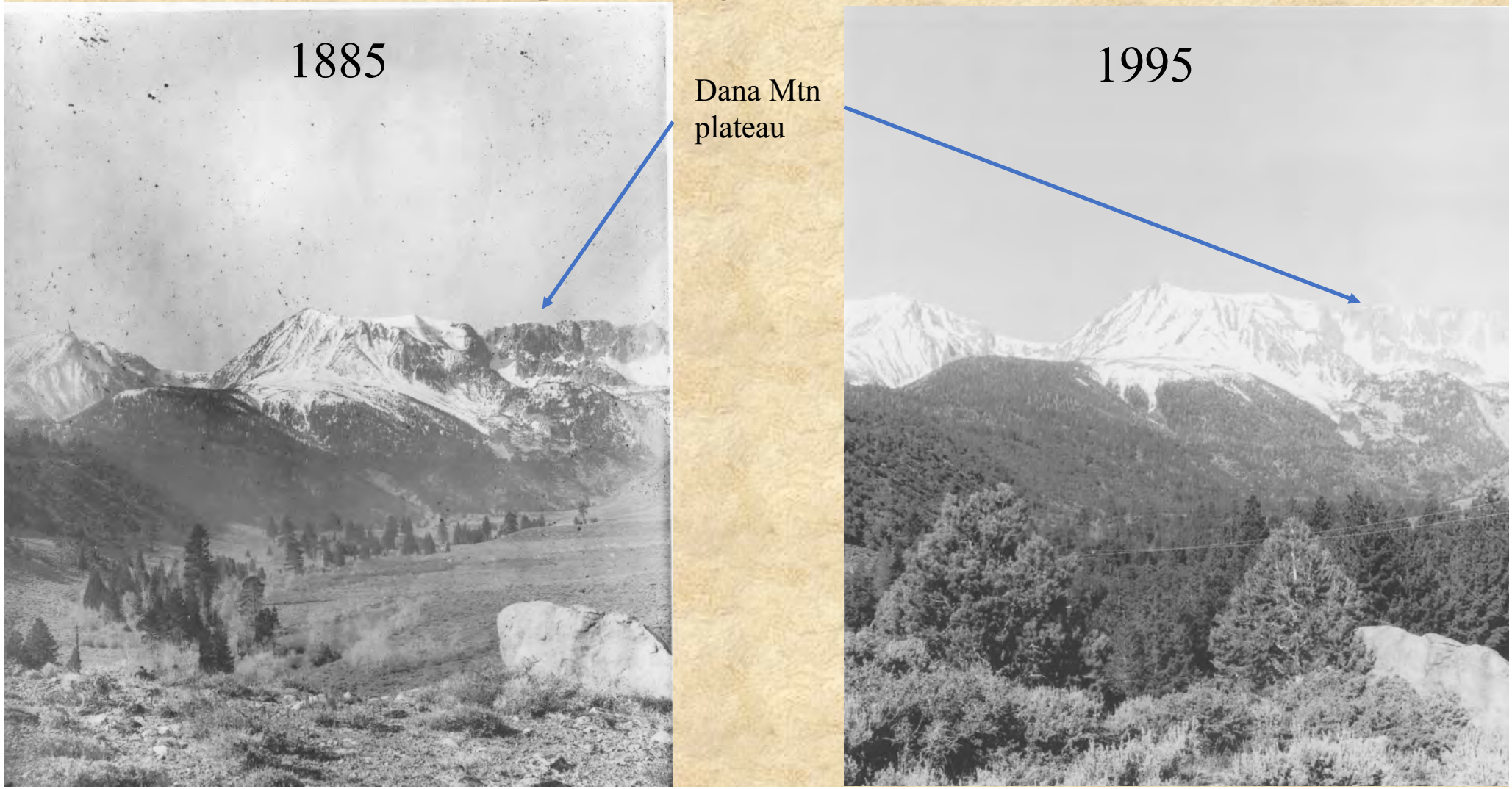
View NE down Bohler Canyon from 8900' elevation

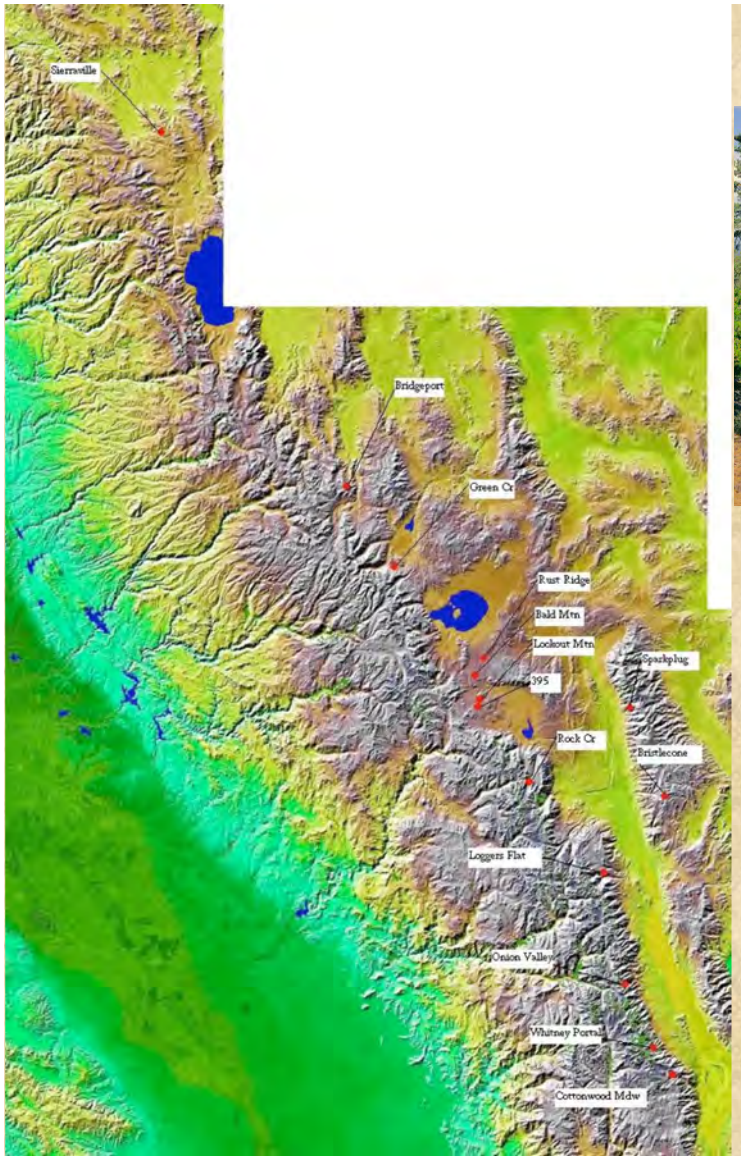
1904

Lower part of Walker Lake

1994

View SW up Lee Vining Creek from 7200’ elevation





Eastern Sierra Fire History

Fire history differences in adjacent Jeffrey pine and upper montane forests in the eastern Sierra Nevada. 2001. Stephens, S.L. Int. J. of Wildland Fire 10: 161-167.

In Valentine Reserve

- wetter upper montane (red and white fir, lodgepole pine) every 25 years
- drier Jeffrey pine forest burned on average every 9 years

Climate, rain shadow, and human-use influences on fire regimes in the eastern Sierra Nevada, California, USA. 2009. North, M.P., K.M. van de Water, S.L. Stephens, and B.M. Collins. Fire Ecology 5(3): 17-31.

14 sites from Cottonwood Mdws. to Sierraville

- Upper montane burned every 13-46 years
- Jeffrey pine burned every 5-17 years
- **Connectivity matters:** Jeffrey pine that burned most frequently, every 5-9 yrs, is in the Mammoth to Mono Craters belt

Types of Fuels Treatments:

Crown Fuels: Crown Separation

Ladder Fuels:

Mechanical and Hand Thinning

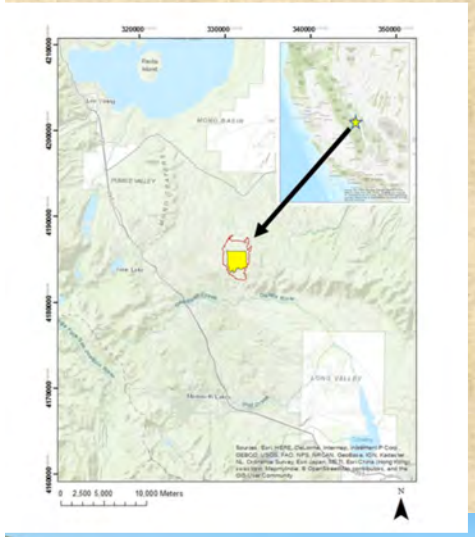
Surface Fuels:

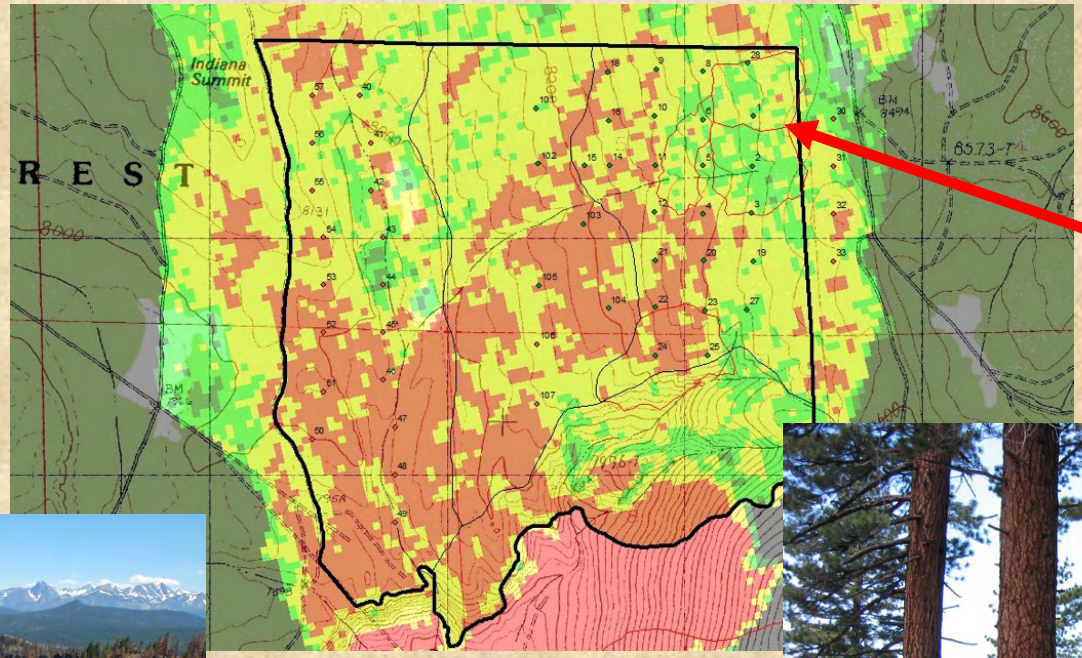
Mastication

Prescribed Fire

Pile & Burn

Local Lesson: Indiana Summit RNA (CA's first Research Natural Area [est. 1932])





Green: low severity
Yellow: moderate severity
Red: high severity

1990s prescribed fires that had reduced fuel loads

The 2016 Clark Fire burned into the RNA's old-growth Jeffrey pine

What are the current rates (2011-2020) of fuels treatments on Forest Service land?

Total FS acreage in the Sierra Nevada: 13 M ac

How much burned each year before 1800: ≈**620,000 ac/yr**

Treatment Type:	Unique Footprint[1] (acres)	Total Accomplished [2] (acres)	Mean size in acres (range)	Median size (acres)	Median distance (ft) between treatments within a project
Mechanical (Mech)	21,211	50,374	36 (0.1-5,249)	13	4623
Prescribed Burn (Rx)	11,861	22,214	40 (0.1-1,298)	13	
Managed Wildfire (Man)	18,919	20,138	2,877 (0.8-82,230)	295	
Mech & Rx	10,861	(23,200[3])			
Rx & Man	58	--			
Mech & Man	341	--			
Mech/Rx/Man	105	--			
Total:	63,357[1]	92,726[2]			

[1] Stacked treatment polygons are condensed into one footprint

[2] Total treatment acreage tallied regardless of overlap

[3] Overlapping acres of treatment (i.e., the same area was thinned and then burned)

Treatments compared to historical levels:

Unique footprint (63K): 10%

Overlapping (93K): 15%

Avg mechanical size: 36 ac

Avg Rx burn size: 40 ac

Avg manage wildfire size: 2900 ac

Avg dist. between trt: 0.8 miles

Large-scale application of fire isn't possible without relaxing how we use and evaluate it

- Current use is limited to reducing surface and ladder fuels
- Focuses on not damaging overstory trees (expecting the precision of thinning)
- But large-scale fire is a 'blunt tool'

Large-scale fire should have 3 silvicultural **and ecological** objectives, and be oriented toward increasing pace and scale

1) Density reduction (that sometimes kills some overstory trees)
2) Tree spatial heterogeneity (individual trees, clumps of trees and openings)
3) Fire-tolerant species (ex. pines) left on hotter, drier site while fire-sensitive species are left in wet locations. Fire selecting for individuals with phenotypes including thicker bark, earlier branch abscission

California: The Pyrogenetic State

No matter how much money, human resources or new technology is thrown at it, in dry western forests, **fire is inevitable and increasing in frequency and severity with climate change.**

So, the pivotal question is: What kind of fire do we want?

Fires that escape suppression during extreme weather conditions?

OR

Intentional fire under weather, human resource, and smoke dispersal conditions of our choosing?

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