California Forests:

Presentation to the California Naturalists

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Susie Kocher, Forestry Advisor,

Central Sierra

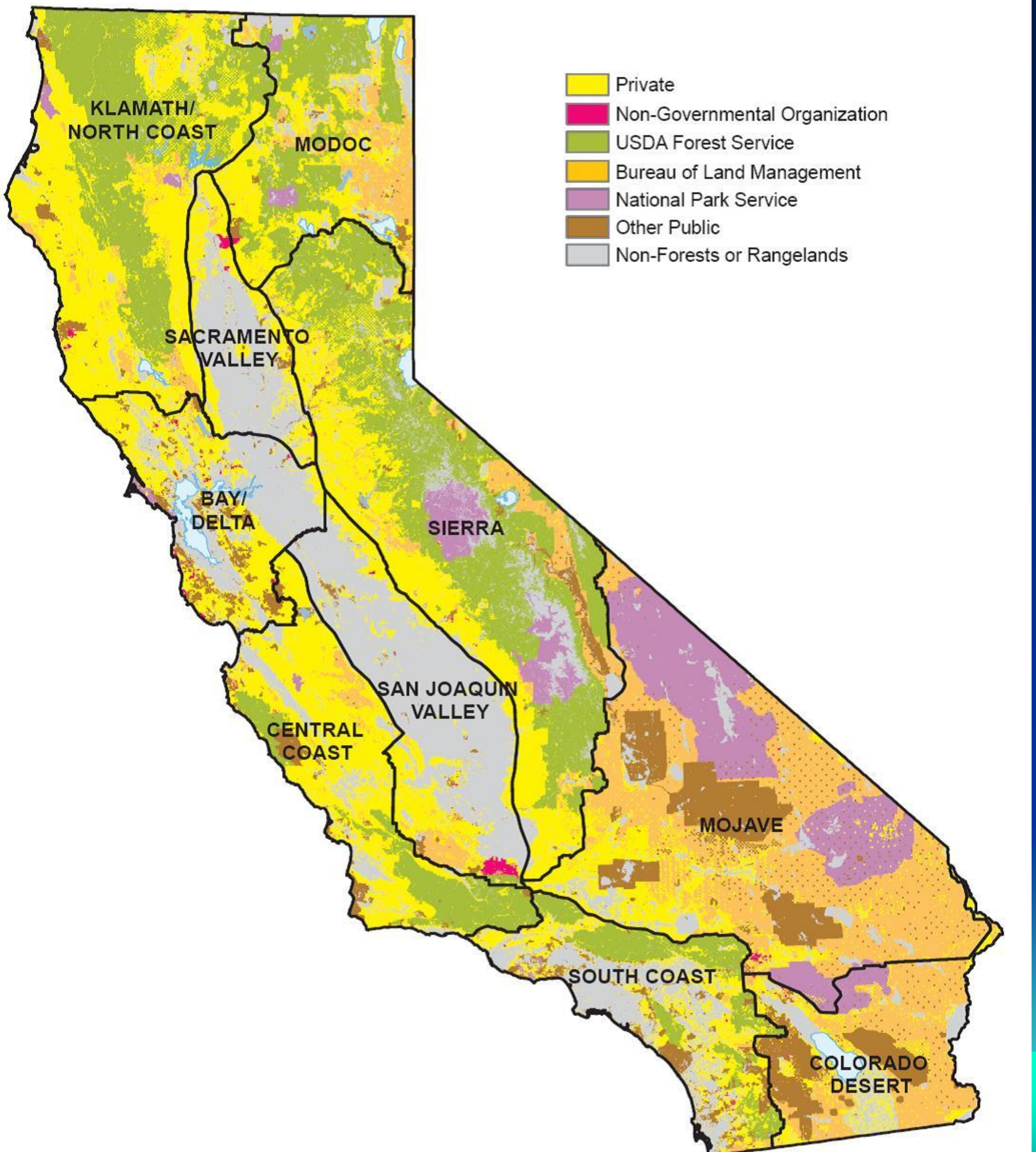
sdkocher@ucanr.edu

Presentation Goals

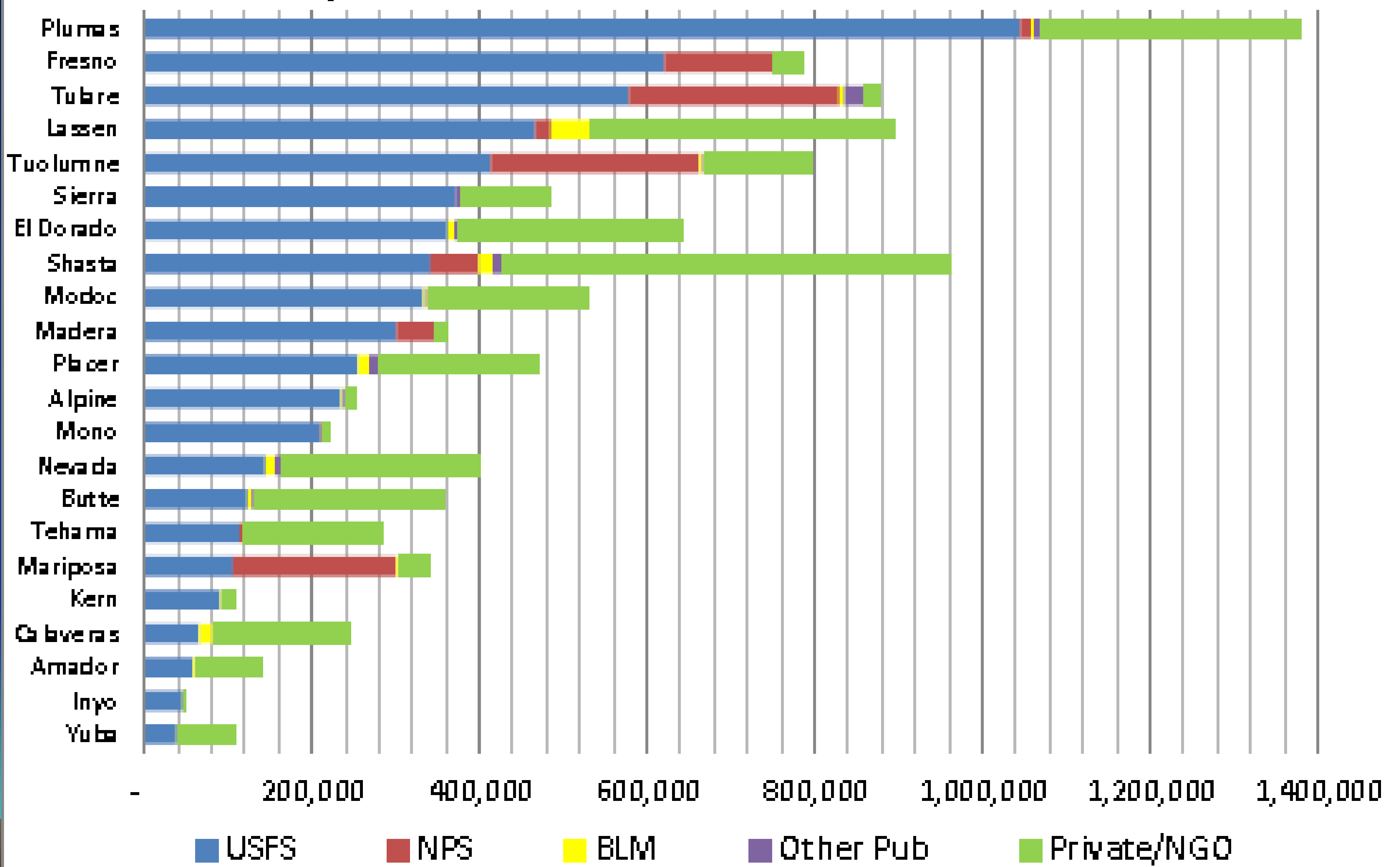
- Overview of forests in California, status and threats
- Familiarity with Sierra conifer species and forest types
- Basic understanding of
  - Sierra forest ecology Interaction / growth of different species
  - Forest fuels reduction projects
  - Insects and disease

33 million acres of Forest in California

- 19 million acres (57%) federal agencies (Forest Service and Bureau of Land Management National Park Service)
- < 1 million acres (3%) State and local agencies (CalFire, local open space, park /water districts, land trusts
- 14 million acres (40%) private
  - 5 million acres (14%) Industrial timber companies
  - 9 million acres individuals where 90% own < 50 acres



Ownership of Productive Forest Land in Sierra Nevada Counties



Sierra Nevada Conifers

- Any of various mostly needle-leaved or scale-leaved, chiefly evergreen, cone-bearing gymnospermous trees or shrubs
- Pines (pinus spp.)
  - Needles in bundles
  - Seeds carried on cones that fall to ground whole
  - Two families are yellow and white pines
- Firs (abies spp.)
  - Needles individually attached to stems
  - Cones do not fall whole to the ground

Foothill pine
Pinus sabiniana

- Needles in bundles of 3, pale gray-green, sparse and drooping, 8 to 13 inches long
- Cones large and heavy, 5-14 inches long
- California Indians used its seeds, cones, bark, and buds as food, and twigs, needles, cones, and resin in basket and drum construction and medicine

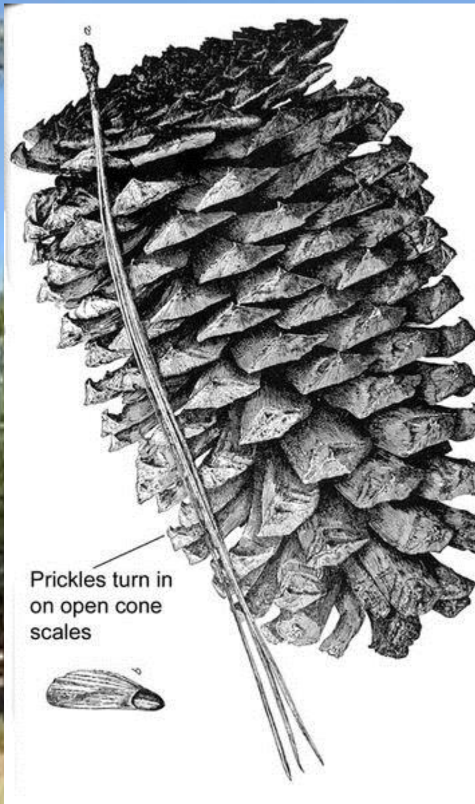
Ponderosa pine *Pinus Ponderosa*

- 2-3 needles per bundle - 3 to 5 inches long
- Cone bracts long and “prickly”
- Orange puzzle piece bark

Jeffrey pine

Pinus Jeffreyi

- 2-3 needles per bundle - 3 to 5 inches long
- Cone stouter with bracts turned in “gentle”
- Resin scent described as vanilla or butterscotch.
- Bark pieces smaller
- Above 5000’



Lodgepole pine
Pinus contorta

- Needles- 2 needles per bundle 1-3" long
- Cones small, egg-shaped cones 1-2" long
- Bark thin and flaky (cornflakes)
- Found in very dry or wet or high elevation locations

Sugar pine

Pinus lambertiana

- Needles in bundles of five 2-4 inch long
- Longest cones of any conifer, 10-26 in long
- Has been severely affected by the white pine blister rust

Western white pine

Pinus monticola

- Needles 2 to 5 inches long.
- Cones long and slender, 5 to 12 inches
- Seriously affected by white pine blister rust
- Found >/6000'

White bark pine
Pinus albicaulis

- Cones small, woody cones, 2-3" long; nearly round; thick cone scales with no prickles. Remain closed on tree even when mature - opened by Clark's nutcracker
- 5 needles / bundle, 1-3" long
- Bark thin, scaly, and grayish
- Often grows in krummholz at tree line

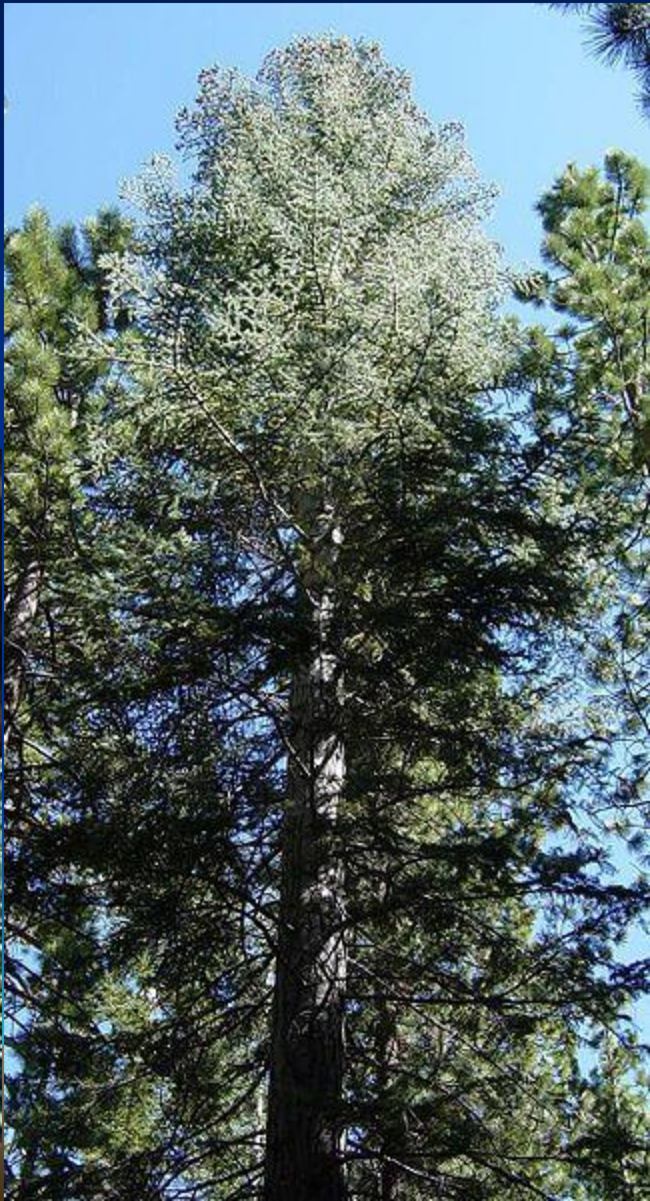
Incense Cedar

Calocedrus decurrens

- Scales on flattened fan-shaped branchlets
- Soft, moderately decay-resistant, wood with a strong spicy-resinous fragrance
- Traditionally used for pencils
- Elevation range about 3000 to 8000 feet

White fir
Abies concolor

- Needles 1 to 2 inches long green to blue-green
- Closed cones 2 to 5 inches long with 100-150 scales
- Elevation range about 3000 to 6000’



Red fir

Abies magnifica

- Bark smooth, grey, with resin blisters when young, orange-red, rough and fissured on old trees
- Needles 1.5 inches long, blue-green with strong stripes below spirally arranged and upcurved
- Cones erect, 4 -8 in long
- Elevation >/ 5000 feet

Douglas-fir

Pseudotsuga menziesii

- Not a true fir
- Cones pendulous, with persistent scales (unlike true firs) with long 3 pointed bracts
- Needles encircle branches
- Elevation about 3000 - 5500’

Mountain hemlocks

Tsuga mertensia

- Bark gray, thin square-cracked or furrowed
- Crown slender with drooping top, becoming cylindric later
- Needles 1/3 - 1 inch long pale blue-green arranged spirally
- Cones 1-3 inches long
- Elevation >/6000’

Giant Sequoia

Sequoiadendron giganteum

- Naturally in 75 groves on Sierra west slope
- World's largest trees / living thing by volume
- Up to 279’ tall and 3,500 years old
- Needles small scale like cover branches completely
- Egg shaped cones 2 by 3” with hundreds of small, light seeds

Characteristics of trees

- Trees outcompete others in their particular location because of species' characteristics
  - Shade tolerance
  - Drought tolerance
  - Fire tolerance
  - Snow tolerance

Shade Tolerance

- Ability of a tree to grow and survive in low light conditions
- White fir can grow in understory shade of other trees
- Life strategy is to survive in the understory until there is a whole in the canopy then shoot up and take over the site
- Can live up to 80 years in the understory waiting for its chance

Pocket of shade tolerant white fir being torched in prescribed burn

Shade Tolerance - continued

- Pines are shade intolerant - Ponderosa pine that is overtopped by other trees and cast into shade will die
- Life strategy is to grow quickly into overstory or die

Shade tolerance in Order
Red fir
White fir
Sugar pine
Incense cedar
Lodgepole pine
Ponderosa pine
Black oak

Drought Tolerance

- Ability of tree to survive under conditions of moisture stress
- Adaptations: Waxy or hairy leaves, stomata that close

<u>Drought Tolerance</u>

Oregon white oak

California black oak

Jeffrey pine

Ponderosa pine

Lodgepole pine

Incense cedar

Douglas fir

White fir

Red fir

Fire Tolerance

- Ability of a tree to survive a fire
- Adaptations:
  Thick bark, deep roots, self pruning lower limbs

Fire Tolerance
Ponderosa pine
Douglas fir
Sugar pine
Incense cedar
Lodgepole pine
White fir

Snow and Cold Tolerance

- Ability of a tree to survive cold temperatures and snow loads
- Adaptations: Conifers with short flexible branches that shed snow, deciduous trees that shed leaves

<u>Snow load tolerance</u>

Red fir

White fir

Jeffrey pine

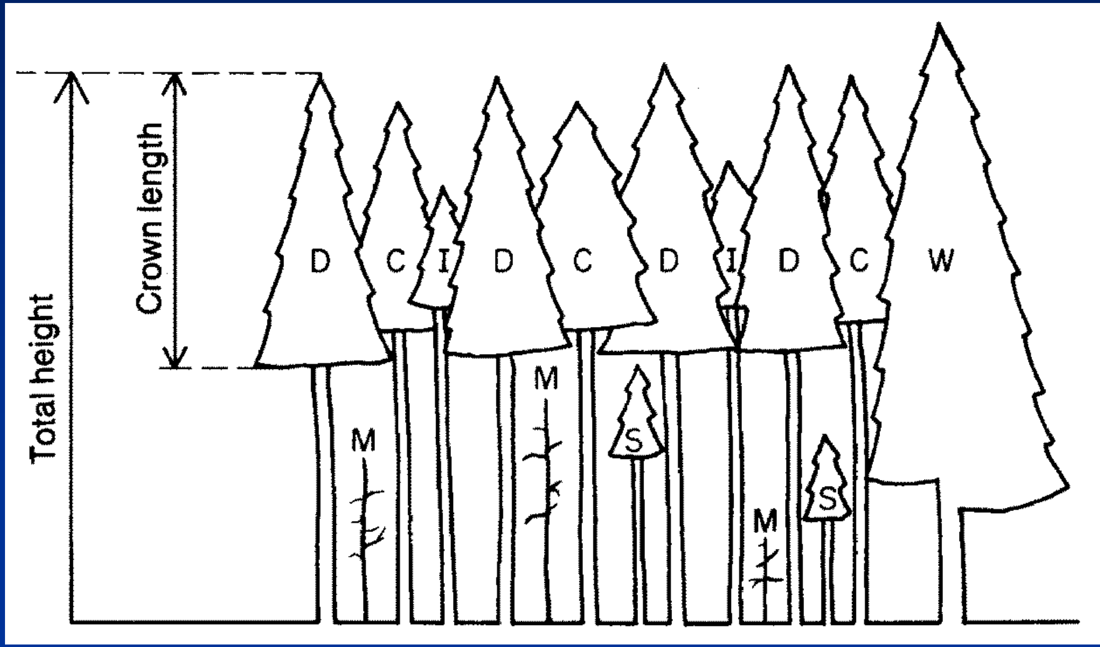
Douglas fir

Sugar pine

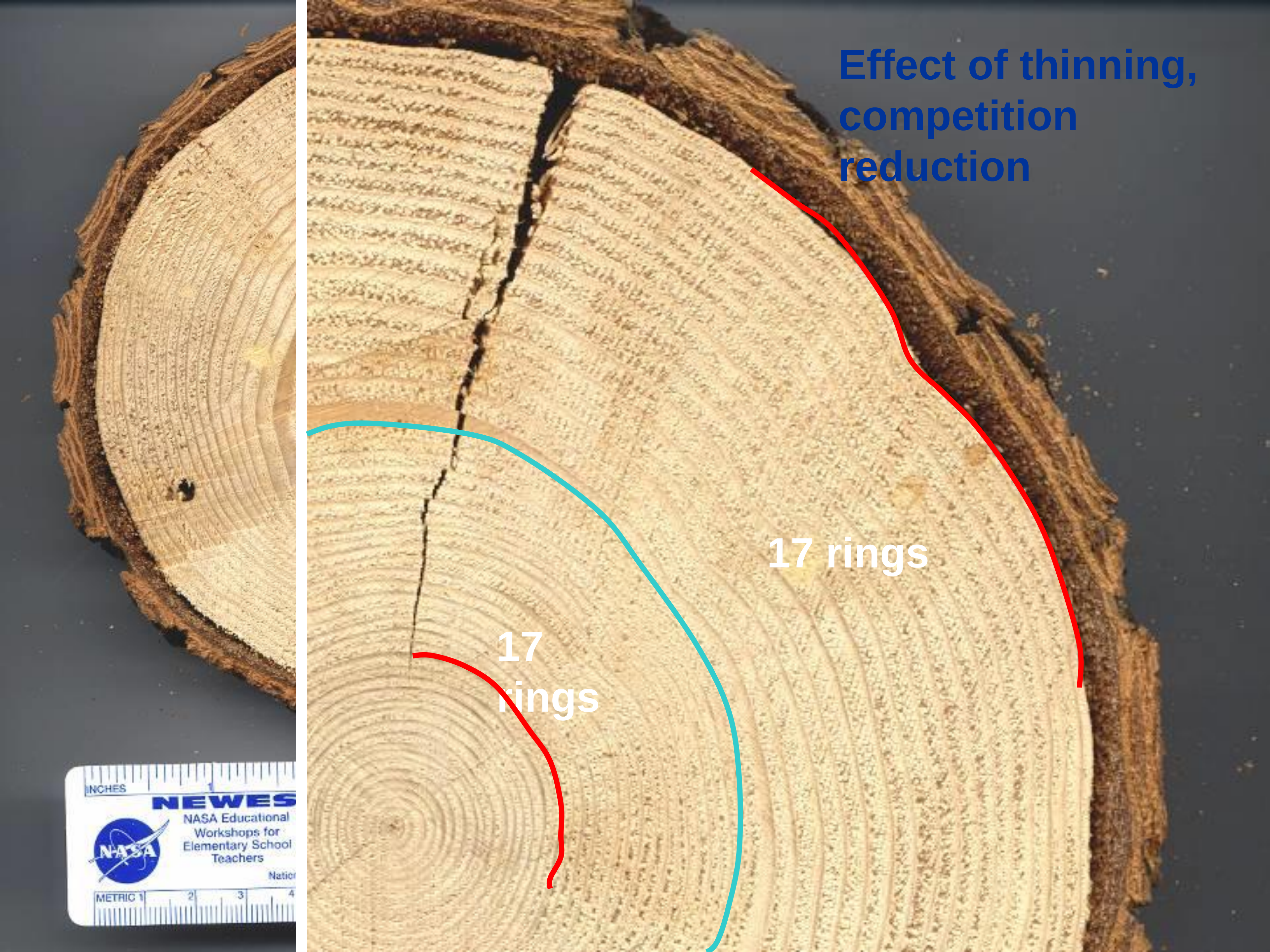
Ponderosa pine

Competition

- Trees on sight are product of genetics & site conditions
- Trees are constantly competing and their form reflects their "progress"
- Tree species are found where they outcompete others
- Forests separate into forest types depending on how elevation and location determine which trees grow there

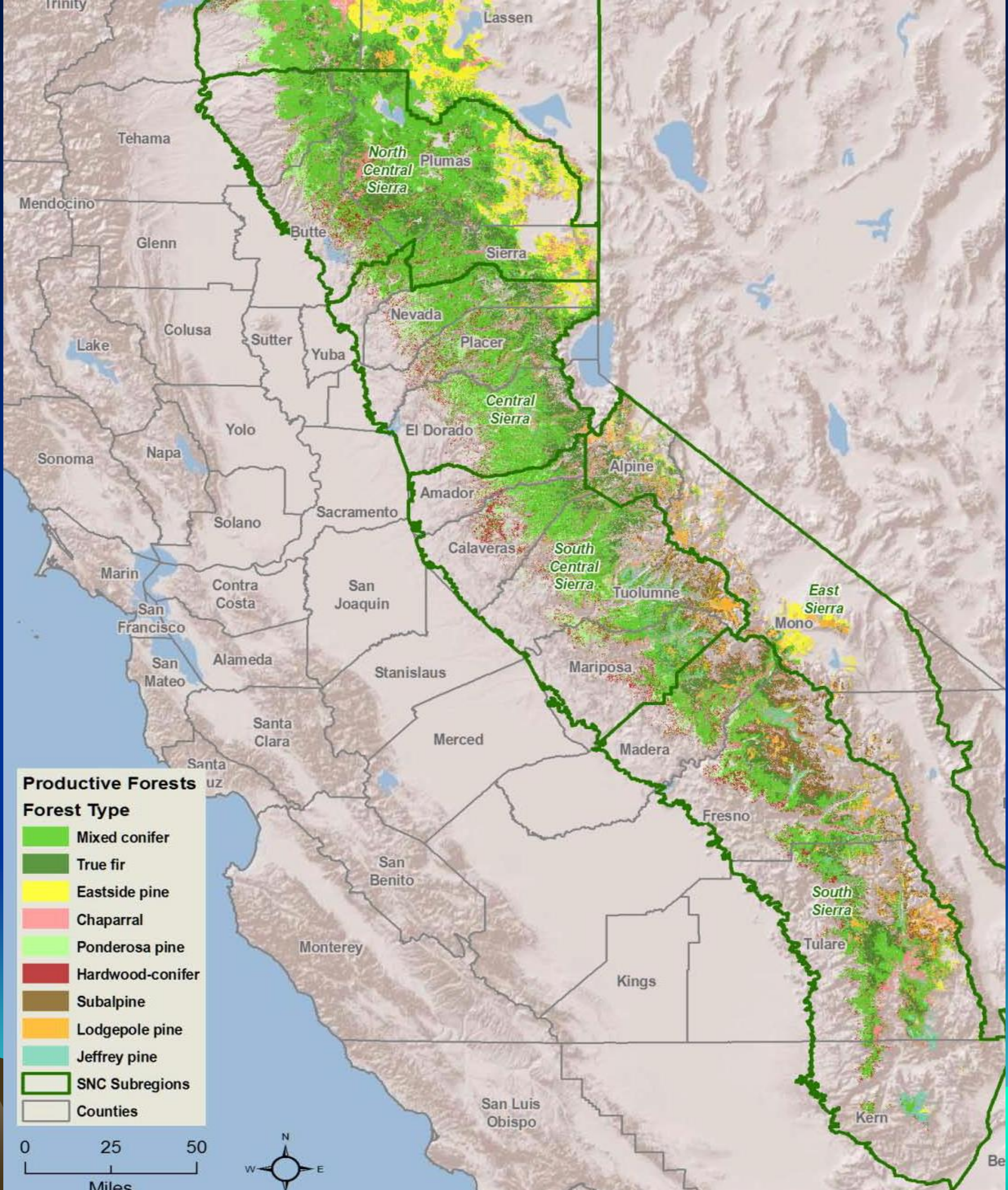


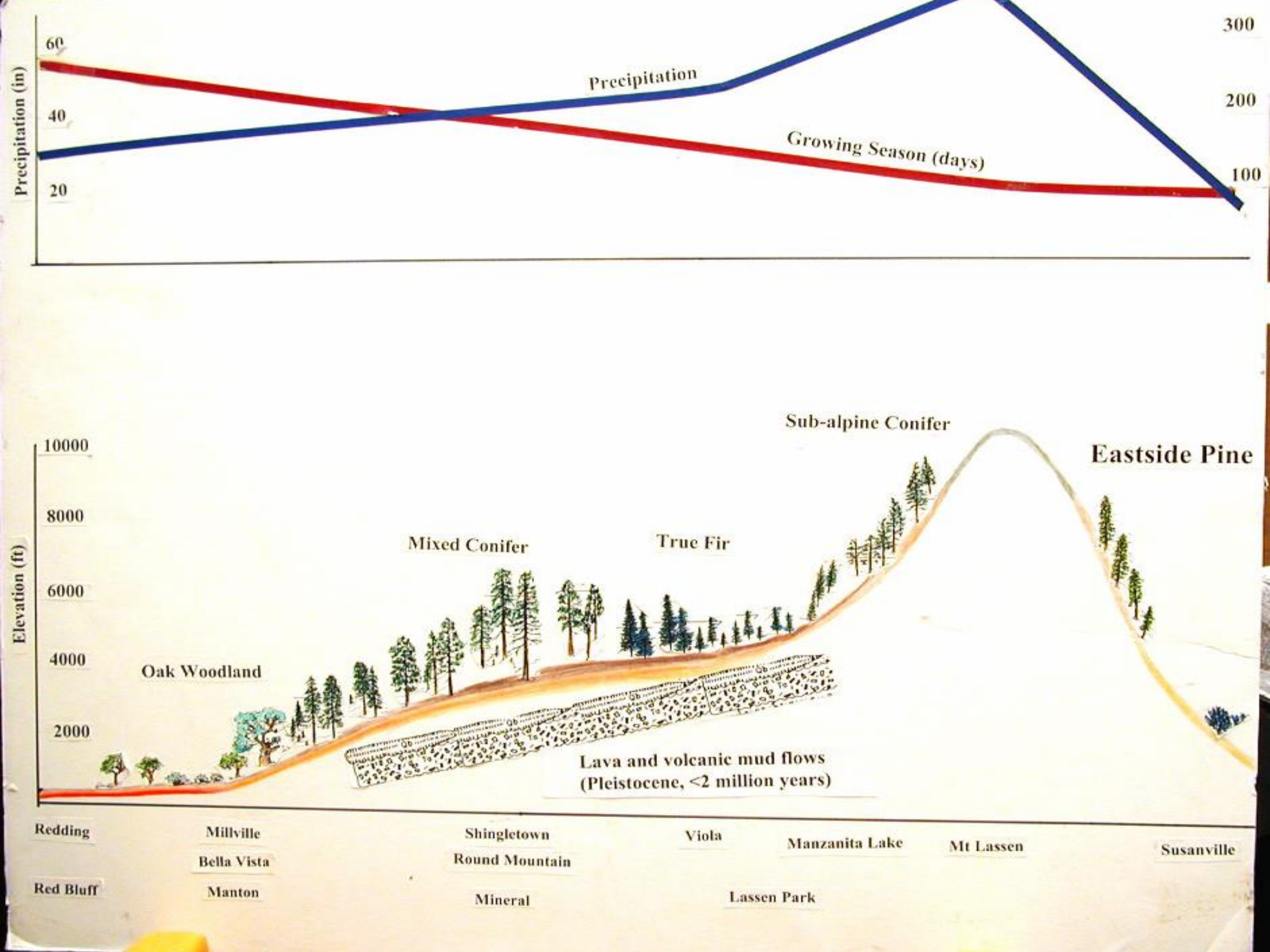
Diameter growth slows with increasing competition. 23 yrs


Effect of thinning, competition reduction
17 rings
17 rings
INCHES
NEWES
NASA Educational Workshops for Elementary School Teachers
NASA
METRIC

Forest types

- Vary according to elevation and latitude





60
40
20
Precipitation (in)
Precipitation
Growing Season (days)
300
200
100
10000
8000
6000
4000
2000
Elevation (ft)
Sub-alpine Conifer
Eastside Pine
Mixed Conifer
True Fir
Oak Woodland
Lava and volcanic mud flows
(Pleistocene, <2 million years)
Redding
Red Bluff
Millville
Bella Vista
Manton
Shingletown
Round Mountain
Mineral
Viola
Lassen Park
Manzanita Lake
Mt Lassen
Susanville

Ponderosa pine

- 2,000-3,000 feet
- Ponderosa pine
- Black oak

Sierra Nevada Mixed Conifer

- 3,000-6,000 feet
- Ponderosa pine, white fir, Douglas fir, sugar pine, incense cedar, black oak

True fir

- 6,000 to 8,000 feet
- White fir, red fir, Jeffrey pine, lodgepole pine, juniper

Sub alpine forest

- 8,000 to 11,000 feet
- Western white pine, mountain hemlock, whitebark pine, lodgepole pine, juniper

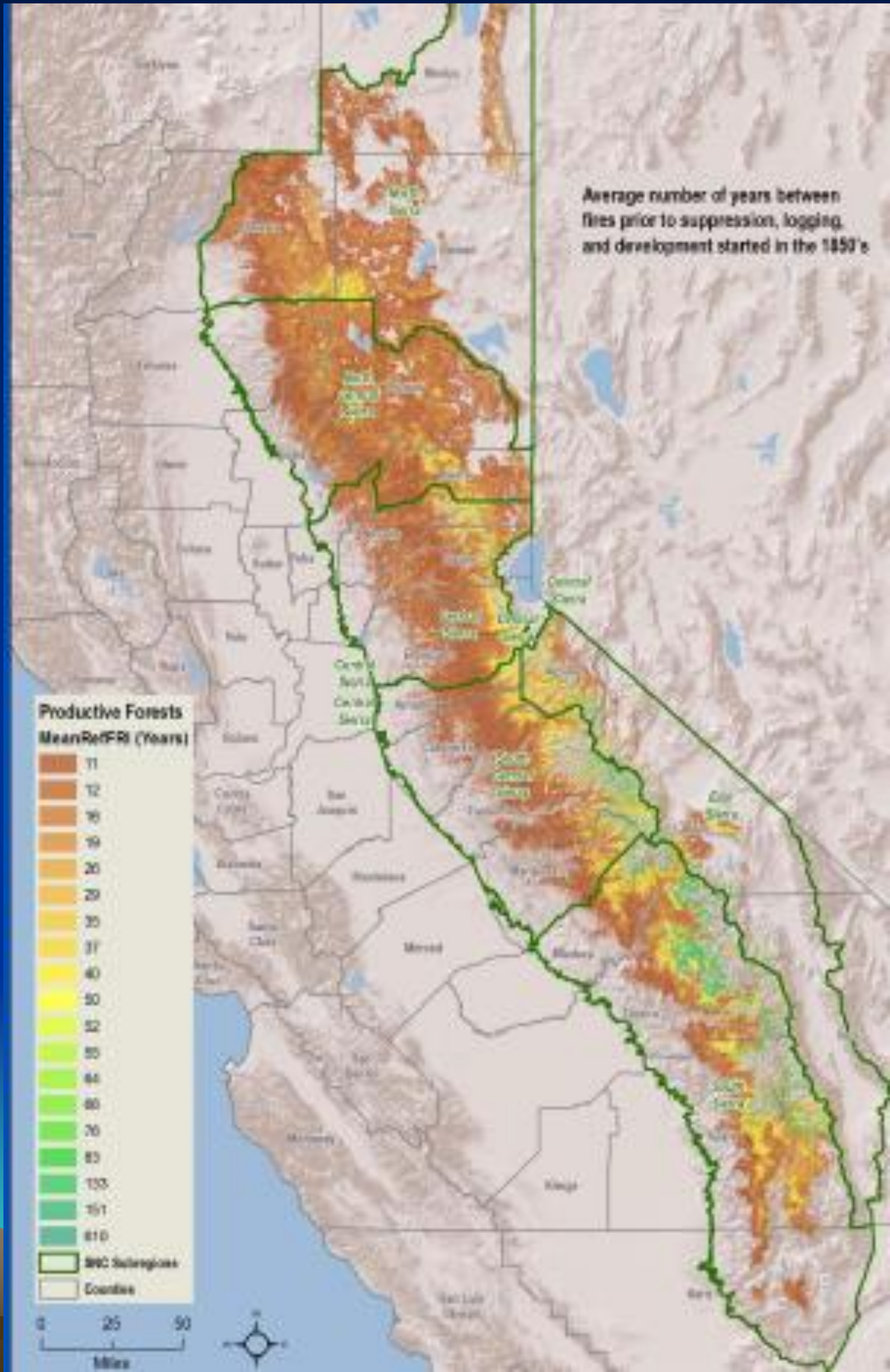
Forest Issues - Wildfire

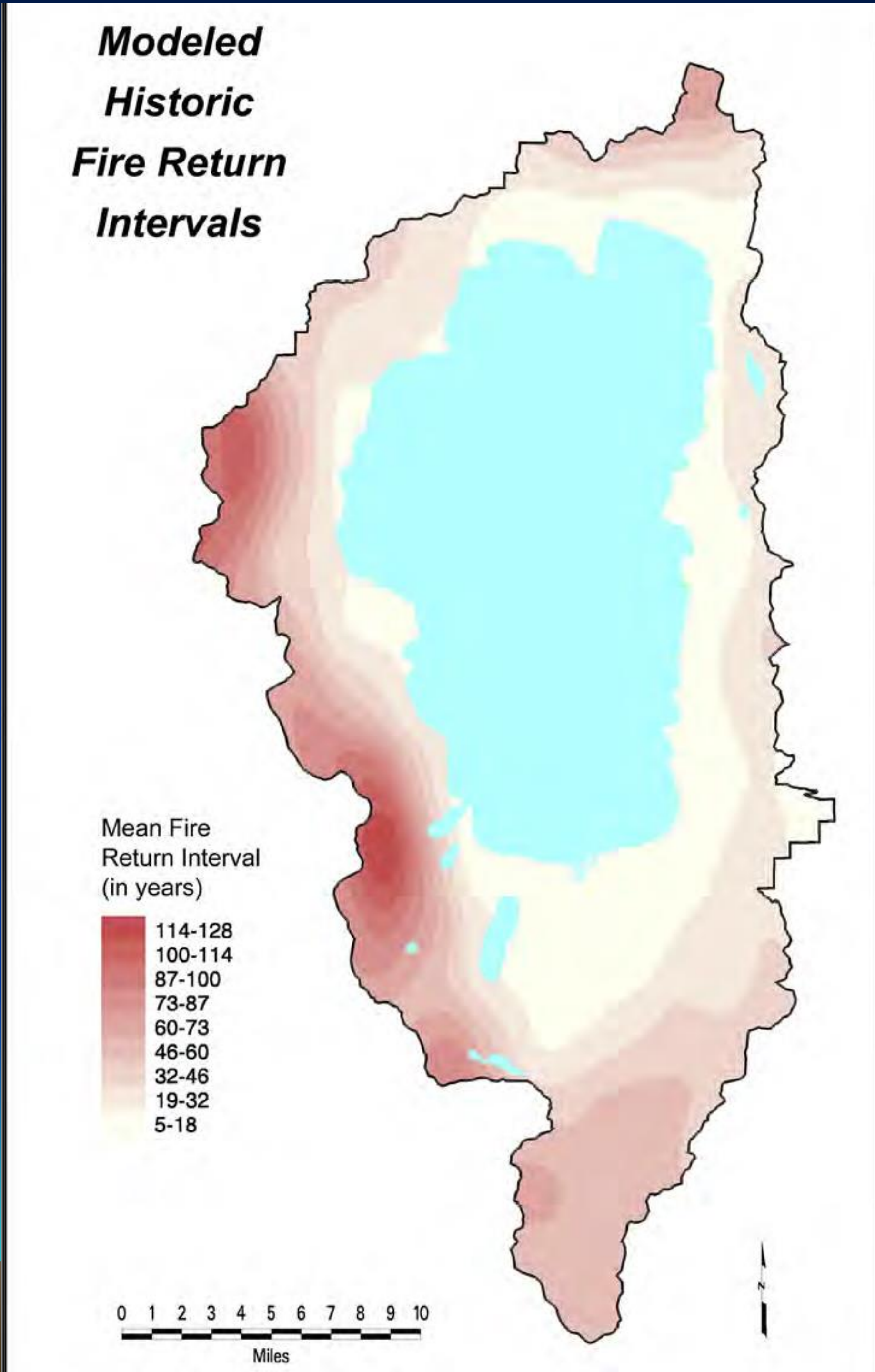
- Sierra forests are adapted to frequent low intensity fire
- How do we know?
  - Ethnographic interviews with native American tribes
  - Dendrochronology (tree ring) studies - Past fire frequency can be determined from the years between fire scars on a single tree or on several trees in an area


1897
1889
1883
1872
1867
1854
1852
1844
1834
1840
1832
1827
1820
1810
1816
1797
1802

Fire Return Interval

- Time between two successive fire events at a given site or area
- Ponderosa 5 – 12 years
- Mixed conifer 8 - 20 years
- Red fir 15 - 50 years
- Sub-alpine 25 - 60 years
- 4.4 -11.9 million acres/ year or 5% - 12% of California's lands burned annually pre-settlement



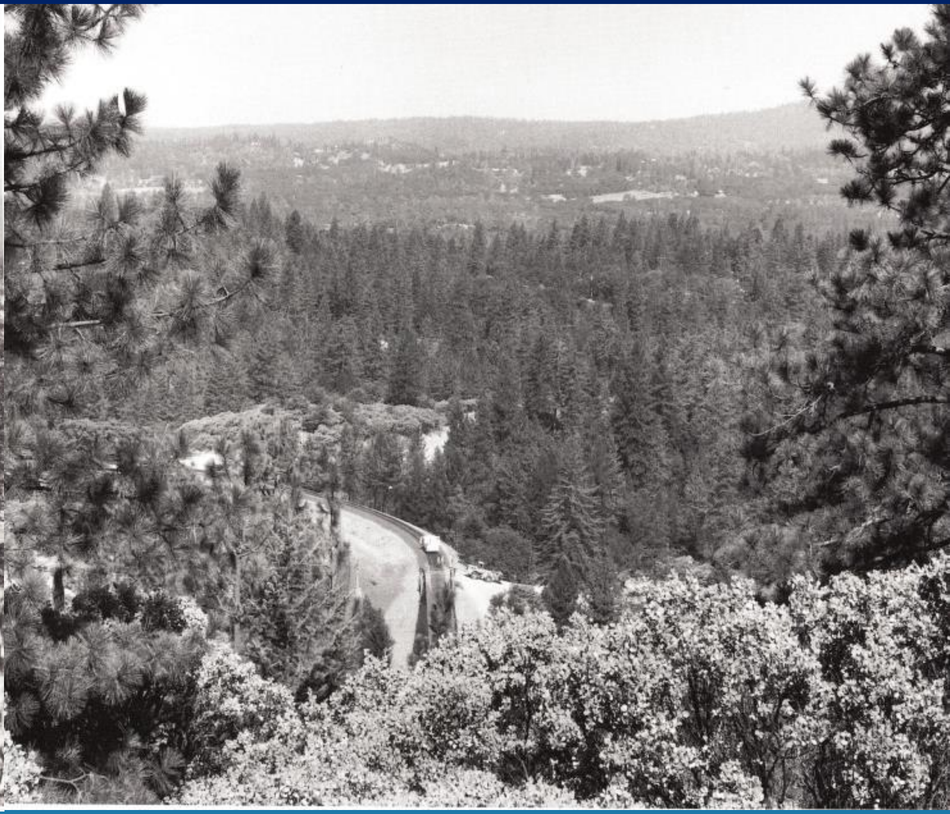


- Skies were likely smoky in the summer and fall in California before fire suppression.
- "Of the hundreds of persons who visit the Pacific slope in California every summer to see the mountains, few see more than the immediate foreground and a haze of smoke which even the strongest glass is unable to penetrate." -- *C.H. Merriam 1898, Chief, US. Biological Survey*

Fire impacts on conifers

- <u>Low severity (Surface fire)</u> – burns surface fuels, flame lengths under 4 feet, can be controlled with fire breaks and hand tools, few trees killed
- <u>Moderate severity (Understory fire)</u> – burn surface and ladder fuels, flame lengths up to 10 feet, some trees killed
- <u>High severity (Crown fire)</u> – burns through crowns of trees supported by surface and ladder fuels with unpredictable behavior, most trees killed

Consequences of Fire Suppression

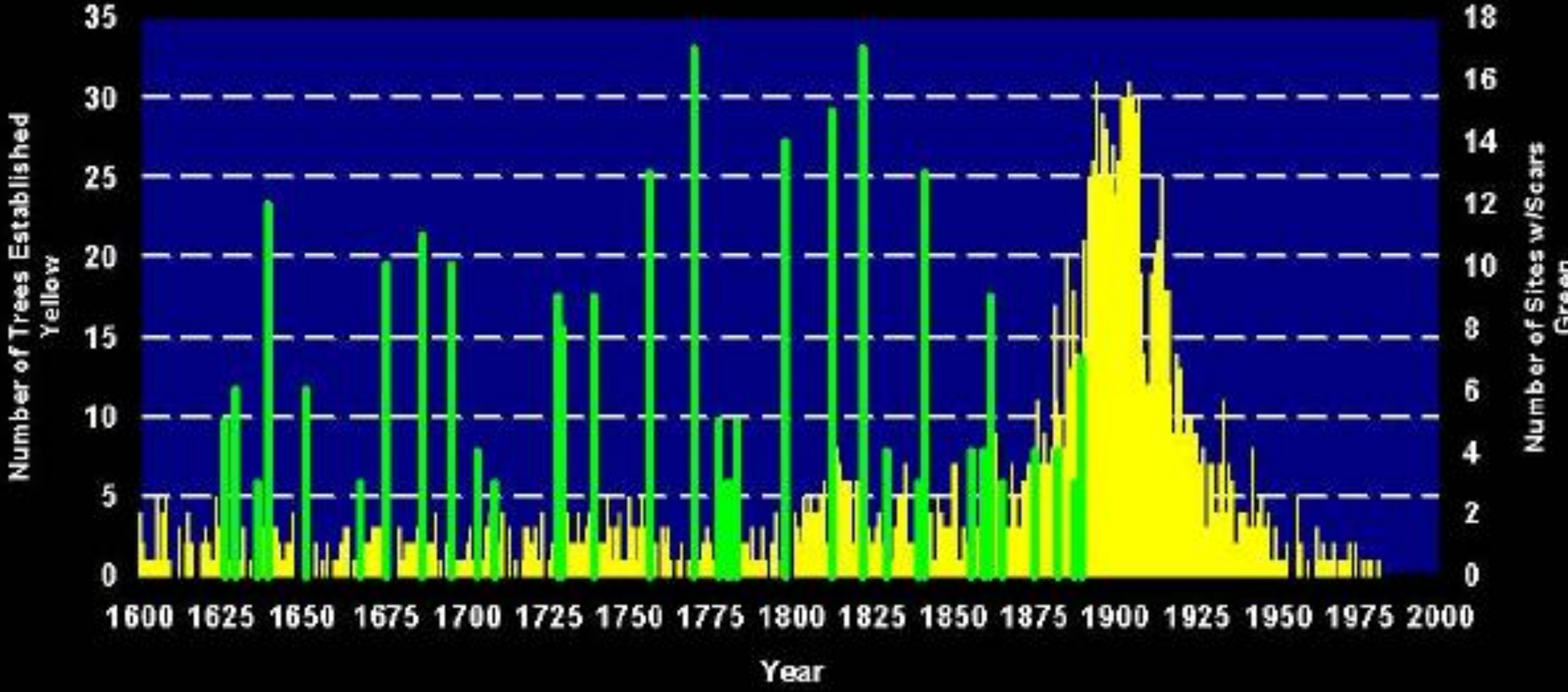


- Long Ravine railroad trestle near Colfax, Placer County. Source: Gruel 2001

Consequences of Fire Suppression

Spaulding Lake in Nevada County, 1919 and 1993. Source: Gruel 2001

Blacks Mountain
Fires & Tree Ages



Green = Fires

Yellow = Tree Establishment

Ecological Consequences

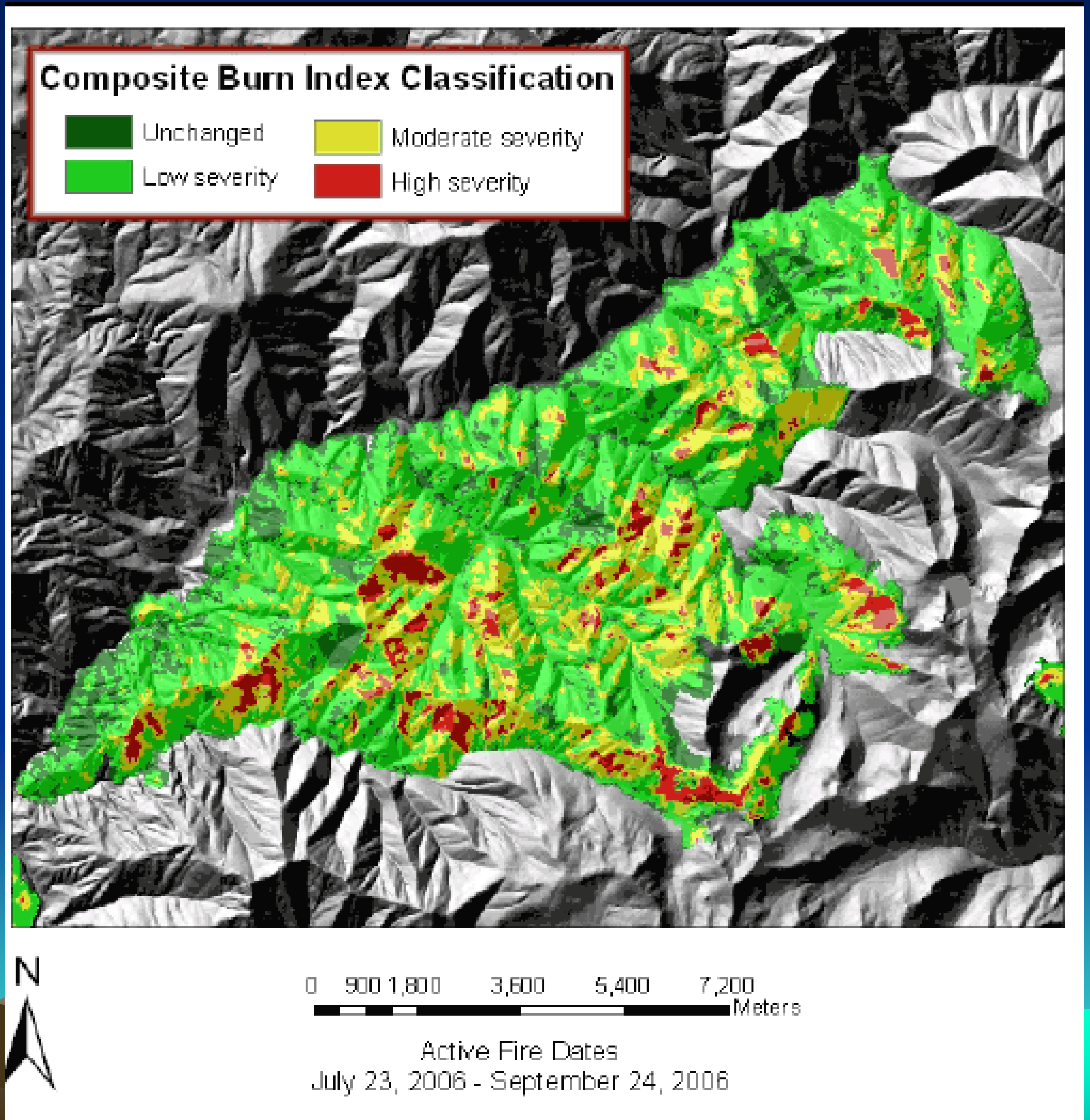
- Increased stress due to water competition leaves trees more vulnerable to insect and disease
- Displacement and reduction of understory plants due to shade
- Conversion of shrub habitats to conifer thickets
- Displacement of deciduous vegetation by conifers, especially in riparian areas
- Reduction and loss of mountain meadows to conifer encroachment
- Reduction and loss of habitat of more open and non-forested habitats
- Huge build up in forest fuels

Increase in high severity fires

- Forests overcrowded and unhealthy
- Fires now more likely to be high severity meaning most or all trees are killed

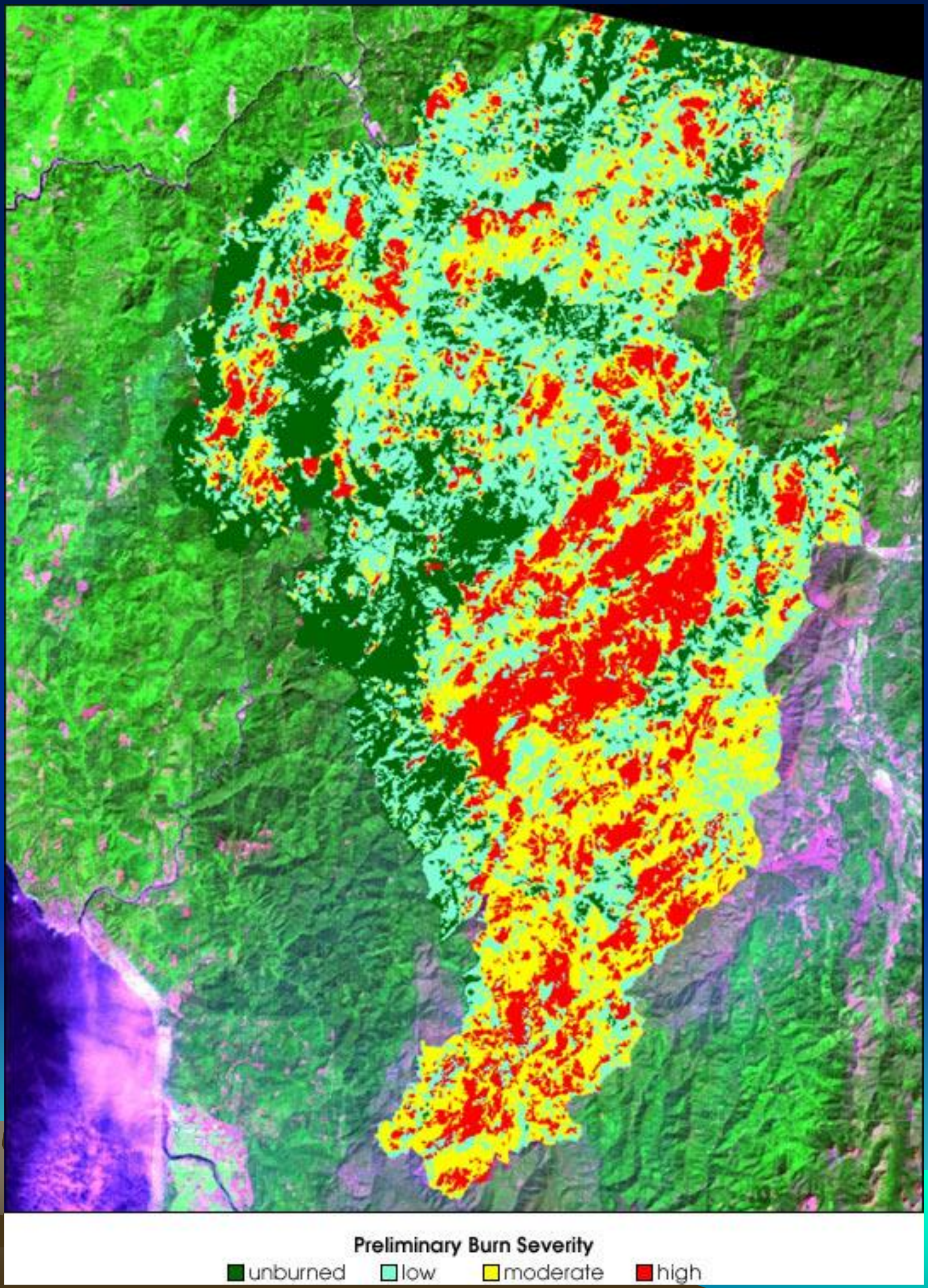
Increase in high severity fires

- Fires are now more likely to be of high severity meaning that most or all trees are killed
- Still a lot of variety in severity
  - Hancock fire 2006

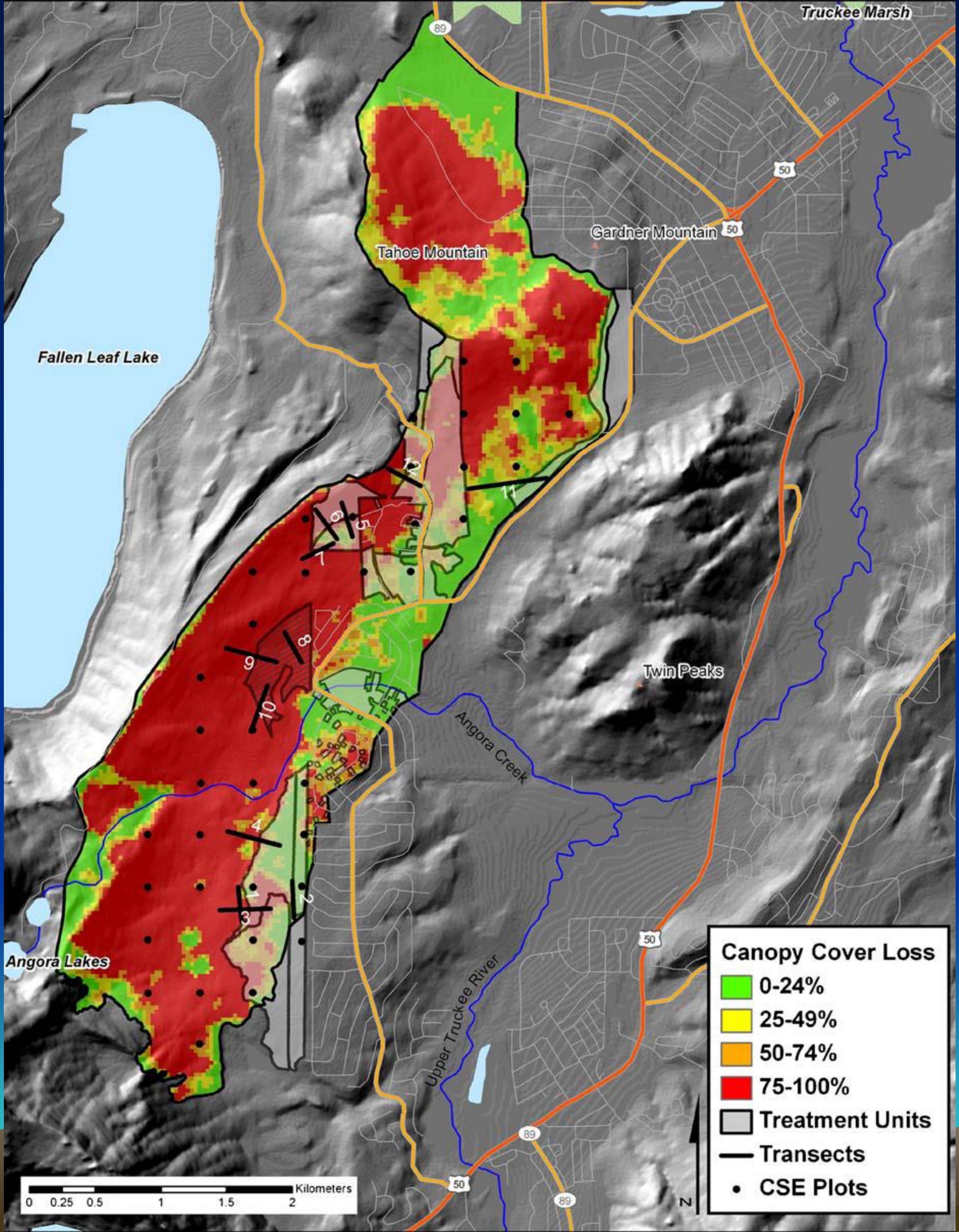


Increase in high severity fires

- 2002 half-million-acre Biscuit fire in SW Oregon

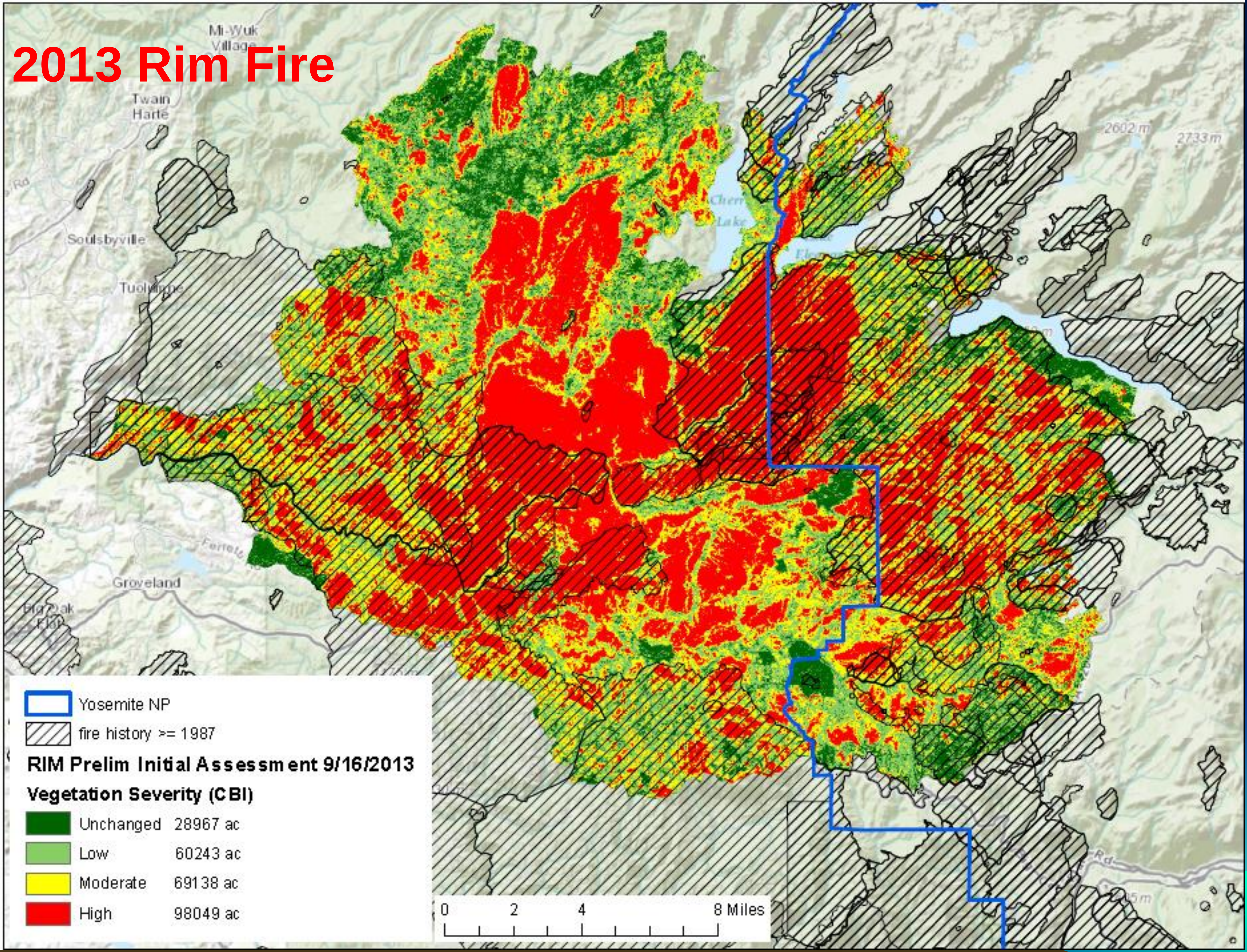


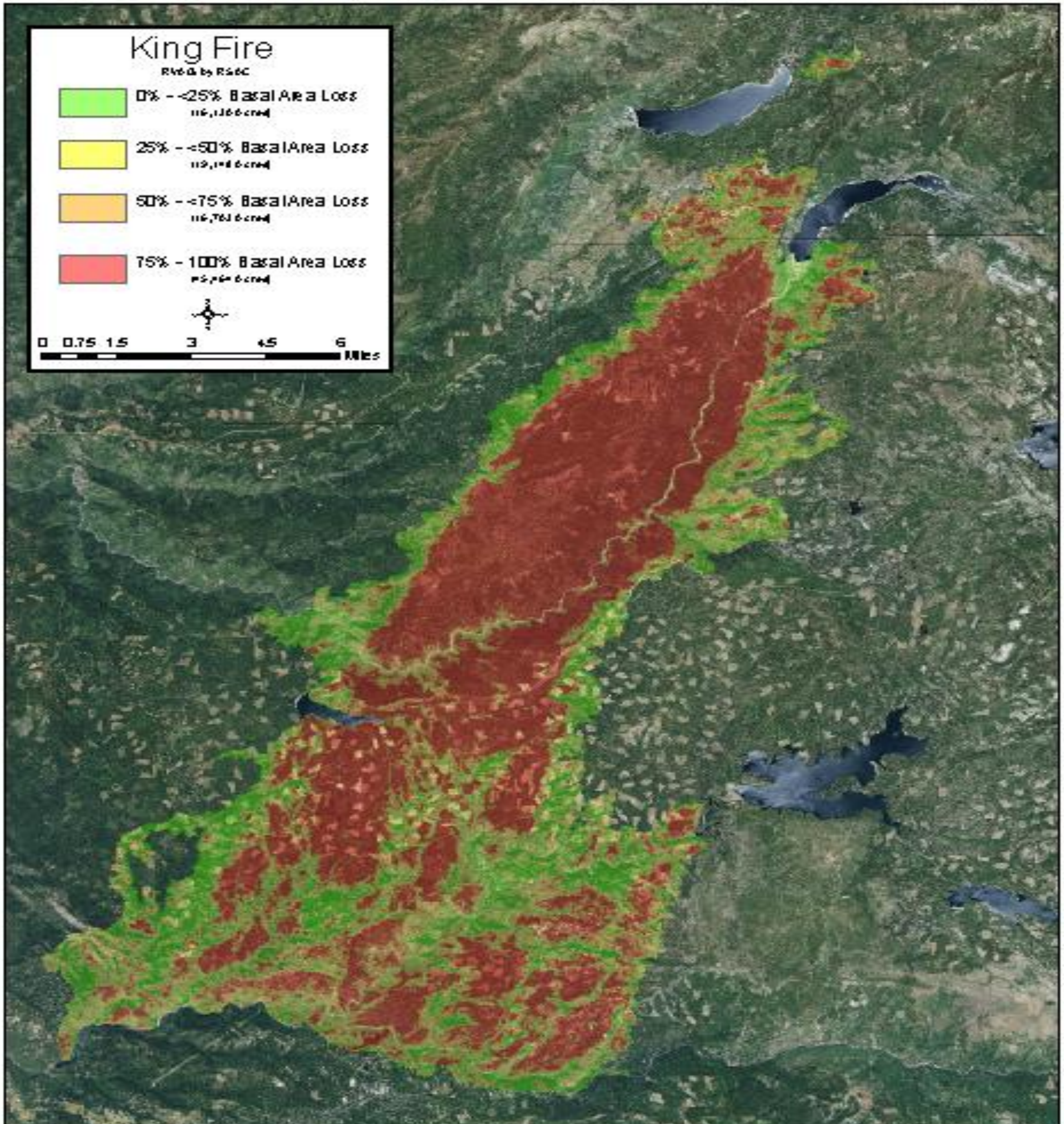
Angora Fire Severity



Source: Safford, et. al. 2009. ***Effects of fuel treatments on fire severity in an area of wildland-urban interface, Angora Fire, Lake Tahoe Basin, California.***

2013 Rim Fire





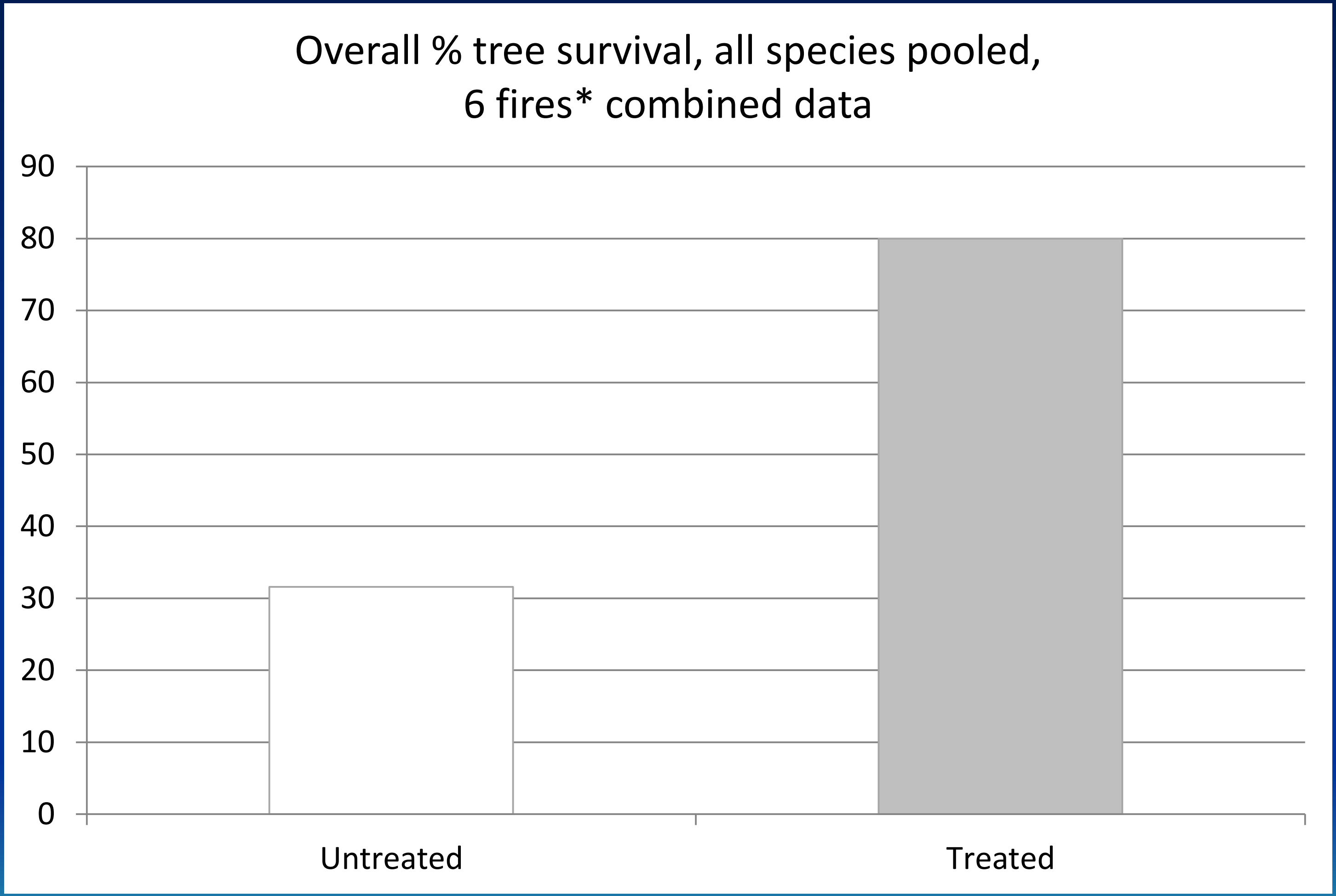
- 2014 King Fire

What can be done?

- Forest fuels removal projects are attempting to substitute for the historical fire regime by altering forest structure
- Some attempts to restore fire to forests, many barriers

Is it working? YES

Tree survival we know fuels reduction projects are increasing % of trees that survive (can be confounded in extreme weather)

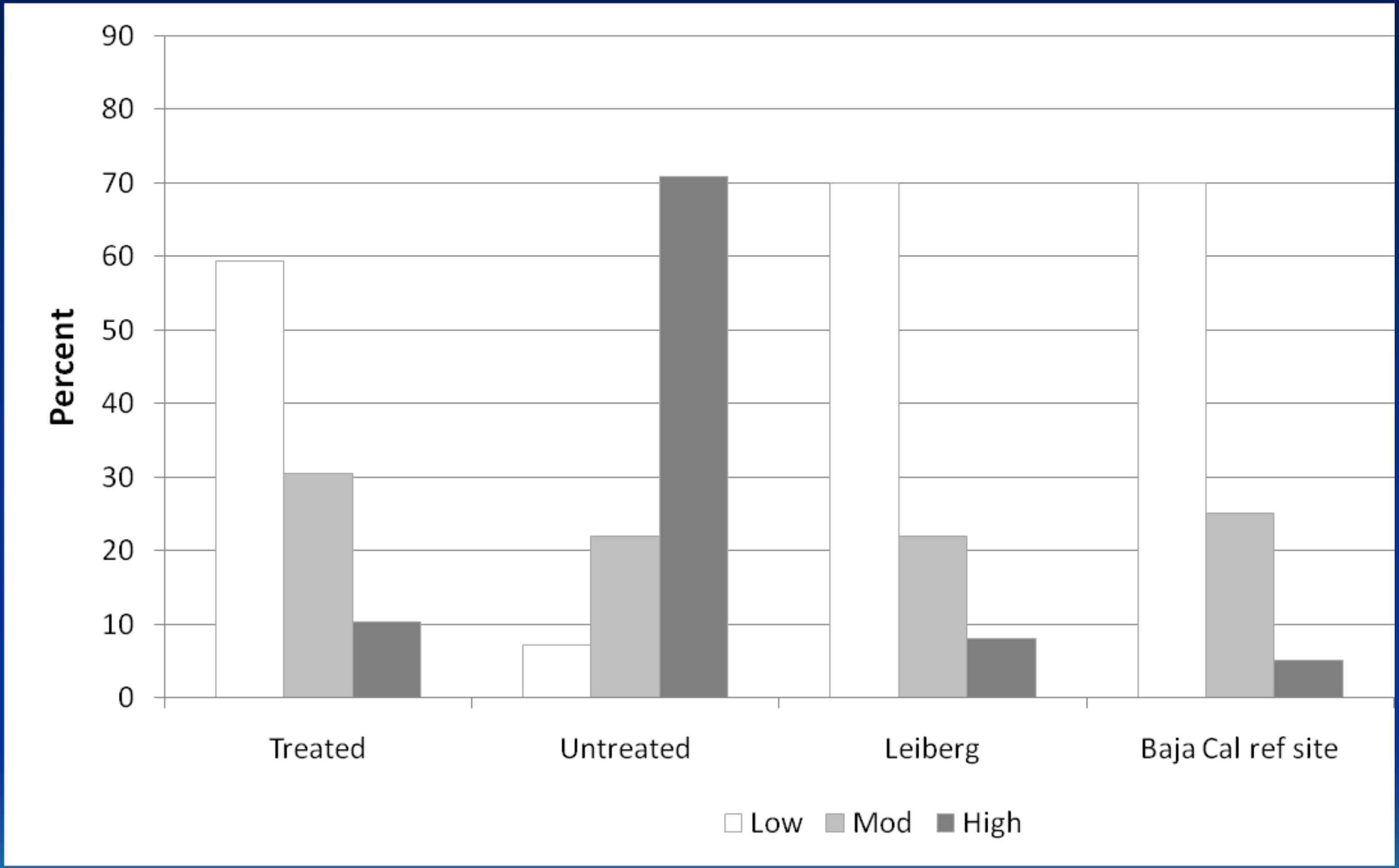


From Hugh Safford 2010
*** Angora, Peterson, Rich, Antelope, Milford, American River fires**

Is it working? YES

Fire severity

the % of area burned at high severity now more closely approximates "natural" conditions



– 6 fires combined data
From Hugh Safford 2010

Estimate of 19th century fires in Sierra Nevada: Leiberg 1902

Living reference system for eastside SN pine forests: Stephens et al. 2008

Is it working? YES, but slow

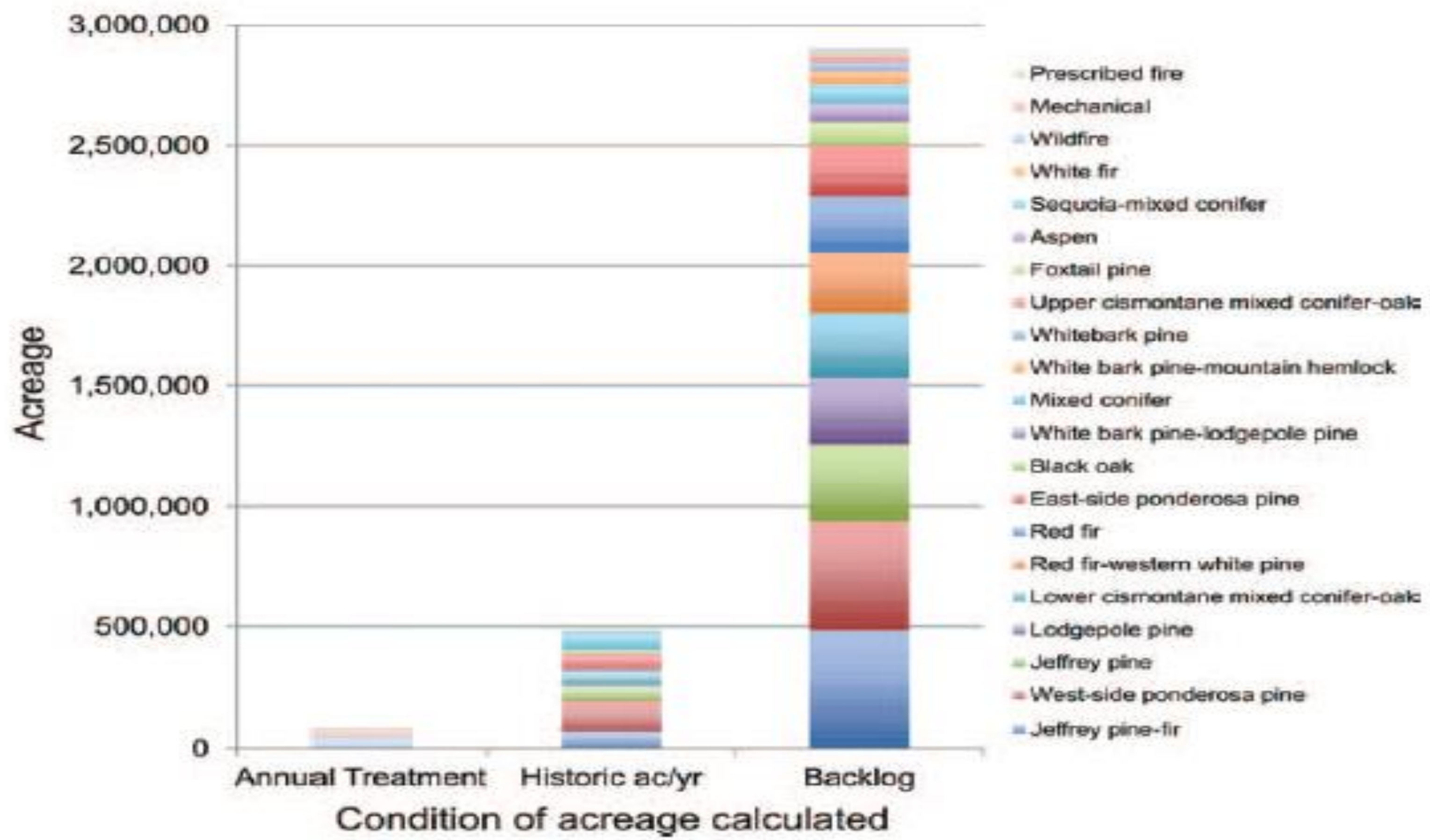


Figure 2. Histogram of the acreage of current annual fuels reduction by type, historical fuels reduction from wildfire by forest type and backlog by forest type. Backlog is a conservative estimate of the acreage that would always have uncharacteristically high fuel loads at current rates of fuels reduction and wildfire burning.

North et al 2013. Using fire to increase scale, benefits and future maintenance of fuels treatments. Journal of Forestry

But more fire has to be part of solution

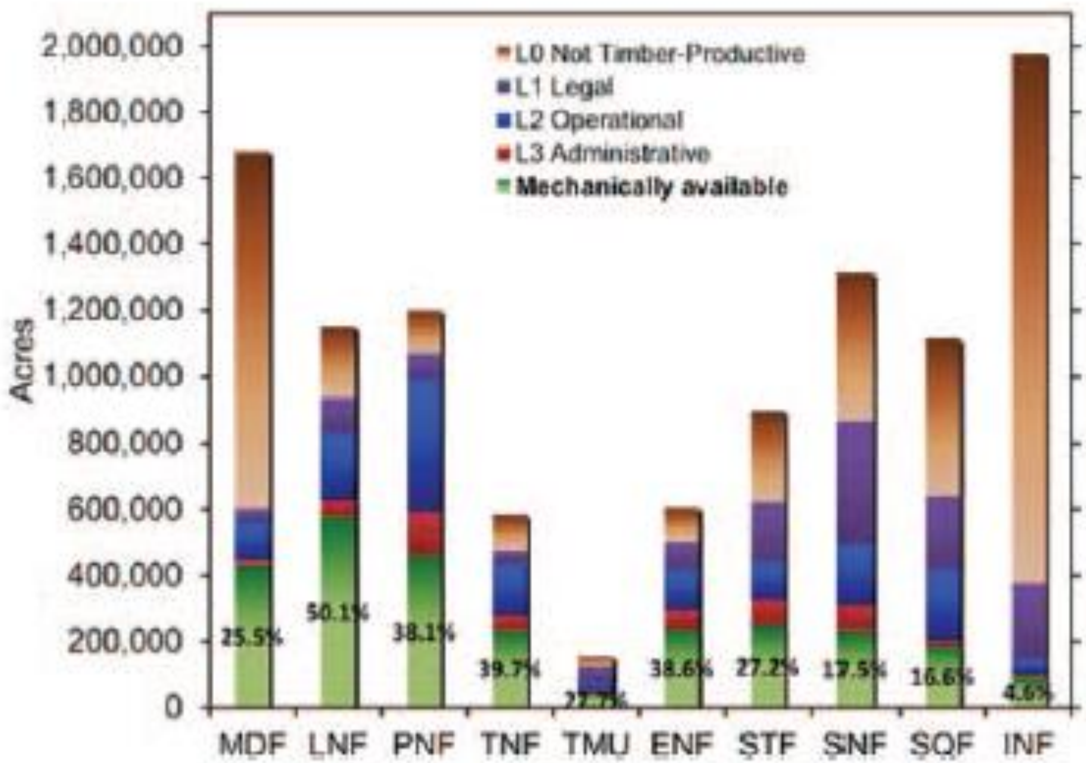


Figure 2. Histogram of how constraints reduce *total* acreage available to mechanical treatment in Sierra Nevada NFs. The height of the bar indicates each NF's total acres, with each constraint designated by a different color. The acreage available for mechanical treatment is what remains in the green portion of each bar and is indicated by the percentage values. Forests are arranged from northern most to southern along the western slope and the Inyo on the eastern slope. The L2 constraint uses scenario C (see Table 1).

North et al. 2015. Constraints on mechanized treatments significantly fuels reduction in the Sierra Nevada. Journal of Forestry

Thinning is still important to improve forest health

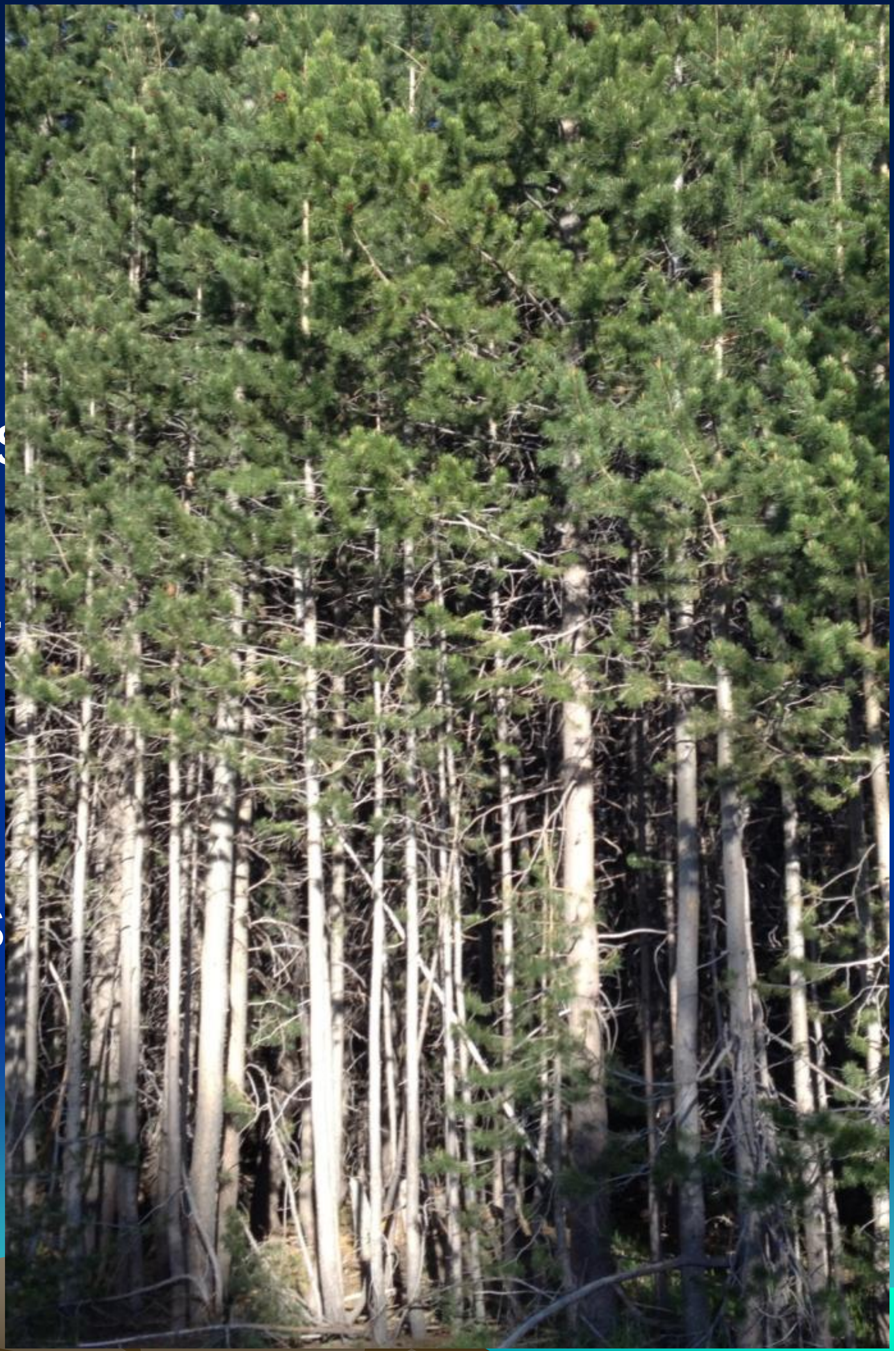
- Trees suffer stress which reduces health and causes mortality
  - Moisture stress
  - Light depravation
  - Nutrient stress

Moisture stress

- Stress from lack of moisture due to overcrowded conditions very common
- **<u>Symptoms</u>:** yellow or withering foliage, decreased growth rate, premature shedding of leaves or needles, dead branches
- Drought stress when prolonged increases success of bark beetle attack and tree mortality
- For high value landscape plants - watering
- For forest - thinning to appropriate stocking level to reduce competition is only strategy

Light deprivation

- Conifers will adapt their foliage to the light conditions available
- **<u>Symptoms</u>:** Suppressed or dead trees in understory, dead branches
- Bottom branches of fir trees die, overtopped pines die
- thinning to appropriate stocking level to reduce competition



Nutrient stress

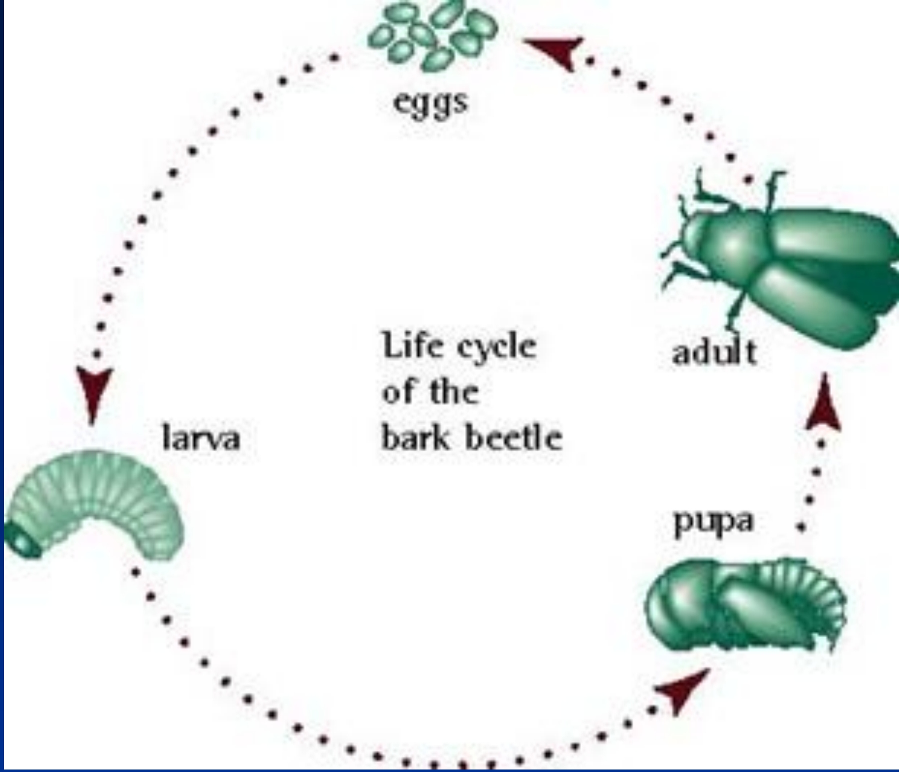
- Stress from lack of nutrient availability is rarely a problem in California forests except on serpentine soils or where severe disturbance of soils - erosion, compaction, fire
- **Symptoms:** Stunted tree growth, yellow foliage, death of buds, needle tips, poor root structures
  - skid roads, road cuts often in groups of trees
- Fertilizer may be applied but is rarely done in forest settings

Improving forest health reduces vulnerability to insects

- Natural and necessary part of forest ecosystem
  - Speed decay of wood back into nutrients
  - Prey on other insects that can be a problem
  - Provide food for wildlife
- Most tree mortality due to insects is localized – a few trees in a small area
- Sometimes boom and bust with large outbreaks and much tree mortality
- Best defense is to keep trees healthy to fight off insects themselves

Beetles

- Bark beetles and engraver beetles
  - Gain entry boring through bark
  - General attack weakest stressed trees
- Female beetles lay eggs in tunnels they excavate beneath bark, disrupt phloem (conductive tissue) and girdle tree (killing it)
- Pitch tubes are symptoms of beetle attack
- Bark beetles attack at base of tree, engravers at top



Western Pine Beetle, Mountain Pine Beetle, Red Turpentine Beetle, Jeffrey Pine Beetle Engraver Beetle

Western Pine Beetle (*Dendroctonus brevicomis*)

- Attacks and kills Coulter /ponderosa pines
- attack midtrunk, then spreads up and down; larvae feed on inner bark, complete development in outer bark; attack in conjunction with other pests
- 2-4 generations / year

To feed on a western pine beetle brood, woodpeckers have stripped off the outer bark of the tree, exposing the bright-orange inner bark

Mountain Pine Beetle

***Dendroctonus ponderosae* -**
attacks and kills lodgepole, ponderosa, sugar, and western white pines

1-2 generations/year

Tree trying to "pitch out" attack

Mountain Pine Beetle in Colorado

Red Turpentine Beetle

- ***Dendroctonus valens* attack a variety of conifer species but is most problematic to Sugar and Ponderosa pines**

Jeffrey pine beetle (*Dendroctonus jeffreyi*)

- Attacks only Jeffrey pine
- 1 to 2 gens /year
- attack midtrunk of large trees, from 5 to about 30 ft;
- long J-shaped galleries, overwinter as larvae in inner bark

Figure 2. Groups of Jeffrey pines killed by Jeffrey pine beetle, Lake Tahoe Basin Management Unit, 1995.

Engraver beetle (*Ips paraconfusus*)

- Attacks pines
- 1 to 5 gens/year adults overwinter
- often make wishbone-shaped tunnels; attack pines near top of stem
- Can breed in slash and firewood

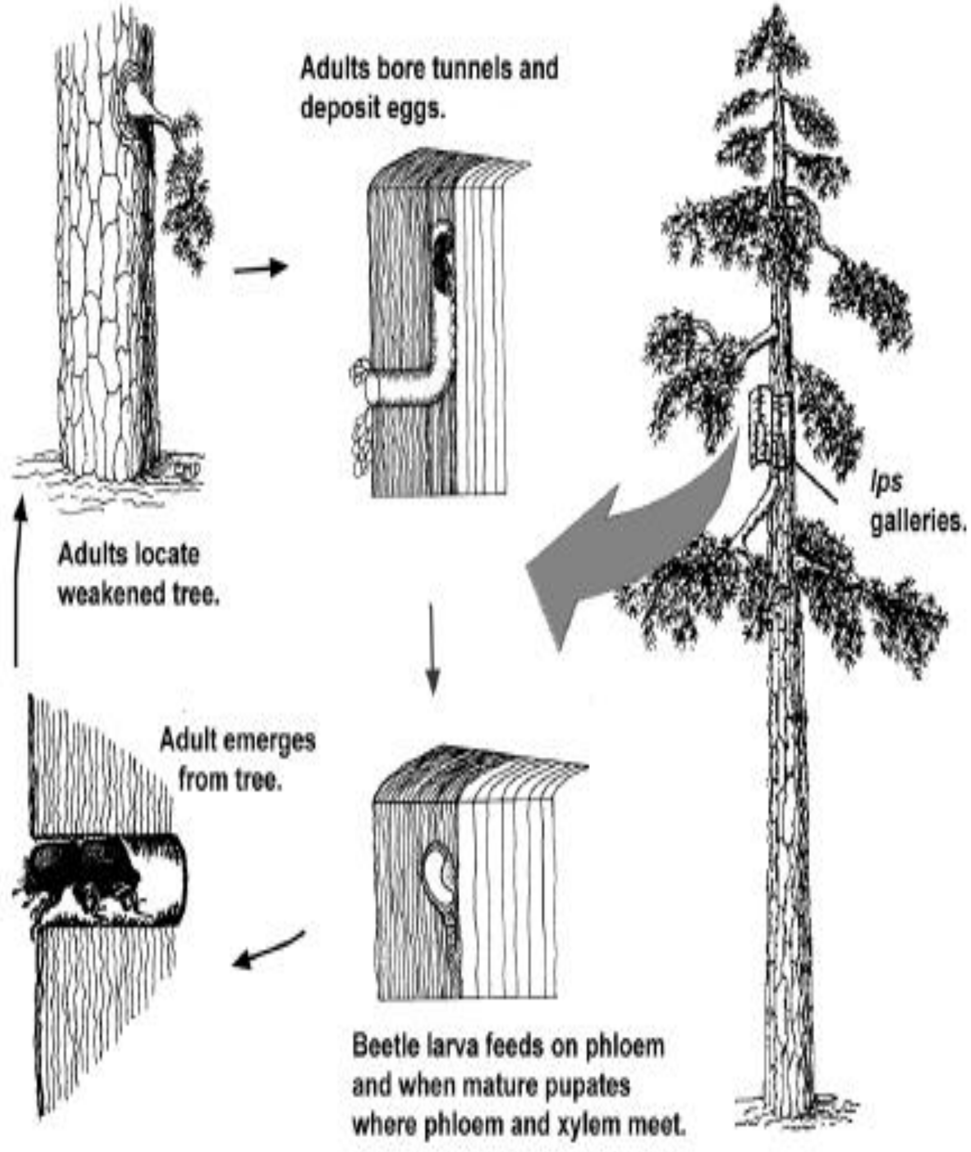


Figure 3. Life cycle of the California fivespined ips, an engraver beetle.

Engraver beetle
(*Ips paraconfusus*)

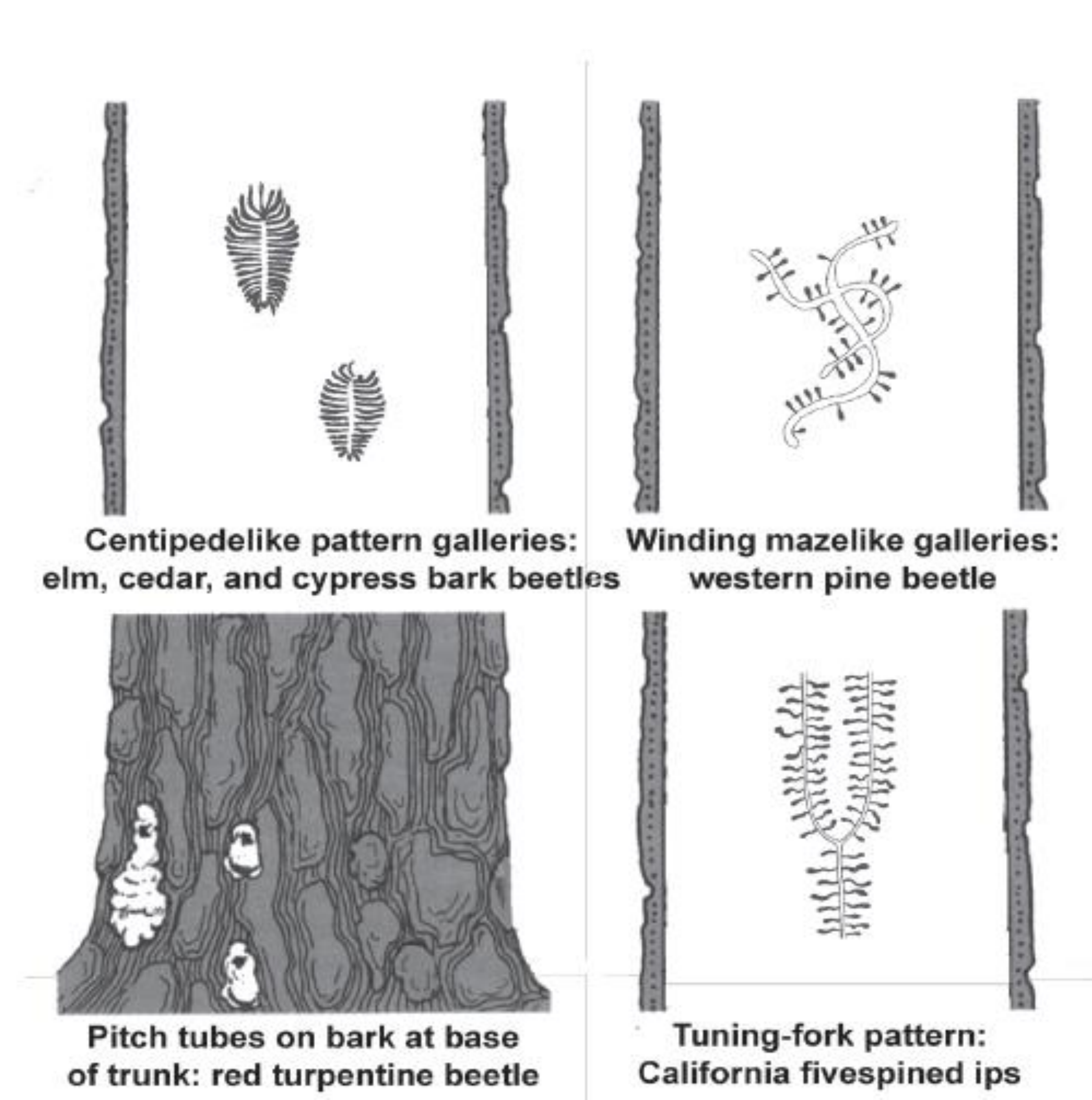
- Large amounts of slash that remains on site long enough for beetles to complete a life cycle (5 weeks) is a concern.
- Prompt slash disposal needed:
  - Chipping
  - Lopping and scattering - lop all branches from those portions of main stems that are 4 inches or more in diameter into small segments (3 feet)
  - Piling and burning.
  - Crushing or mashing slash with logging equipment.
  - Removal from site.

Fir engraver (*Scolytus ventralis*)

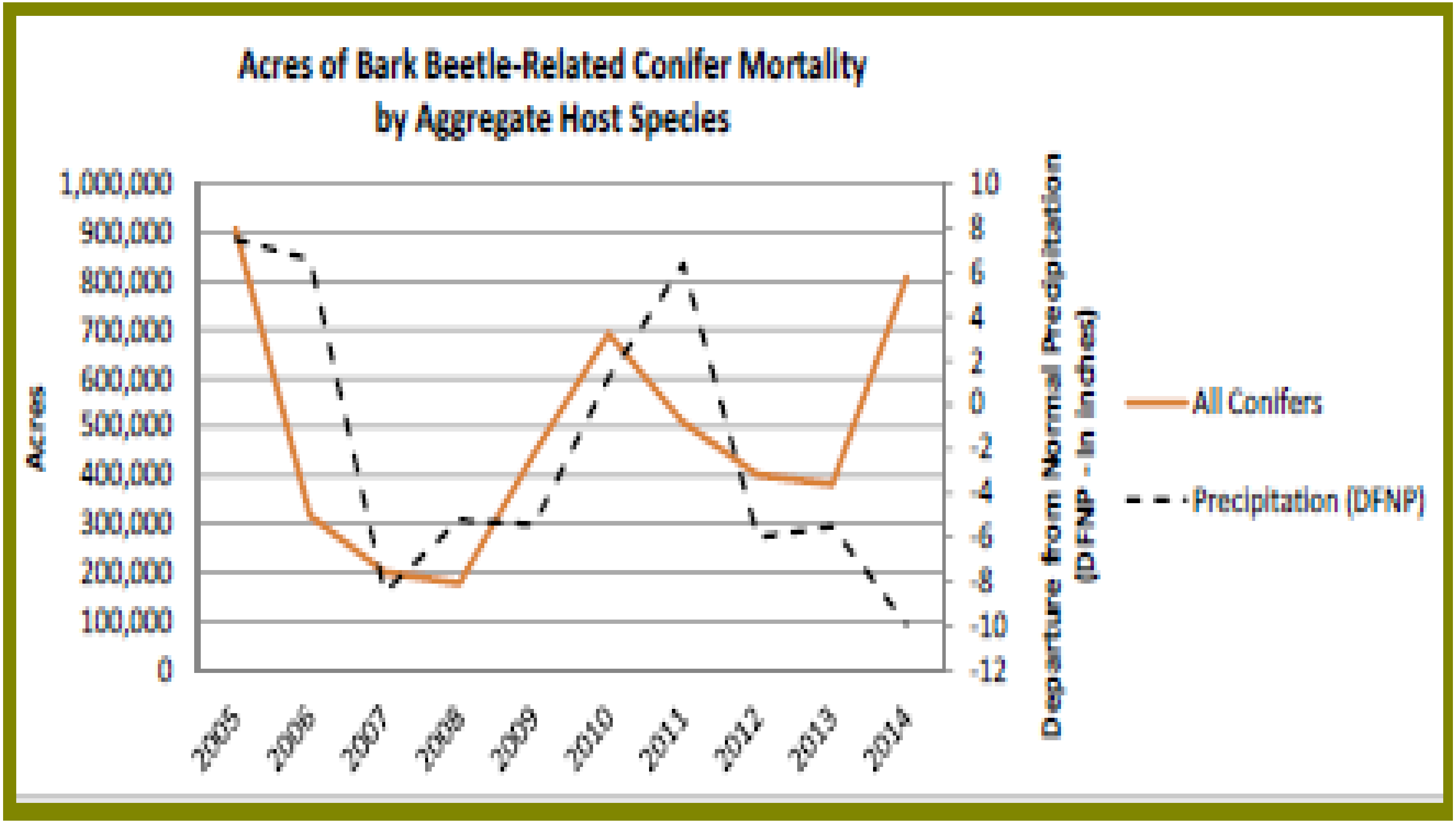
- Attacks white and red fir
- 1 to 2 generations /year
- overwinter as larvae; adults excavate deep and long, two-armed galleries across the grain of the sapwood
-

How to ID beetles

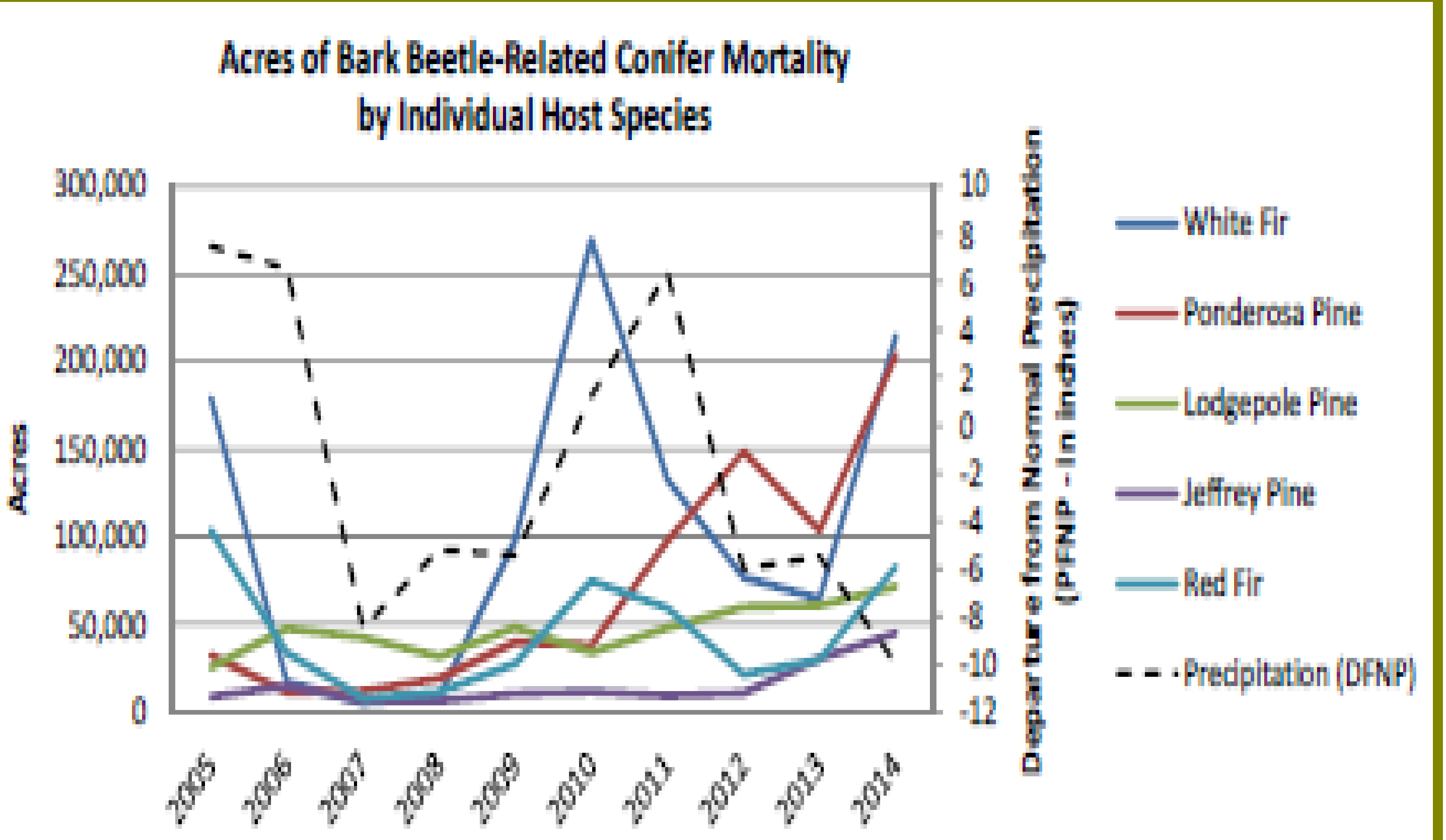
- By species of tree
- By location of insect attack on stem
  - On large pines, engraver beetles attack near the top, red turpentine beetles attack the bottom of the trunk.
- By patterns of galleries under bark



Tree death is accelerating with the drought



Ponderosa pine and white fir especially



April 2015 Aerial Survey

- 2014, mortality area doubled to 900K acres (44 million flown).
- 2015, ponderosa and grey pine in foothills, likely blue /live oak
- Mortality severe in pines, especially at lower elevations
- Conifer mortality scattered at higher elevation (too early)
- Sequoia and Sierra NF had common and severe pine mortality everywhere at lower elevation mostly from Western Pine Beetle

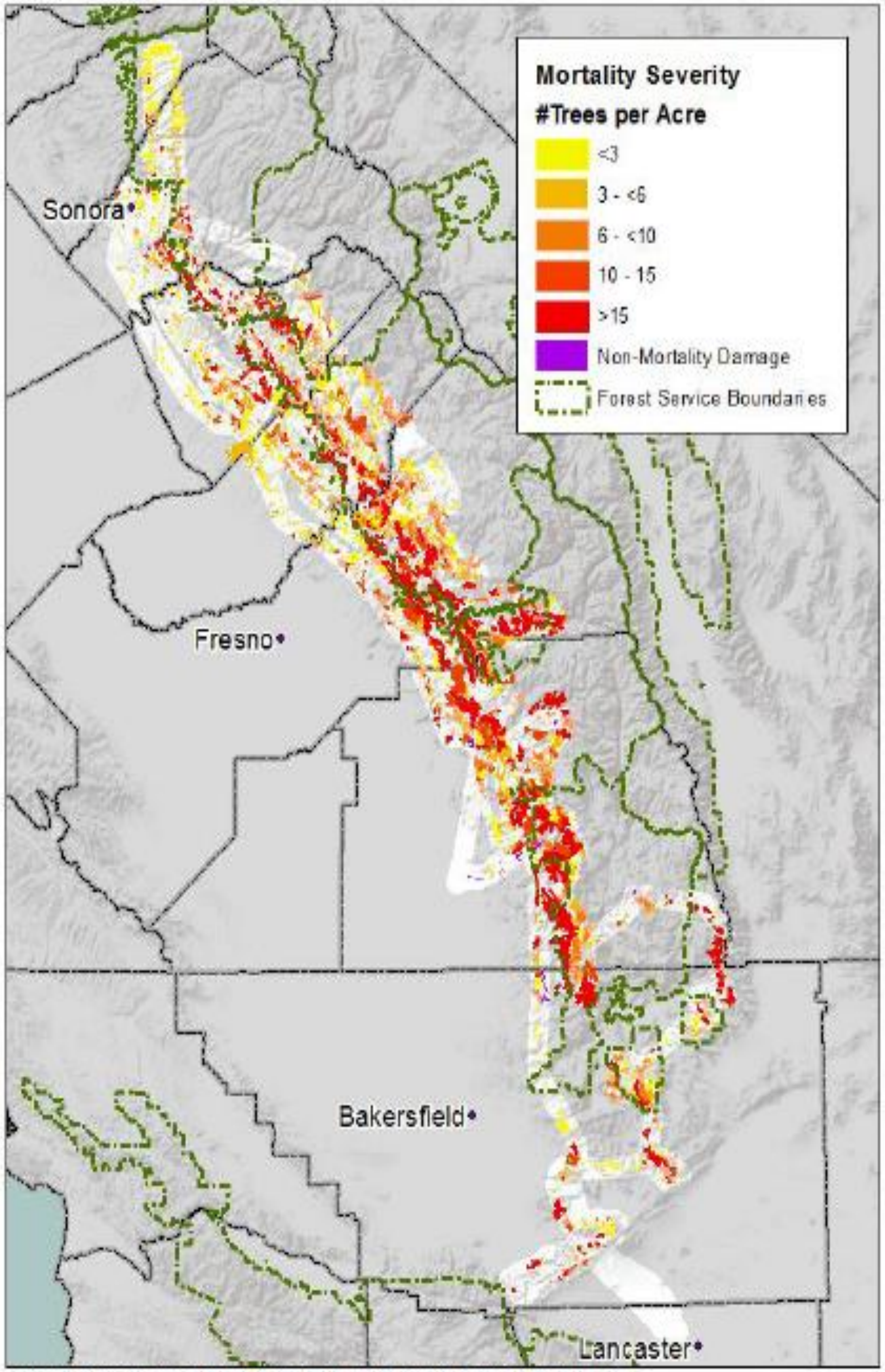


Figure 3. Overview of flown area and mapped tree mortality and damage.

April 2015 survey

Figure 5. Ponderosa and gray pine mortality south of Sonora near the Stanislaus NF.

Insect Management Strategies

- Chemical treatments ineffective at the forest scale
- Possibly effective for landscape trees with high value (best is to water – 10 gal/inch of dbh around dripline)
- Best strategy is to keep individual trees healthy:
  - Thin to reduce overcrowding
  - Remove high risk trees during thinning
  - Minimize damage to trees during operations (insects can enter wounds)
  - Plant a variety of species adapted to site
  - Remove bark from infected trees or cut for firewood to minimize spread

Chemical treatments

- Insecticides registered for bark beetle control are preventative and must be applied before trees are attacked.
  - No insecticide prevents tree mortality once a tree has been successfully infested.
- The most common method is to spray the bole
  - carbaryl can provide 2 years of protection for most tree species
  - pyrethroids (bifenthrin or permethrin) treatments generally provide one.
  - Must be administered by licensed /insured applicator.

Resources for Conifer/ Forest Issues

- Forestland Stewardship Curriculum
  - http://anrcatalog.ucdavis.edu/Forestry/8323.aspx
- Forestland Steward Newsletter
  - http://ceres.ca.gov/foreststeward/html/newsletter.html
- Network of UCANR natural resource advisors and specialists
  - http://ucanr.edu/forestry/
- CalFire forest advisors
- http://www.fire.ca.gov/resource_mgt/downloads/ForestAdvisorList.pdf
- For individual landscape tree health questions, contact a licensed arborist

Thank you!