

# Twentieth-century Decline of Large-diameter Trees in Yosemite National Park



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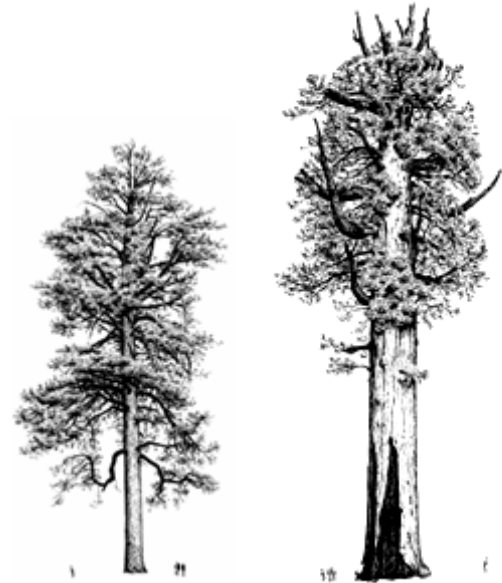
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**CEREC 2008: Climate, Ecosystems and Resources in California**

# Research Issues

- Big trees
  - Forest structure: while living, as snags, as logs
  - Habitat for epiphytes, understory, vertebrates
  - Have persisted through time and fire
- Are large-diameter tree densities changing?
  - Most studies are of species presence
  - Slow recruitment of large-diameter trees
  - Idea that large-diameter trees are resilient



*Pinus jeffreyi*

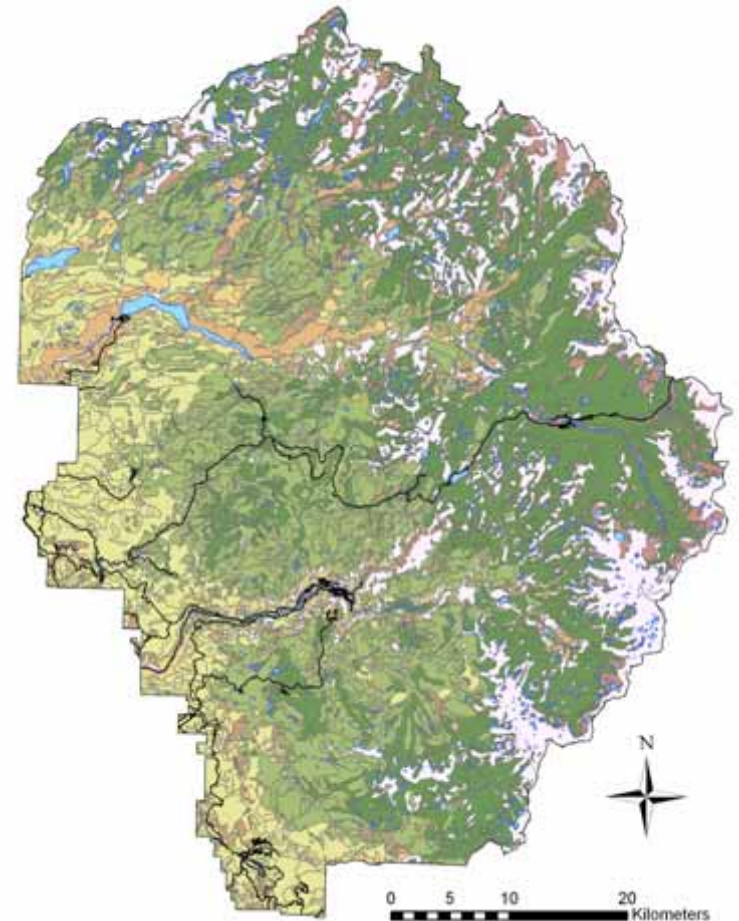
*Sequoiadendron  
giganteum*

Artwork: Robert Van Pelt

Thomas 1979, Harmon and Hua 1991, Franklin *et al.* 1996,  
Franklin *et al.* 2002, Lindenmayer and Franklin 2002, Sillett and Van Pelt 2007, Van Pelt and Sillett 2008

# Yosemite Vegetation

- Physical features
  - Area: 3,027 km<sup>2</sup>
  - ~84% vegetated
  - Elevation: 657 – 3,997 m
  - Precipitation: 800 – 1,720 mm
- Forest types
  - Subalpine coniferous forests
  - Upper montane coniferous forests
  - Lower montane coniferous forests
  - Non-coniferous and non-forest
- Tree diversity (25 species)



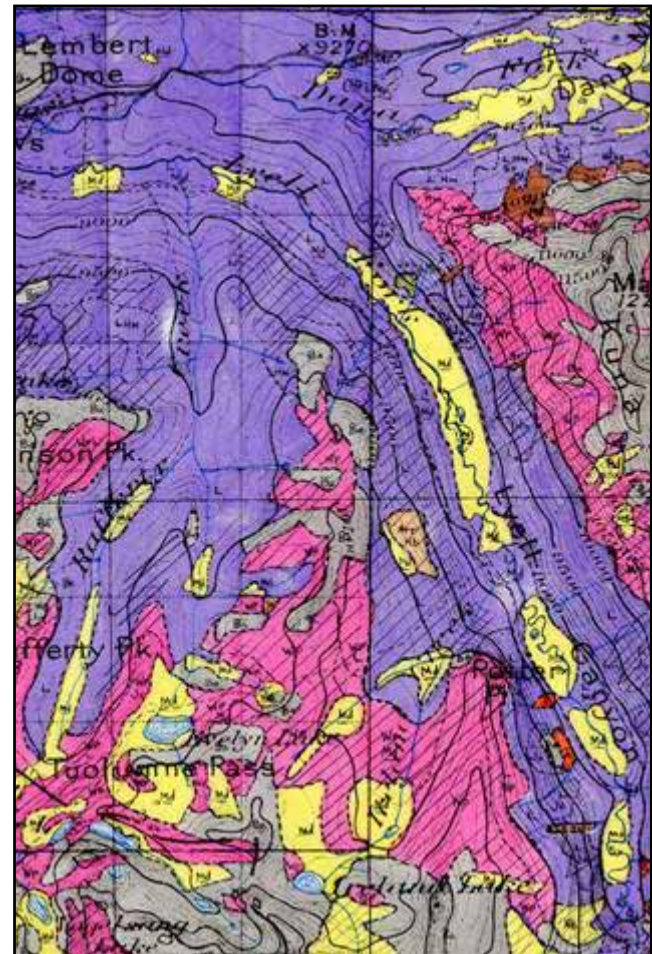
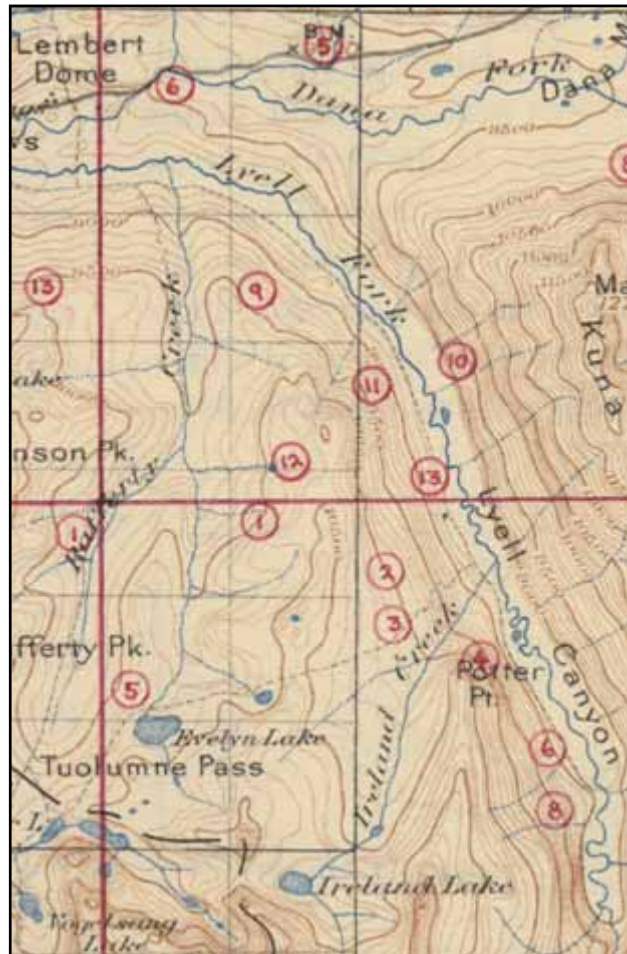
# Data Summary

- Plots
    - Selected all plots with at least one tree  $\geq 10$  cm dbh
    - Plots within park boundary
    - Wieslander survey (1932 – 1936)
      - 656 plots
      - 809 m<sup>2</sup> (1 chain by 2 chains)
      - 16,460 trees
      - Four diameter classes: 10-30 cm; 31-60 cm; 61-91 cm;  $\geq 92$  cm
    - Modern survey (1988 – 1999)
      - 207 plots
      - 1,000 m<sup>2</sup> (mostly circular)
      - 6,871 trees
      - Diameter in cm
- Large-diameter tree  
Provided  $\geq 5\%$**

# Data Consolidation

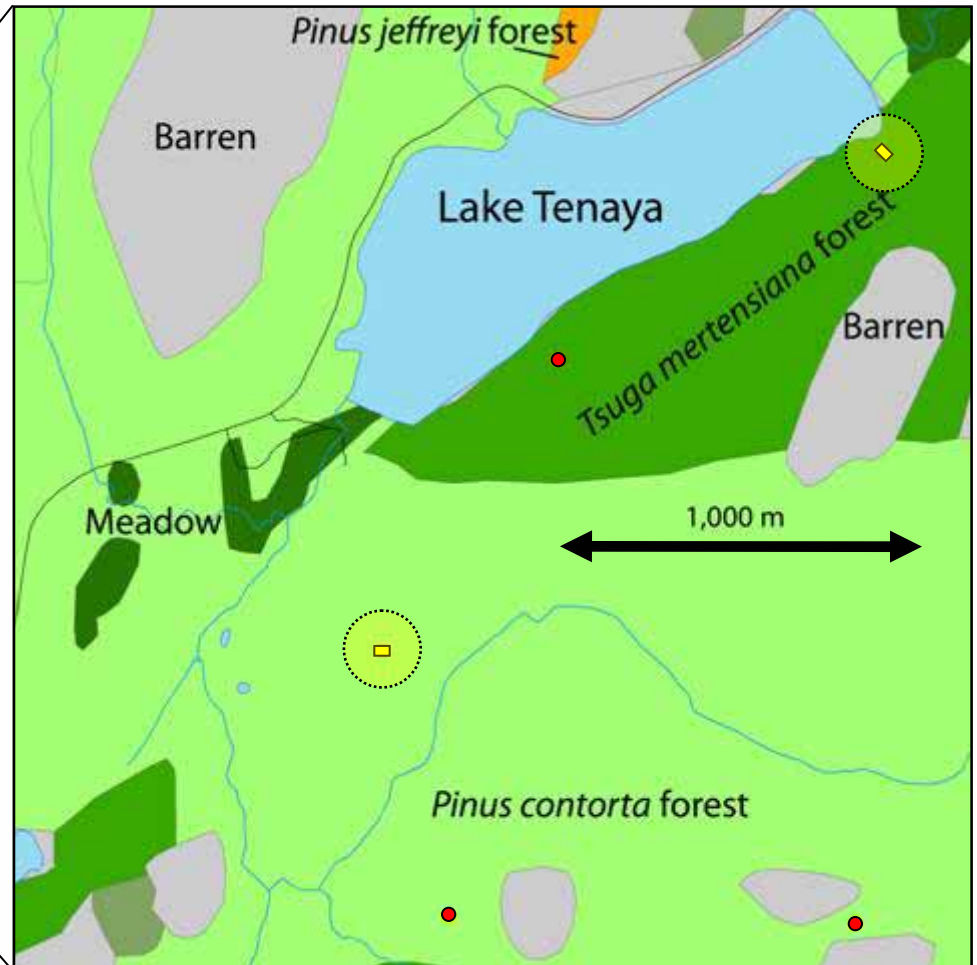
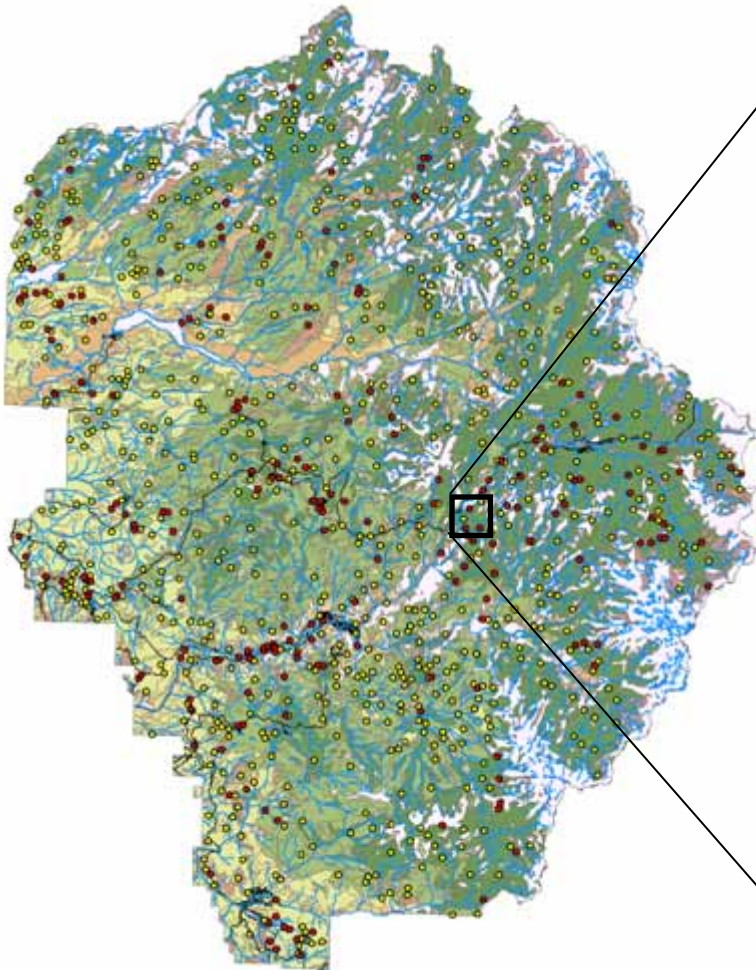
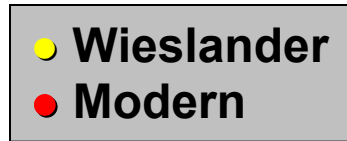
- Grouped plots based on 1935 vegetation maps
- Confirmed equivalent physical attributes of each vegetation type
  - Aspect
  - Slope
  - Elevation – some difference in lower montane forests

# Wieslander Survey Maps



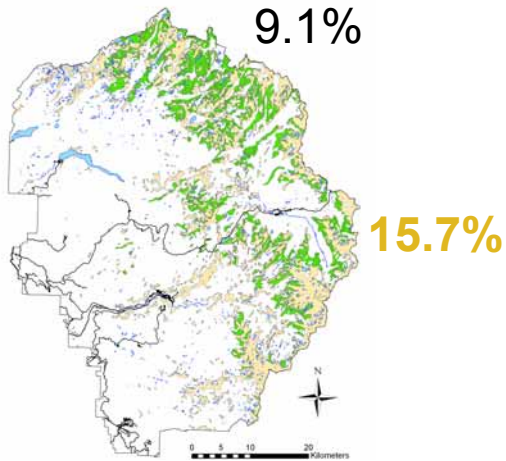
Images courtesy Berkeley VTM Project, <http://vtm.berkeley.edu>

# Plot Stratification

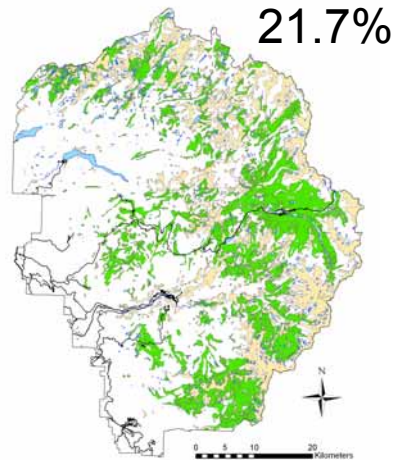


# Consolidated Forest Types

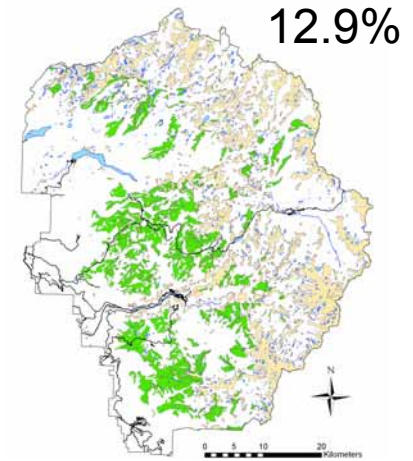
High  
Elevation



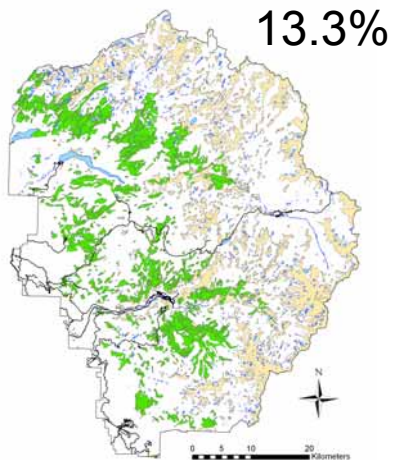
*Pinus albicaulis* – *Tsuga mertensiana*



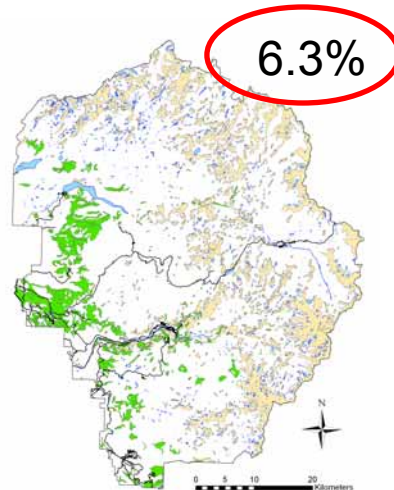
*Pinus contorta*



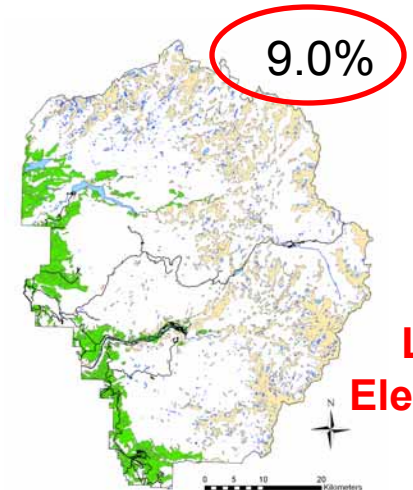
*Abies magnifica* – *Pinus monticola*



*Pinus jeffreyi* – *Abies*



*Abies concolor* mixed conifer



*Pinus ponderosa* mixed conifer

Low  
Elevation

# Species Summary

## Gymnosperms

<b><i>Abies concolor</i></b> (white fir) n = 3,043 ✨
<b><i>Abies magnifica</i></b> (red fir) n = 3,479 ✨
<b><i>Calocedrus decurrens</i></b> (incense cedar)
<b><i>Juniperus occidentalis</i></b> (western juniper)
<b><i>Pinus albicaulis</i></b> (whitebark pine) n = 1,172 ✨
<b><i>Pinus contorta</i></b> (lodgepole pine) n = 7,032 ✨
<b><i>Pinus jeffreyi</i></b> (Jeffrey pine)
<b><i>Pinus lambertiana</i></b> (sugar pine)
<i>Pinus monophylla</i> (singleleaf piñon)
<b><i>Pinus monticola</i></b> (western white pine)
<b><i>Pinus ponderosa</i></b> (ponderosa pine)
<i>Pinus sabiniana</i> (gray pine)
<b><i>Pseudotsuga menziesii</i></b> (Douglas-fir)
<i>Sequoiadendron giganteum</i> (giant sequoia)
<b><i>Tsuga mertensiana</i></b> (mountain hemlock)

## Angiosperms

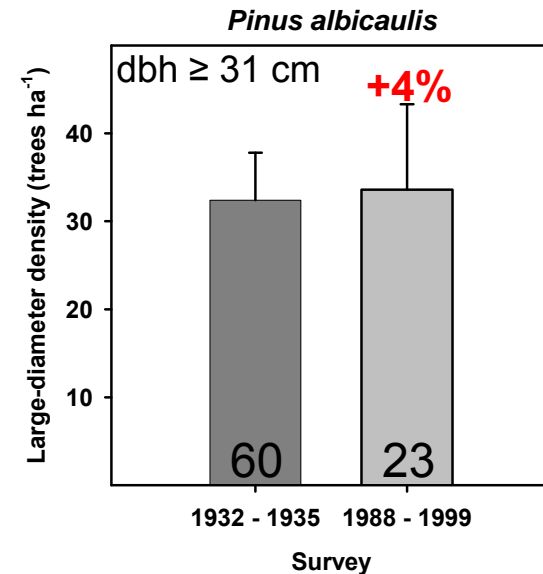
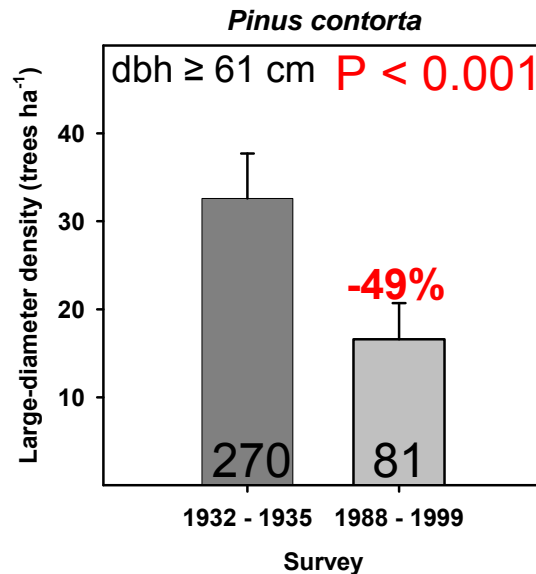
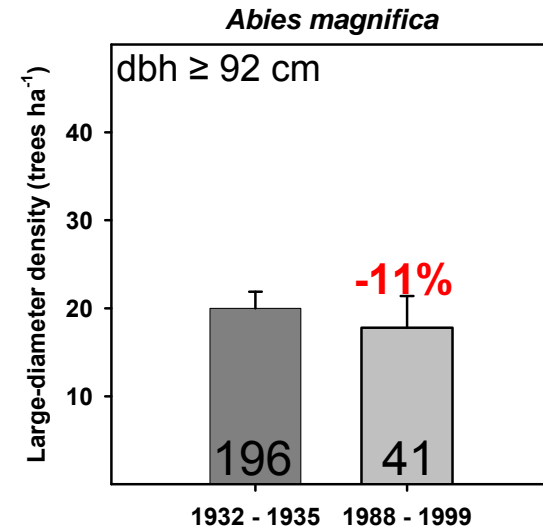
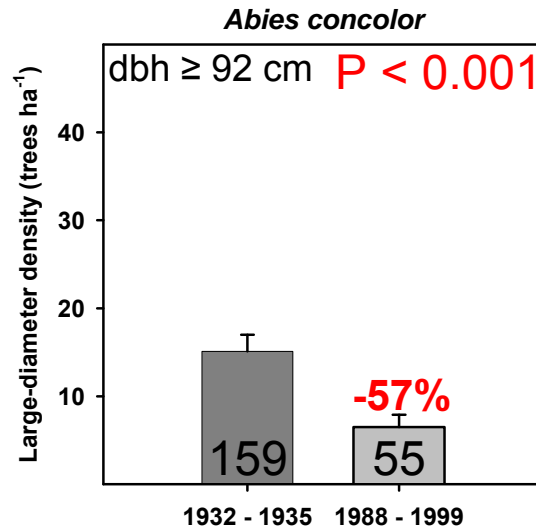
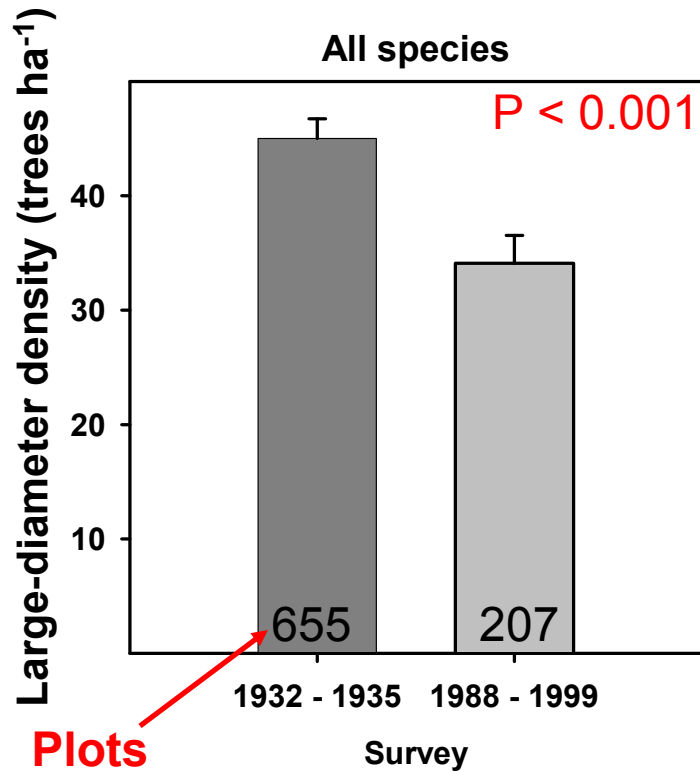
<i>Acer macrophyllum</i> (bigleaf maple)
<i>Alnus rhombifolia</i> (white alder)
<i>Alnus incana tenuifolia</i> (thinleaf alder)
<i>Cornus nuttallii</i> (Pacific dogwood)
<i>Populus tremuloides</i> (quaking aspen)
<i>Populus trichocarpa</i> (black cottonwood)
<b><i>Quercus chrysolepis</i></b> (canyon live oak)
<b><i>Quercus kelloggii</i></b> (California black oak)
<i>Salix</i> spp. (willow)
<i>Umbellularia californica</i> (California laurel)

### “Large diameter”

- *Abies concolor*: ≥ 92 cm
- *Abies magnifica*: ≥ 92 cm
- *Pinus contorta*: ≥ 61 cm
- *Pinus albicaulis*: ≥ 31 cm

White 1966, Parker 1986, McDonald 1990, Peterson *et al.* 1990, Garrison *et al.* 2002,

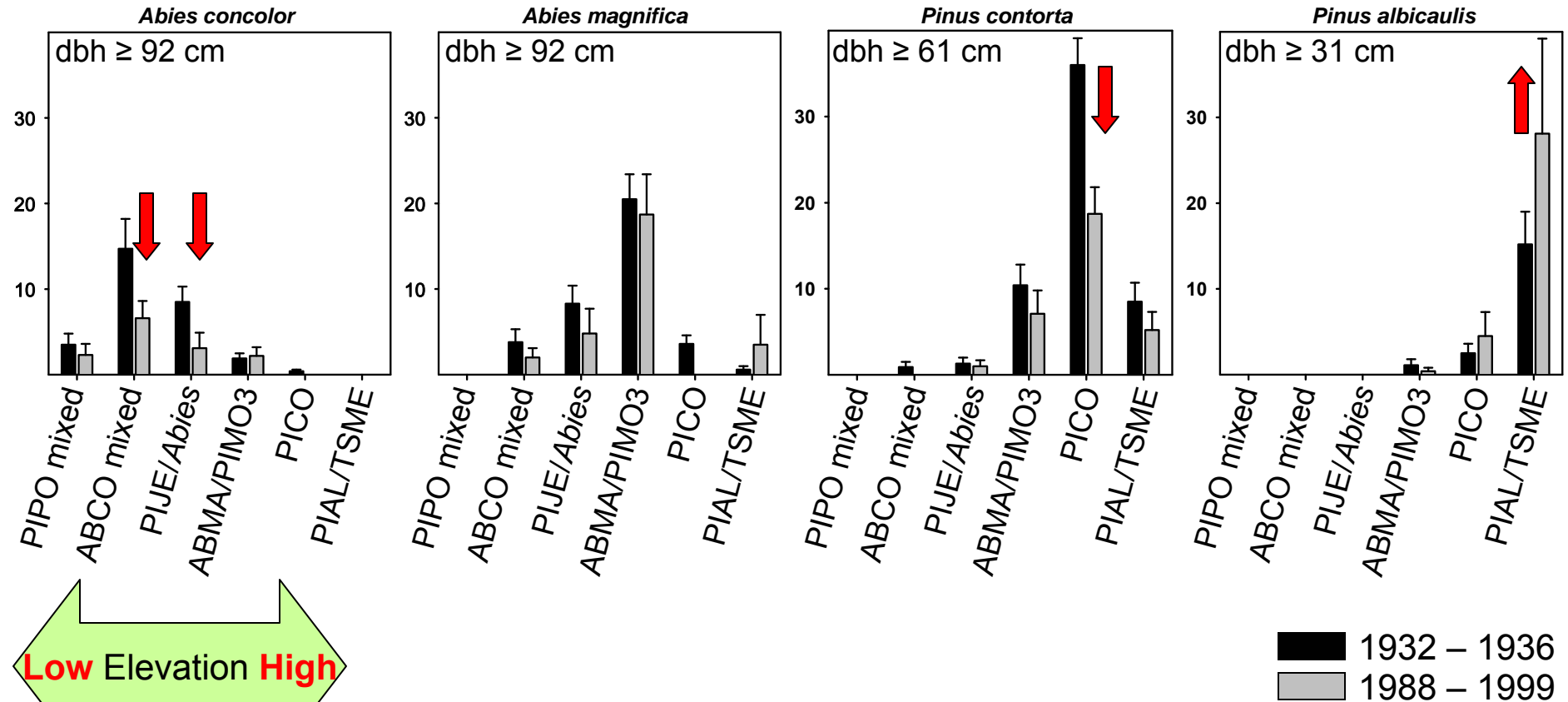
# Large-diameter Trees



Expected fire-intolerant trees to recruit into large diameter classes

# Species Changes by Forest Type

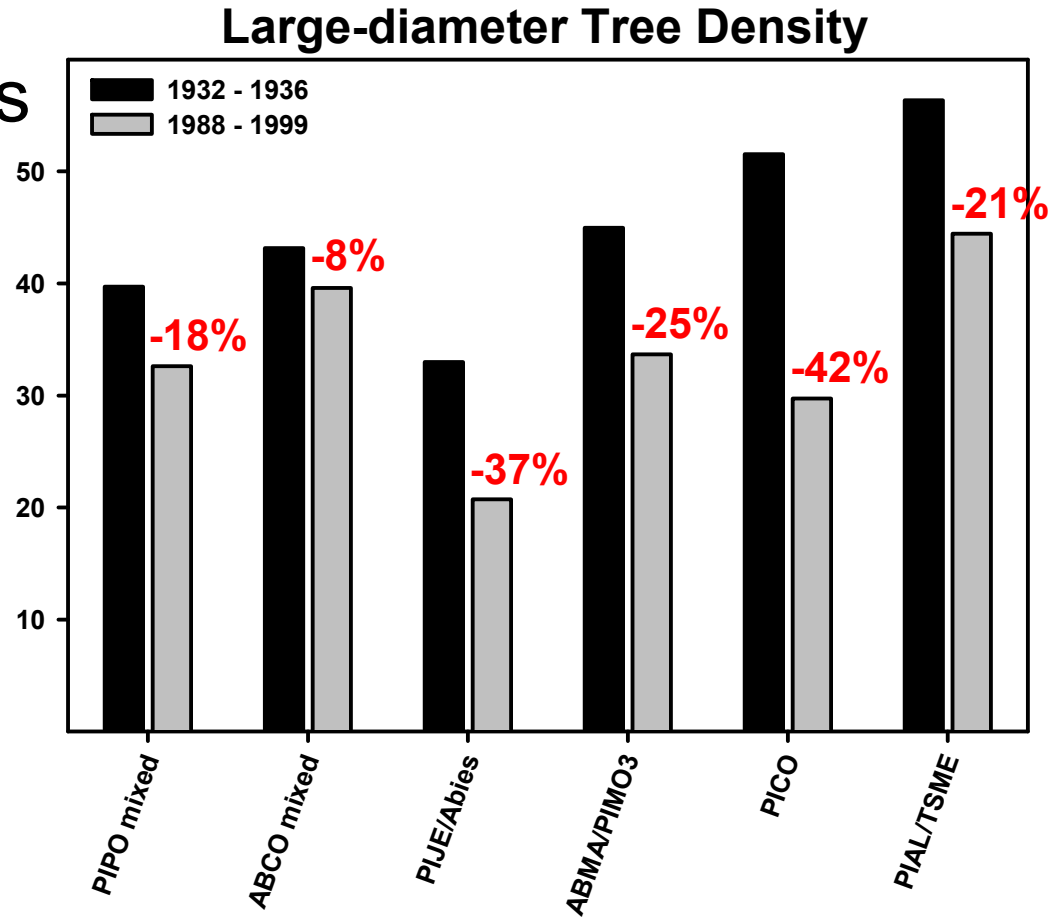
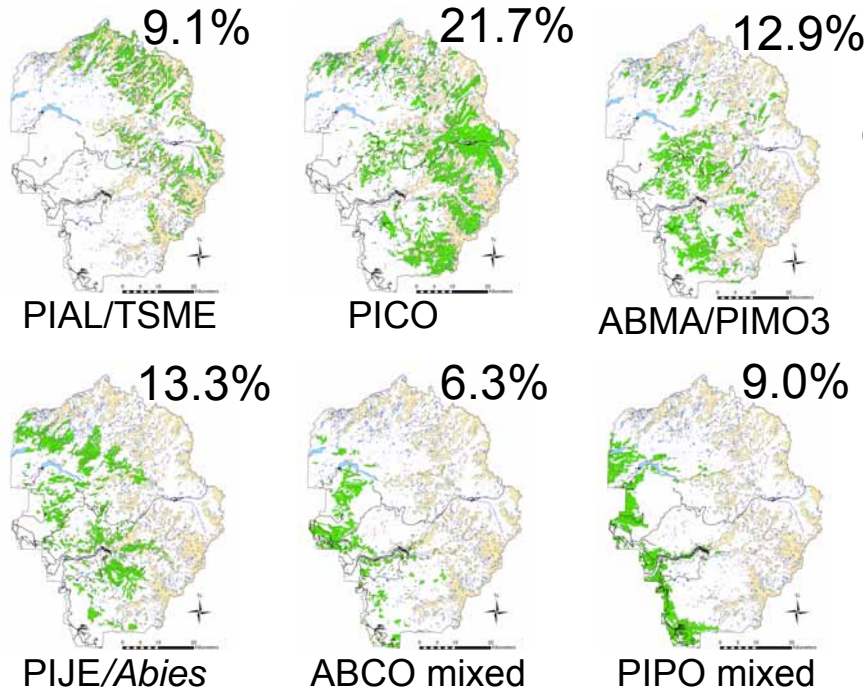
Large-diameter tree density (trees ha<sup>-1</sup>)



Species changes are not the same in all forest types

# Aggregate Changes in Forests

- Composite of all species
- Uneven decline



**Changes are not the same among forests**

# Take Home Points

- Large-diameter trees of most species are declining
- Change varies by species and forest type
- If climate-driven, decline may increase

## Management emphasis?

- Large-diameter individuals of pre-fire-suppression species
- Increase wildland fire use (especially in high snowpack years)
  - To decrease water stress
  - To minimize risk of high-severity fire

# Acknowledgements

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- Jan van Wagtendonk\*
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\*Dissertation committee