



# Tree Mortality in the Sierra Nevada

*Understanding why so many trees have died and what to do next.*

Photo by Sierra Nevada Conservancy



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# Talk outline

- Water stress and tree mortality
- Forest succession
- Replanting at the neighborhood scale



Photo by: USFS Region 5

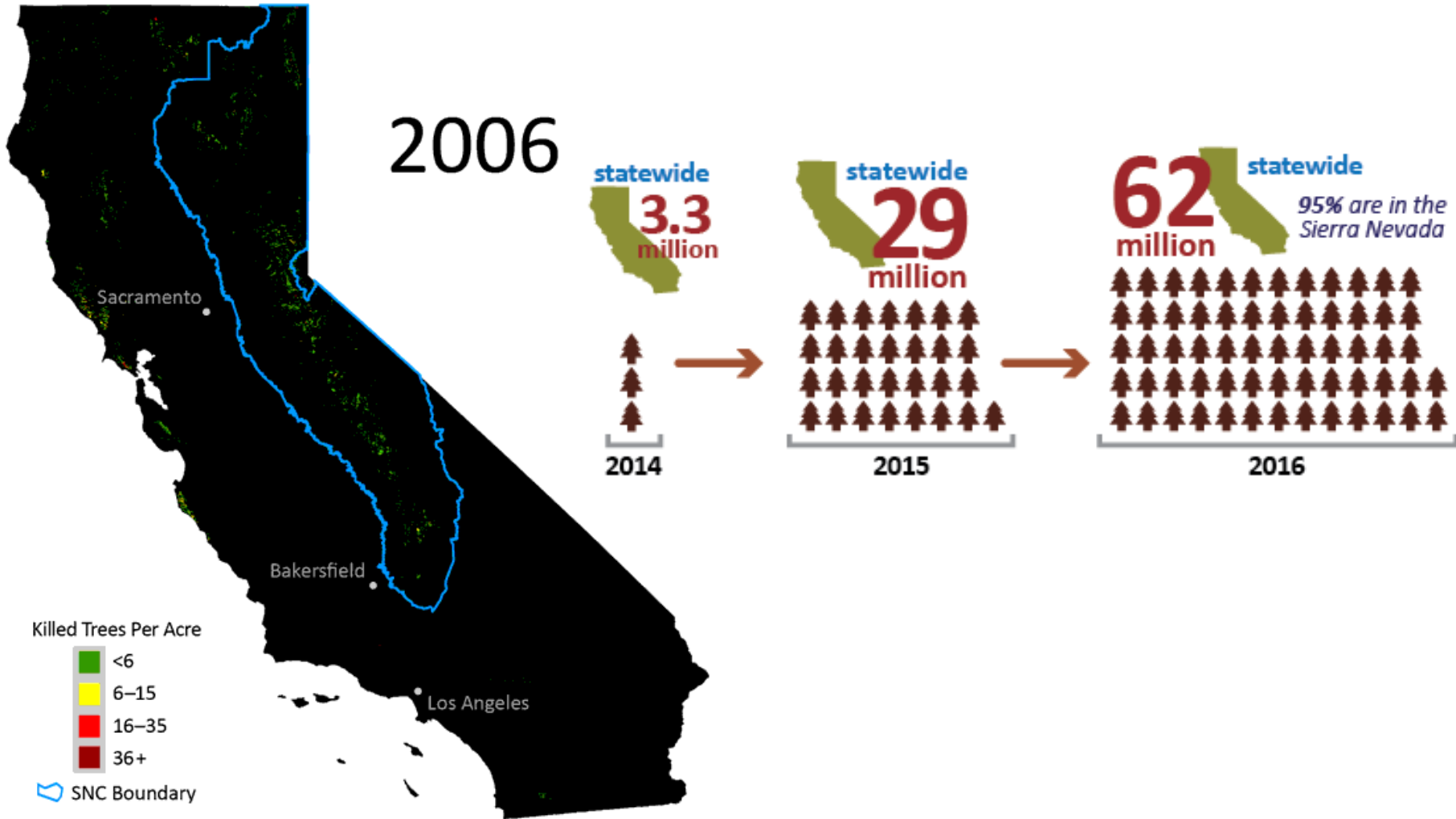


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# Tree mortality throughout the state has been severe



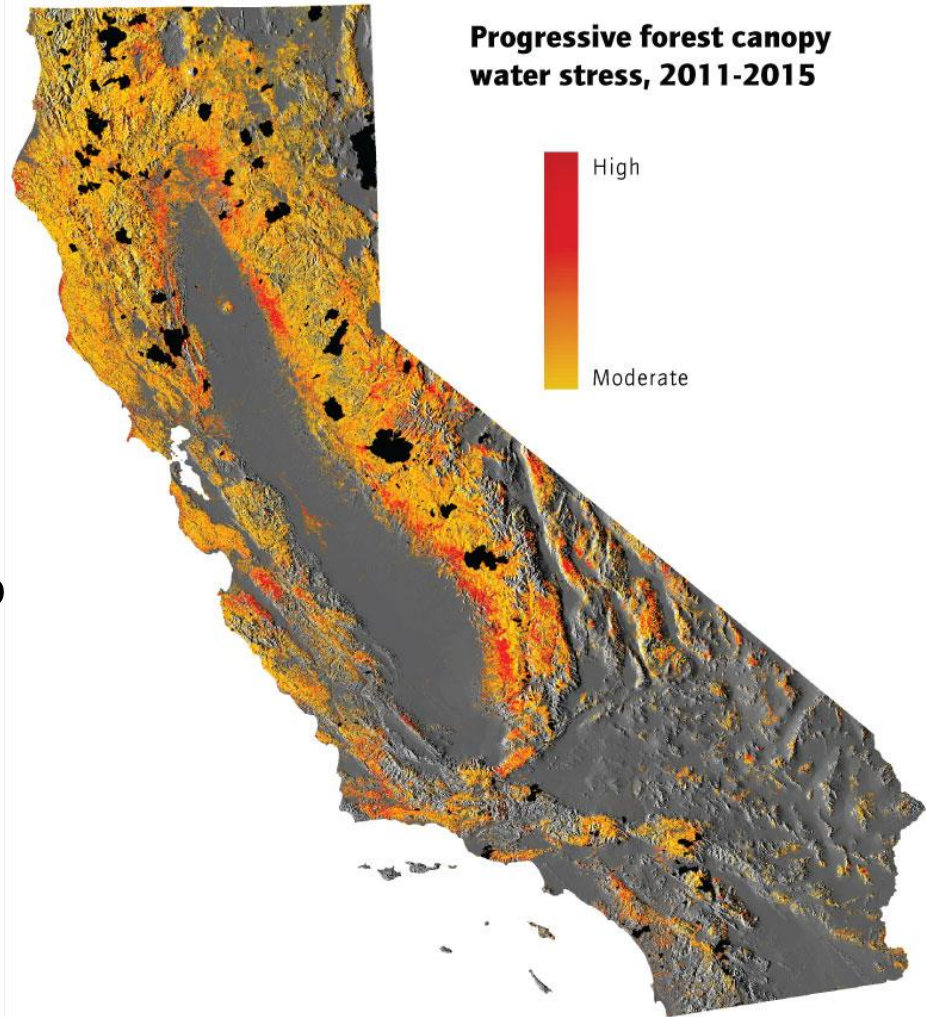
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# Water stress has played a significant role

- Warm drought of 2012 to 2016 caused moisture stress throughout the state, especially at lower elevations in southern Sierra Nevada
  - Plants need more moisture when its hotter
- 100 years of fire suppression has led to overcrowded forests
  - Individual trees get less soil moisture when they are crowded
- Water stress weakens the ability of trees to fight off attack by native bark beetles



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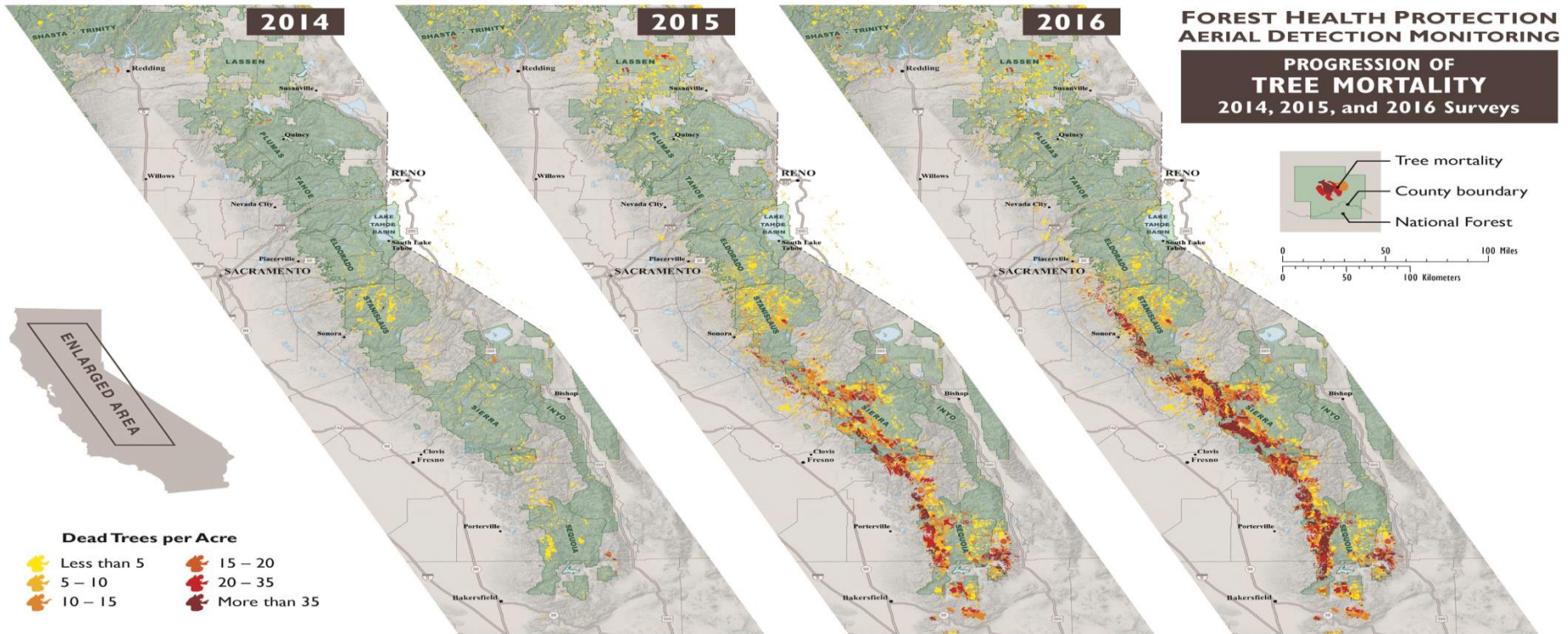
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# Tree mortality reflects drought stress



UNITED STATES DEPARTMENT OF AGRICULTURE



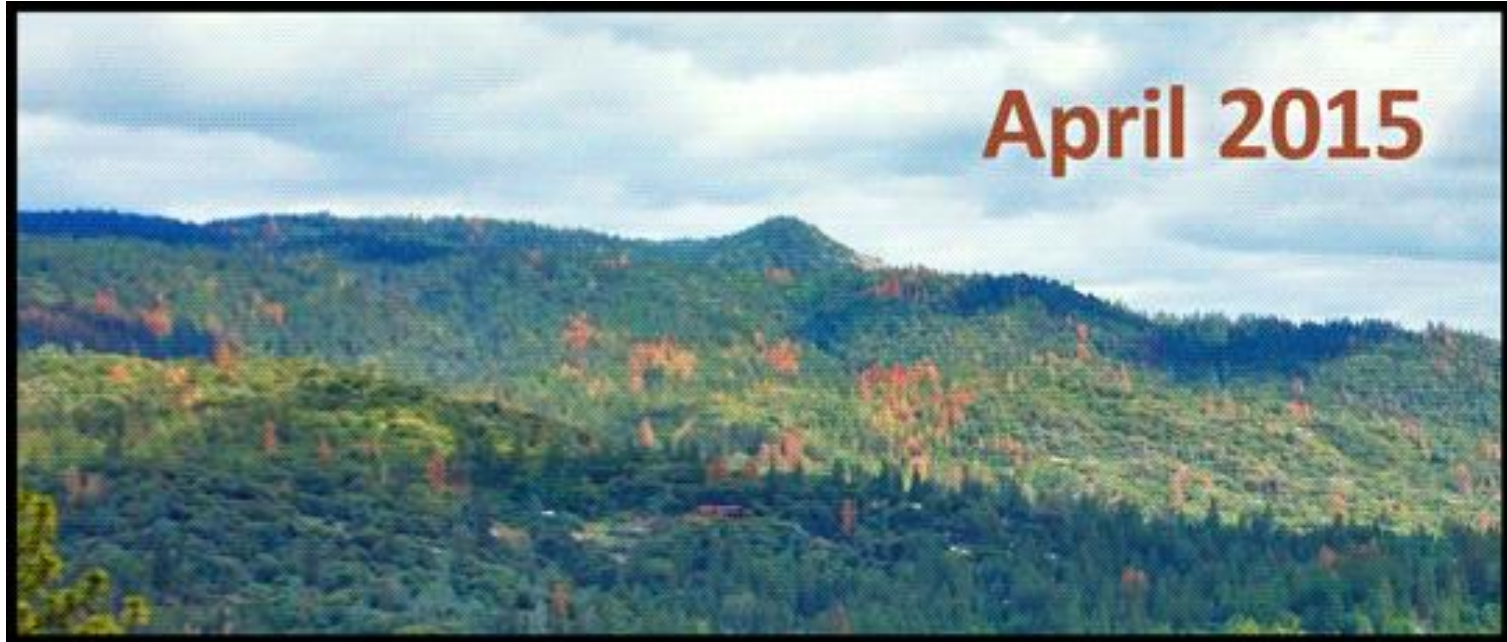
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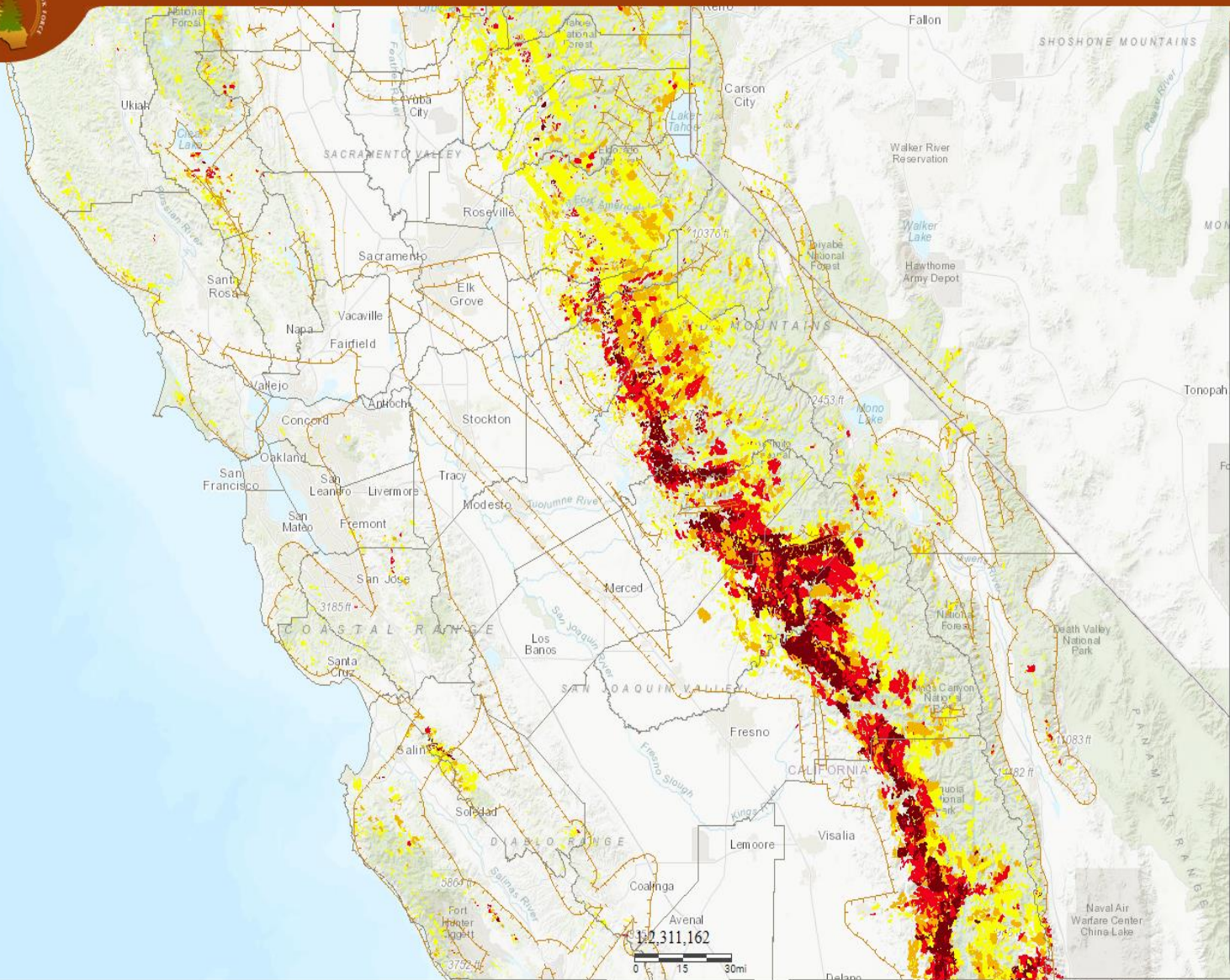


Location in Madera County before and after tree mortality began spreading.  
Photos: Margarita Gordus, CA Department of Fish and Wildlife





# Tree Mortality Viewer



### LAYER VISIBILITY

Click to toggle the visibility of the various layers

- Tree Mortality**
  - USFS 2016 Flown Area
  - 2016 USFS Survey
  - 2015 CAL FIRE Southern CA Survey
  - 2015 USFS Survey
  - 2014 USFS Survey
  - 2013 USFS Survey
  - 2012 USFS Survey
- Hazard Zones**
  - Tier One High Hazard Zones
  - Tier Two High Hazard Zones
- Treatment Projects**
  - Mortality Projects
- Assets**
  - Communications
  - Transportation
    - Rail Stations
    - RailRoads
    - Primary and Secondary Roads

# Forest Succession - What will the future forest be?

- Depends on living trees still on site:
- Ponderosa pine seedlings grow well only in sunny conditions and do not tolerate shade, but seedlings may be found in gaps created by canopy trees dying, sprout on bare mineral soil
- In shade, incense cedar and white fir, often growing in understory. Sugar pine and Douglas-fir may be found in intermediate conditions
- Oaks may be doing well where nearby conifers have died and be taking over where other trees have been removed
- Fir and cedar already in the understory likely to take over





# Yosemite National Park - Mixed-Conifer Site (YOMI)

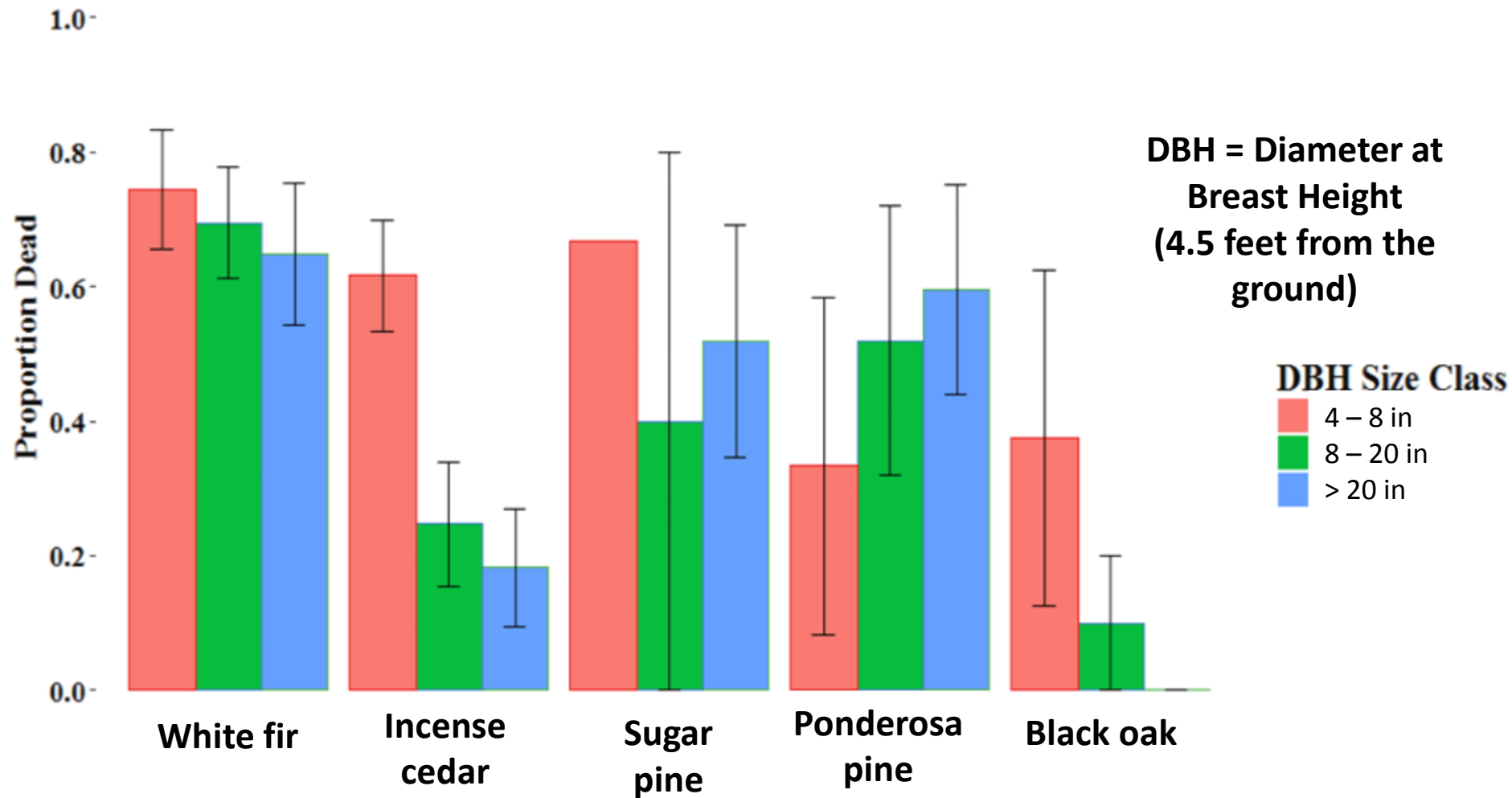
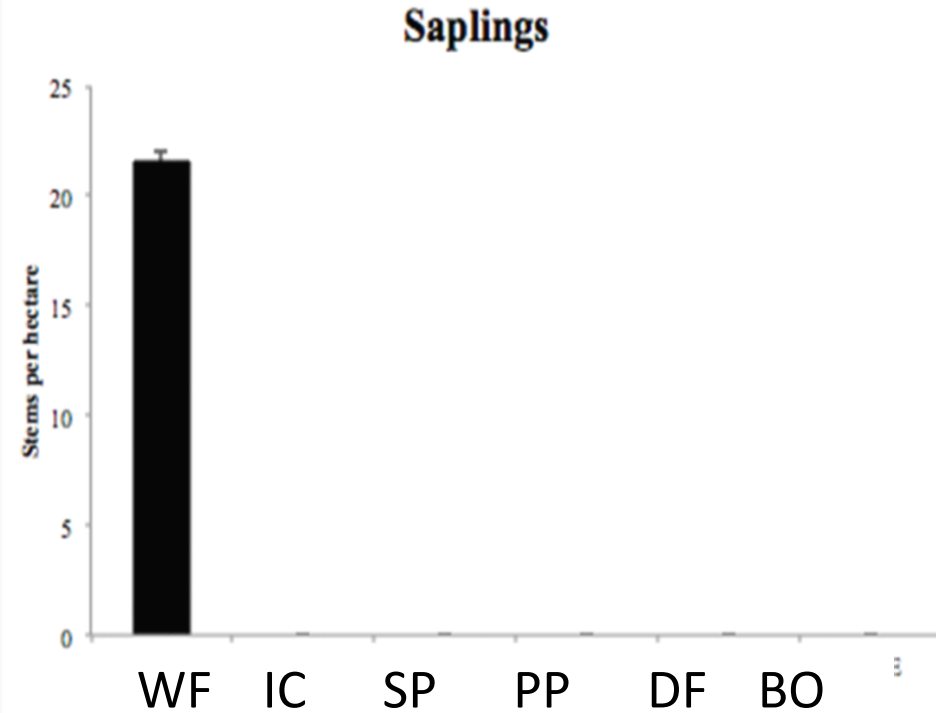
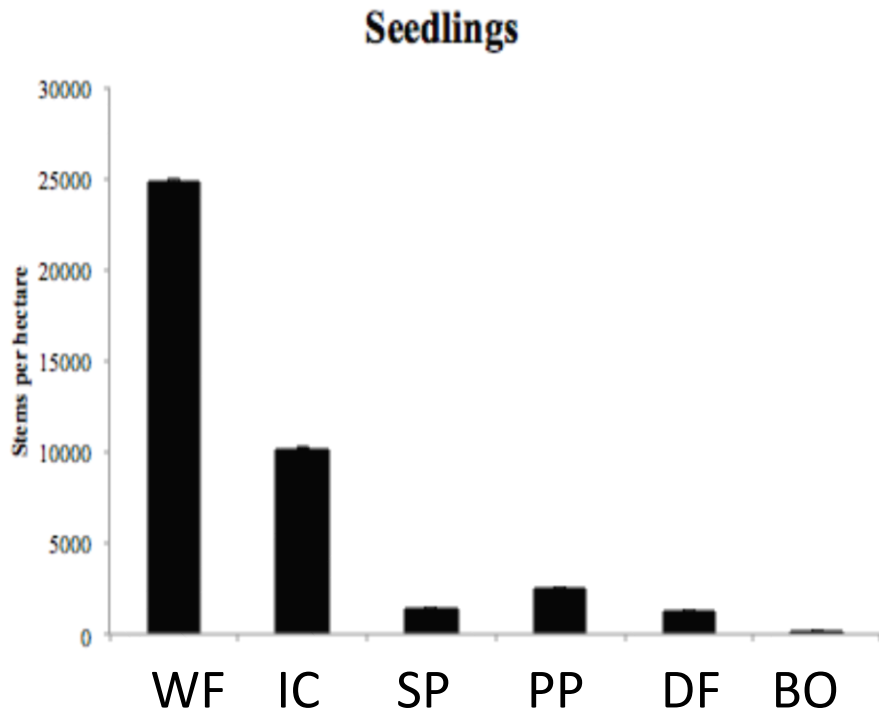


Figure 1. Proportion of dead trees by species and DBH size class for major species at the mixed-conifer site near Hodgdon Meadow, Yosemite NP (YOMI). Bars represent standard error.





**Figure 2. Density of seedlings (stems <4.5' height) across all species at the mixed conifer site near Hodgdon Meadow, Yosemite NP. First year seedlings were excluded from the data.**

**Figure 3. Density of saplings (stems  $\geq$  4.5' height; < 4 in DBH) at the mixed conifer site near Hodgdon**



# Pines may need to be planted to recover in some locations

Just because pines have been killed by beetles doesn't mean they are not well suited for replanting

- Pines are well adapted to the Sierra Nevada
- Beetles typically don't attack trees under five inches in diameter
- Historical data and reconstruction studies in the Sierra indicate mixed-conifer forests were highly **clustered** with **gaps** where sun loving pines grew



Ackerson Meadow, Toulumne County (1941)  
Old growth stand of ponderosa pine

UC Library, Digital Collections



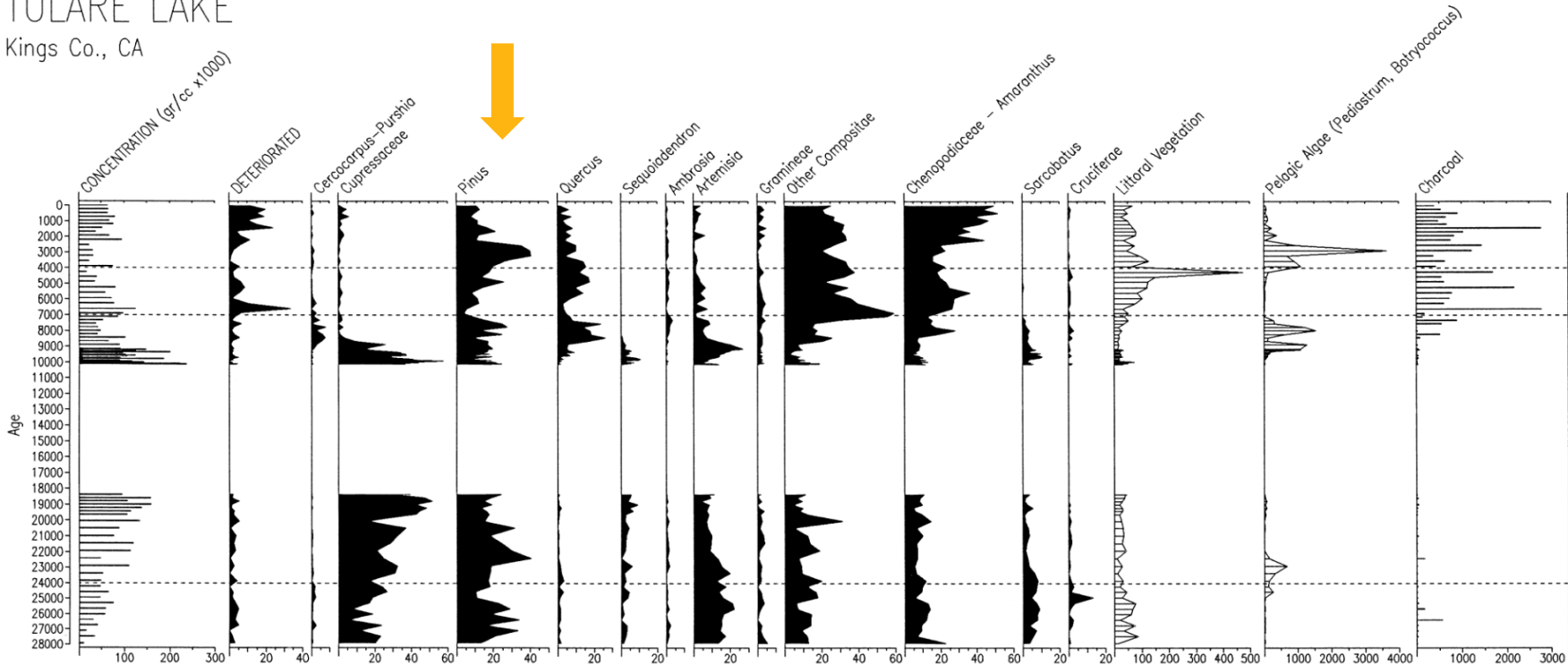
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# Pollen studies show pines abundant in Sierra for 28,000 years

TULARE LAKE  
Kings Co., CA



O.K. Davis / Review of Palaeobotany and Palynology 107 (1999) 249-257

Fig. 3. Percentage pollen diagram for selected (abundant) palynomorphs from Tulare Lake core 2. Types right of Cruciferae are not included in the pollen sum (divisor for pollen percentages). Horizontal lines denote important events in the record (not zone boundaries) the lowest line at 24,000 yr B.P. marks a decreased sedimentation rate and a decrease in lake level. The 7000 yr B.P. line marks the last occurrence of the pollen of *Sarcobatus* a Great Basin species. The 4000 yr B.P. line marks the beginning of higher lake levels during the late Holocene.

Davis, O. 1999. Pollen analysis of Tulare Lake, California: Great Basin-like vegetation in Central California during the full-glacial and early Holocene. *Review of Palaeobotany and Palynology*, 107:49-257.





# Replanting at the Neighborhood Scale - Process

- Assess your landscape
  - See what is left after tree removal. Survey your property, marking where you find living trees and identify by species and size.
- Nurture existing trees
- Replant
- Maintain



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# Nurture existing trees

- If you have a significant number of trees left, you may not need to replant.
- Thin trees so that available sun and soil moisture is focused on the healthiest trees.
- Water where trees are receiving more sun to reduce stress.
- Clear out competing shrubs, grass and other vegetation.
- Digging up natural seedlings and moving them is not often successful.



# Replanting tree choices

**Native trees** - Native conifers are adapted to our climates. Due to climate change, choosing trees that were grown from seed stock collected from a slightly lower elevation may hedge against warmer temperatures in the future.



## Seed Zones of California



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# Neighborhood forest re-establishment through cooperation

## NATIVE SHRUBS & GROUND COVER

*Arctostaphylos patula* - Greenleaf Manzanita  
*Artemisia tridentata* spp. *vaseyana* - Mountain Sagebrush  
*Rosa woodsii* 'ultramontana' - Woods Rose  
*Purshia tridentata* - Bitterbrush

## SEED PERENNIALS

*Eriogonum umbellatum* spp. *polyanthum* - Buckwheat  
*Penstemon* sp. - Native Penstemon  
*Linum lewisii* - Blue Flax  
*Epilobium canum* spp. *latifolium* - California Field  
*Lupinus breweri* - Brewer's Lupine  
*Wyethia mollis* - Woolly Mules Ears

## NATIVE CONIFERS

Planting larger native conifers from nursery stock between lots will help create forest spaces and privacy more quickly. Connecting temporarily to drip irrigation will promote plant survival and more rapid growth in the first 2 to 5 years.

*Pinus jeffreyi* - Jeffrey Pine  
*Pinus lambertiana* - Sugar Pine  
*Calocedrus decurrens* - Incense Cedar

## DEFENSIBLE SPACE ZONES

Plant conifers, flammable shrubs and groundcover sparsely with more plants that have a higher water content within 30' of structures. These plants will require regular watering. See the plant lists for plant recommendations, planting conditions and sizes.

## NONCOMBUSTIBLE ZONE

Install BMPs, rock mulches, herbaceous perennials and plants with very low combustibility within 5' of structures. Keep area clear of wood piles, wood mulches and pine needle duff. See the plant list for plant recommendations, conditions and sizes.

By working together neighbors can restore the forest more quickly and provide a wild fire resistant landscape. Purchasing and planting native trees, shrubs and perennials together property owners can reduce their individual costs for plants and materials. Lower costs can mean larger nursery plants and greater numbers increasing the immediate visual improvements. Coordinating plant locations and spacing between parcels as a neighborhood can; further increase the immediate impact, create a more sustainable, fire safe landscape and provide long term forest health.

## NEIGHBORHOOD FOREST REVEGETATION ON PRIVATE PARCELS



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# Replanting tree choices

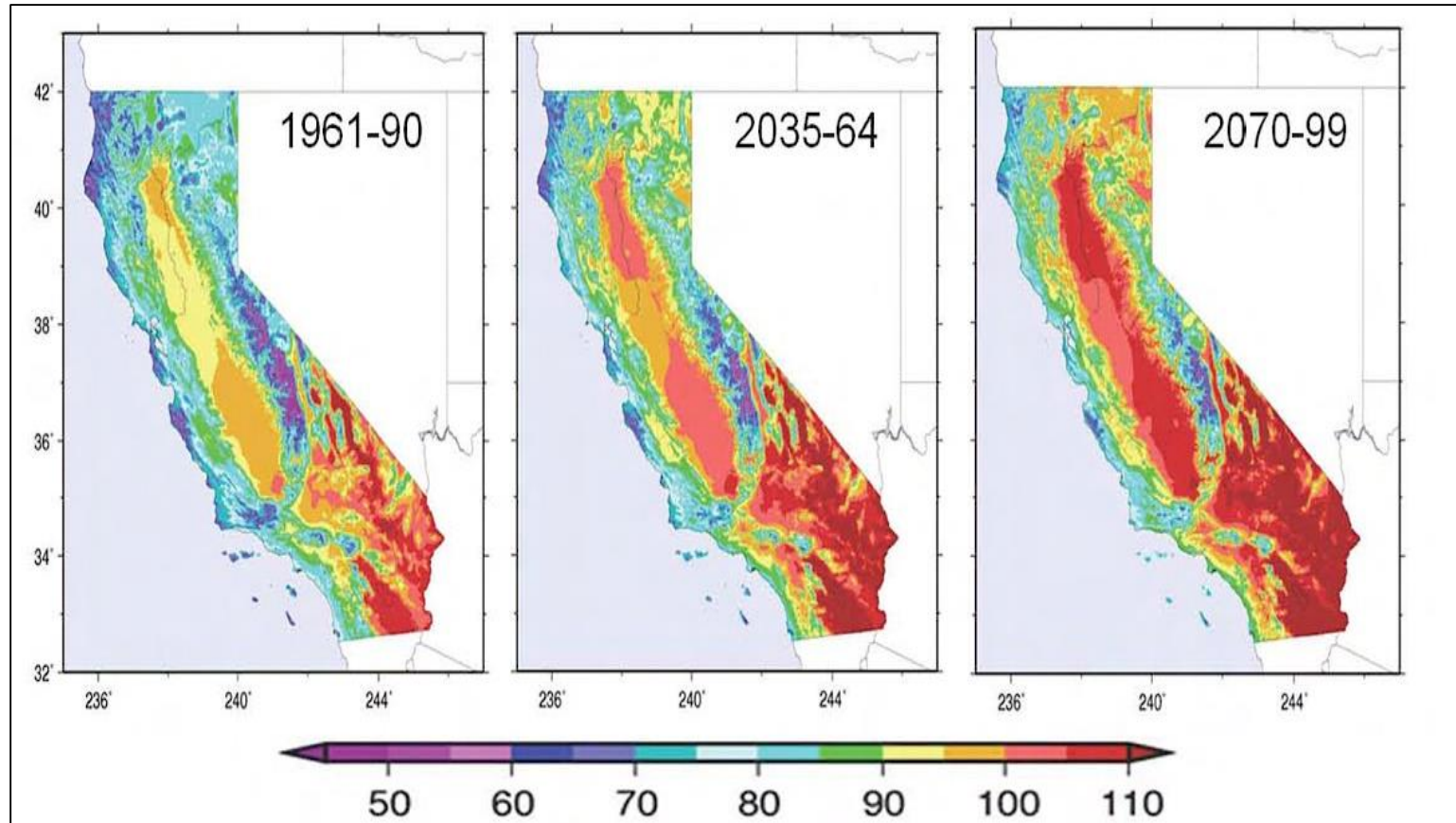
**Landscape trees** – Trees other than conifers can also be planted. This could include native and nonnative species.

- These can provide color, aesthetic or other values.
- Important to choose the most appropriate site for the tree.
- Choose a tree that is best adapted to the local growing conditions and will thrive in the area with the fewest pest problems.
- Important to choose plants that are not invasive or weeds.



# Choosing the right landscape trees

- Species suited to your location will change with a warming climate



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# Species not expected to perform well – based on “warm” or “warmer” city

Climate Zone:	10	11	12	13	14	15	16
Species	Riverside	Yuba City	Stockton	Fresno	Barstow	El Centro	Susanville
Allepo pine					•		
Apple							•
Australian willow						•	
Black Cottonwood							•
Bradford pear			•	•			
Canary Island pine	•			•			
Chinaberry					•		
Chinese elm				•	•		
Chinese Pistache		•		•			
Common Hackberry			•				
Crape Myrtle				•			
Darlington oak				•			
Deodar cedar				•			
Evergreen ash			•				
Fern pine				•			
Gingko				•			
Golden chain trees	•						
Honey Locust							•
Indian laurel fig						•	
Lemon scented gum						•	
London plane tree	•	•					
Modesto ash						•	
Norway Spruce							•
Orange	•						
Purple leaf plum		•		•			
Raywood Ash	•			•			
Redwood		•					
Siberian elm						•	
Silver dollar eucalyptus						•	
Silver wattle						•	
Southern Magnolia	•	•					
Sweetgum		•	•	•			
White Mulberry		•			•		

warmer, maybe drier on average... so...

assess <b>your tree's</b> environment →	~ reflective surfaces? Paving? ~ sandy/rocky soils? slope? ~ etc. (you know this!)
evaluate your tree's climate envelope →	~ is it "at the edge" now? ~ SelecTree
consider the major landscape pests →	~ UC IPM website ~ Pest Vulnerability Matrix (PVM)
understand <b>and meet</b> your tree's water needs →	~ WUCOLS ~ calculate! ~ apply properly





Search by Name

# SelectTree: A Tree Selection Guide

[Search Trees by Characteristics](#)

Search for trees

Search

[Search Help](#)

- [Tree Characteristics Glossary](#)
- [Search Help](#)

[About SelectTree](#)

Do not be very upright in your dealings for you would see by going to the forest that the straight trees are cut down and the crooked ones are left standing.

— Chanakya

[Right Tree Right Place](#)

[Utility Precautions](#)

[Browse securely](#)



*Pittosporum undulatum*

Fairly drought resistant...

Photo by M. Ritter, W. Mark, J. Reimer and C. Stubler

~ you can search for a tree by desired characteristics!



<http://ipm.ucanr.edu/>

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# UC IPM

Statewide Integrated Pest Management Program

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*Solve your pest problems with UC's best science*


### What's New

- Highlights:
  - [2016 Annual Report](#)
  - [Strategic plan 2015-2023](#)
  - Pest Notes: Invasive Plants and Widow Spiders and Their Relatives updated
  - Green Bulletin: May 2017
  - Quick Tips: 40 English Quick Tips updated
  - Retail Nursery & Garden Center IPM Newsletter: May 2017
  - Ag Pest Management: Citrus, Alfalfa and Avocado revised, Prune, Plum, Pistachio, Cherry, Asparagus, Apricot, and Grape updated
- [More...](#)

### QUICK LINKS

- Newsletters
- Recursos en español
- Online training
- Weather, models, & degree-days


### Home, Garden, Turf & Landscape Pests




### Agricultural Pests



### Natural Environment Pests



### Exotic & Invasive Pests



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# Compare my trees' water use to other species:

The screenshot shows the homepage of the WUCOLS IV website. The browser address bar displays [ucanr.edu/sites/WUCOLS/](http://ucanr.edu/sites/WUCOLS/). The page features a navigation menu on the left with items: Home Page, User Manual, Plant Search Instructions, Plant Search Database, Download WUCOLS IV Plant List, Download WUCOLS IV User Manual, Water Requirements for Turfgrasses, Partners, and Acknowledgements. The main content area is titled "Home Page" and includes a "GETTING STARTED" section with the following text: "If you are using the WUCOLS list for the first time, it is essential that you read the *User Manual*. The manual contains very important information regarding the evaluation process, categories of water needs, plant types, and climatic regions. It is necessary to know this information to use WUCOLS evaluations and the plant search tool appropriately. To access the *User Manual*, click on the tab (on left) and view specific topics." Below this text is a paragraph about water conservation in California landscapes, and a photograph of a garden with various plants.

[ucanr.edu/sites/Wucols](http://ucanr.edu/sites/Wucols)



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## Replant – size options

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*Saplings:* Most expensive. Requires soil amendments and weekly waterings during the dry season for the first few years. Best for select locations near the home for visual screening or wind breaks.

*Container grown seedlings:* Much less expensive. May require some care including watering during the dry season. May be held in pots until ready to plant.

*Oaks:* Container sized plants can be expensive. Least expensive option is starting by seed. Gather acorns locally in the fall and plant immediately. Germination success can be high if done right.



# Common Planting Problems

**1. Too Deep**  
needles buried  
hole okay  
tree position poor



**2. Too Shallow**  
roots exposed  
hole too shallow



**3. Air Pocket**  
from improper  
tamping



**4. 'L' Roots**  
hole shallow



**5. 'J' Roots**  
hole shallow  
roots often exposed  
to air



**6. Compacted Roots**  
hole too narrow  
not properly  
opened



**7. Not Vertical**  
shallow planting  
caused by improper  
digging of hole



**8. Too Loose**  
improper  
tamping after  
planting



**9. Poor Planting Soil**  
planting in rotten wood,  
deep duff or debris,  
not damp mineral soil



**10. Satisfactorily  
Planted Tree**

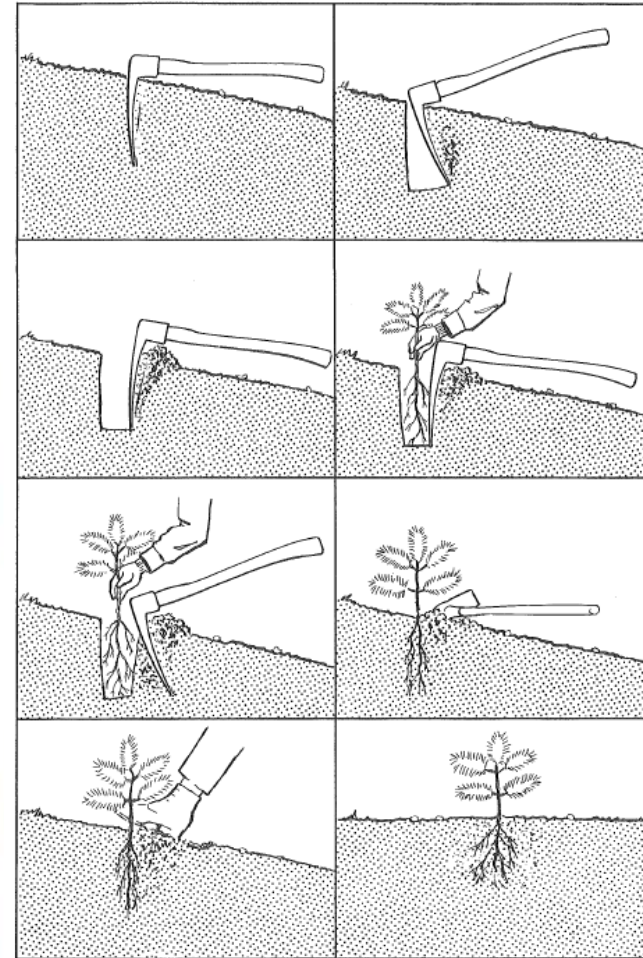


Figure 18. Steps in tree planting, using the western planting tool.



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# Buying Trees


- For small scale replanting
  - Local nurseries
- For larger plantings
  - El Dorado County Resource Conservation District has partnered with the USFS nursery in Camino, CA
    - 200 seedling minimum
    - Orders must be received by Oct 1 each year for Sugar pine, and Dec 1 for all other species
    - <http://www.eldoradorcd.org/nodes/info/reforestation.htm>
    - (530)295-5630



# Maintain trees

- Amount of maintenance will vary with tree type, size, location and local conditions.
- Keep newly planted trees well watered during the growing season. Many trees will need to be watered for the first couple of years or until established.
- Mulch
- Staking – depending on the size and type
- Clear competing vegetation
- Prune – only critical branches



An aerial photograph of a vast forest. The foreground and middle ground are filled with dense evergreen trees, many of which have turned a golden-brown color, suggesting autumn. In the distance, there are rolling hills and mountains under a clear sky. A large, semi-transparent white circle is overlaid on the left side of the image, containing text.

## **Acknowledgements**

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## **Presentation**

The presentation was developed by:

- Susie Kocher and Scott Oneto, UCCE Central Sierra (El Dorado, Calaveras, Amador and Tuolumne Counties)

# Master Gardener's FAQs

- Can trees recover if damage appears minimal? / Is this tree really dead?
- If bark beetle is cause of mortality, can you replant in same exact spot where tree was removed, or is there a threat of damage/disease to new tree?
- Will the beetle infestation return? this year now that the drought is over in most areas of California?
- Are there specific trees recommended for replacement? What species and mix should I plant?
- Can I replant ponderosas despite future droughts and beetle attacks?
- Do we need to rethink what plants we are using if the climate is warming, do they need to rethink what plants are best for their sites, elevation, etc.
- What other plants besides trees should I use?
- When to plant, how to plant and where to purchase appropriate trees, groundcovers and shrubs?

