Tree Mortality in the Sierra Nevada

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

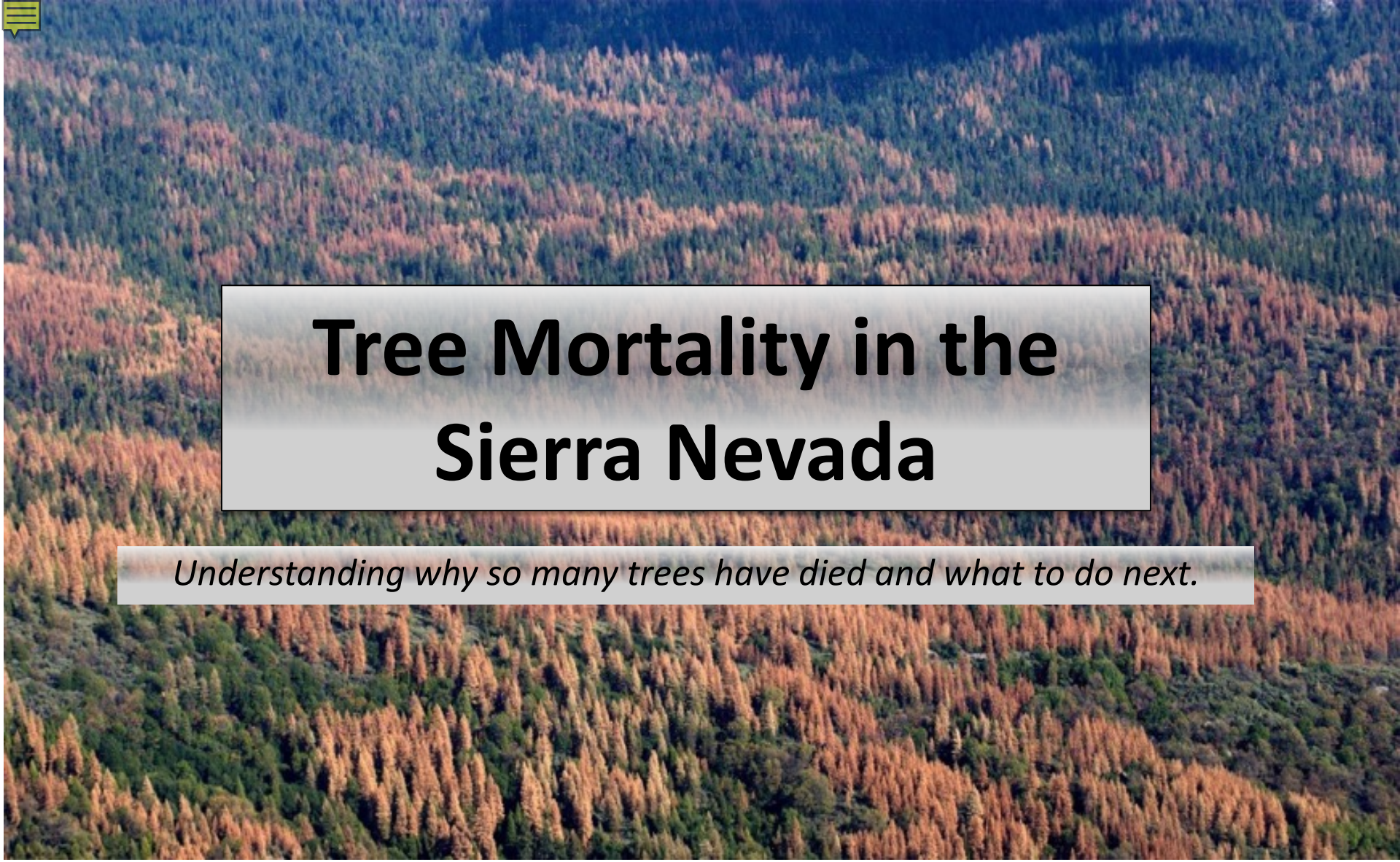

Photo by Sierra Nevada Conservancy

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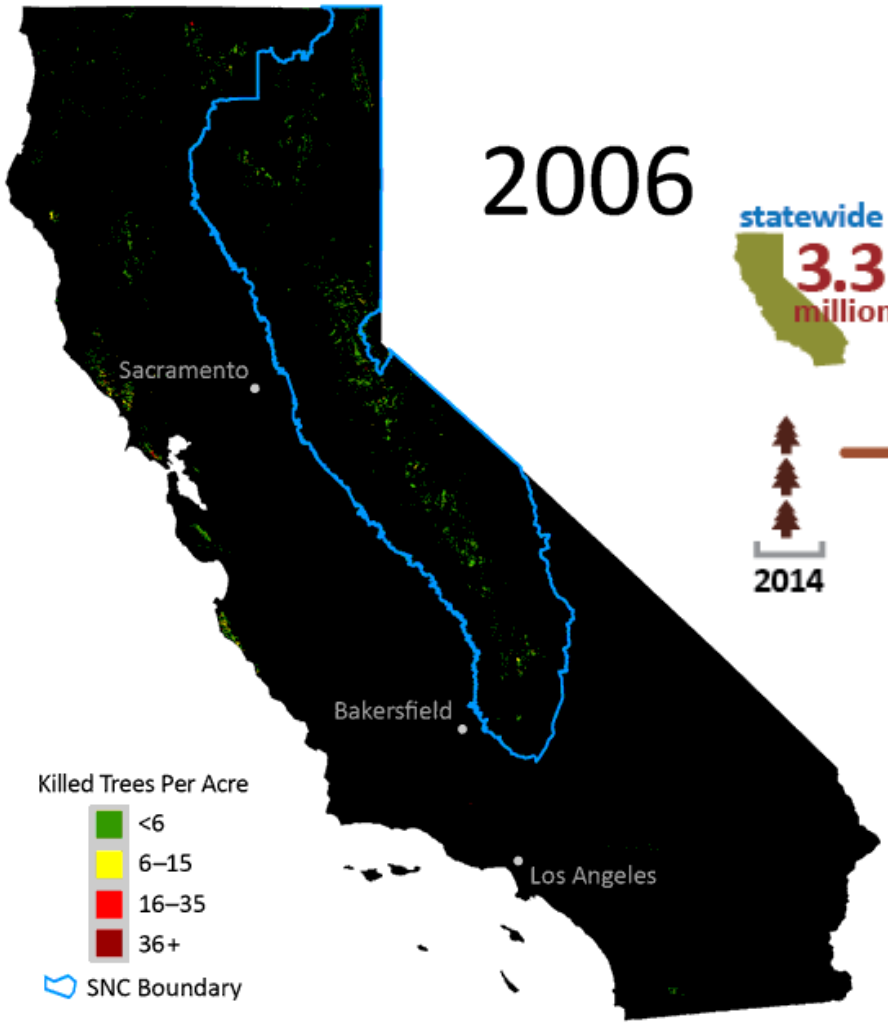
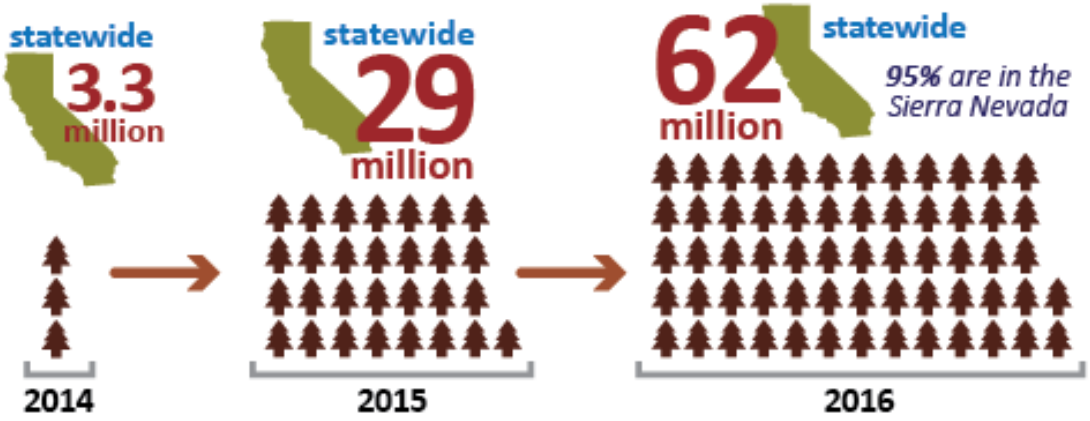
Talk outline

- Water stress and mortality
- Bark beetles as a mortality agent
- Forest succession
- Reforestation
- Replanting at the neighborhood scale

Photo by: USFS Region 5

Tree mortality throughout the state has been severe





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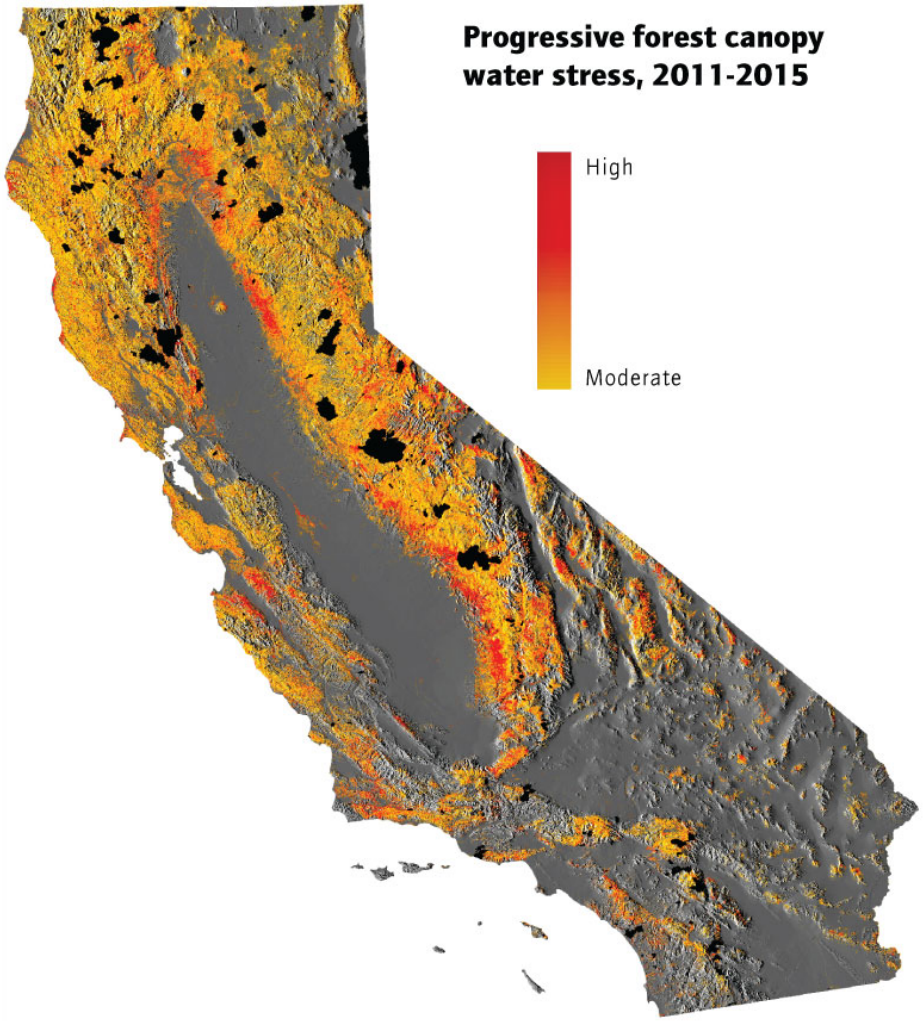
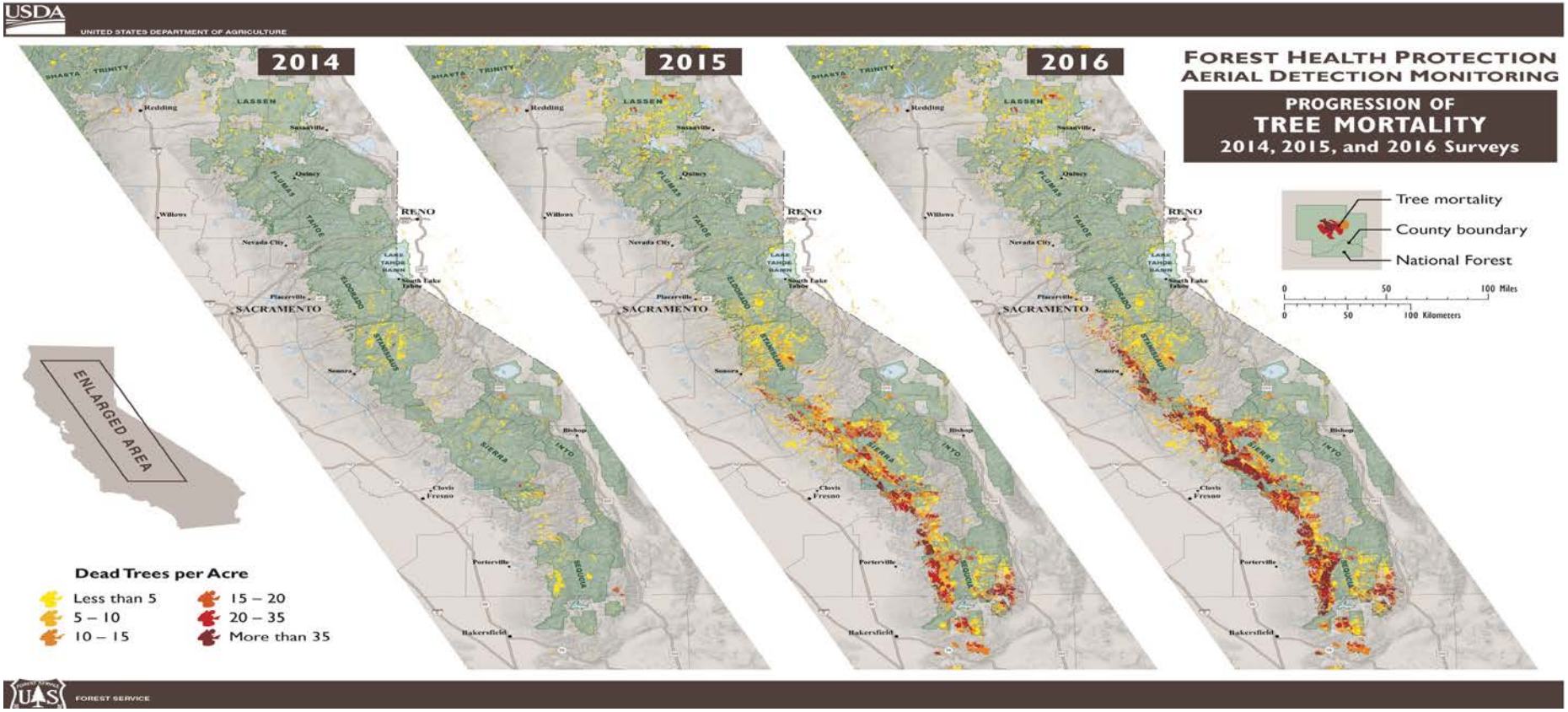
Water stress has played a significant role

- 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



Tree mortality reflects drought stress



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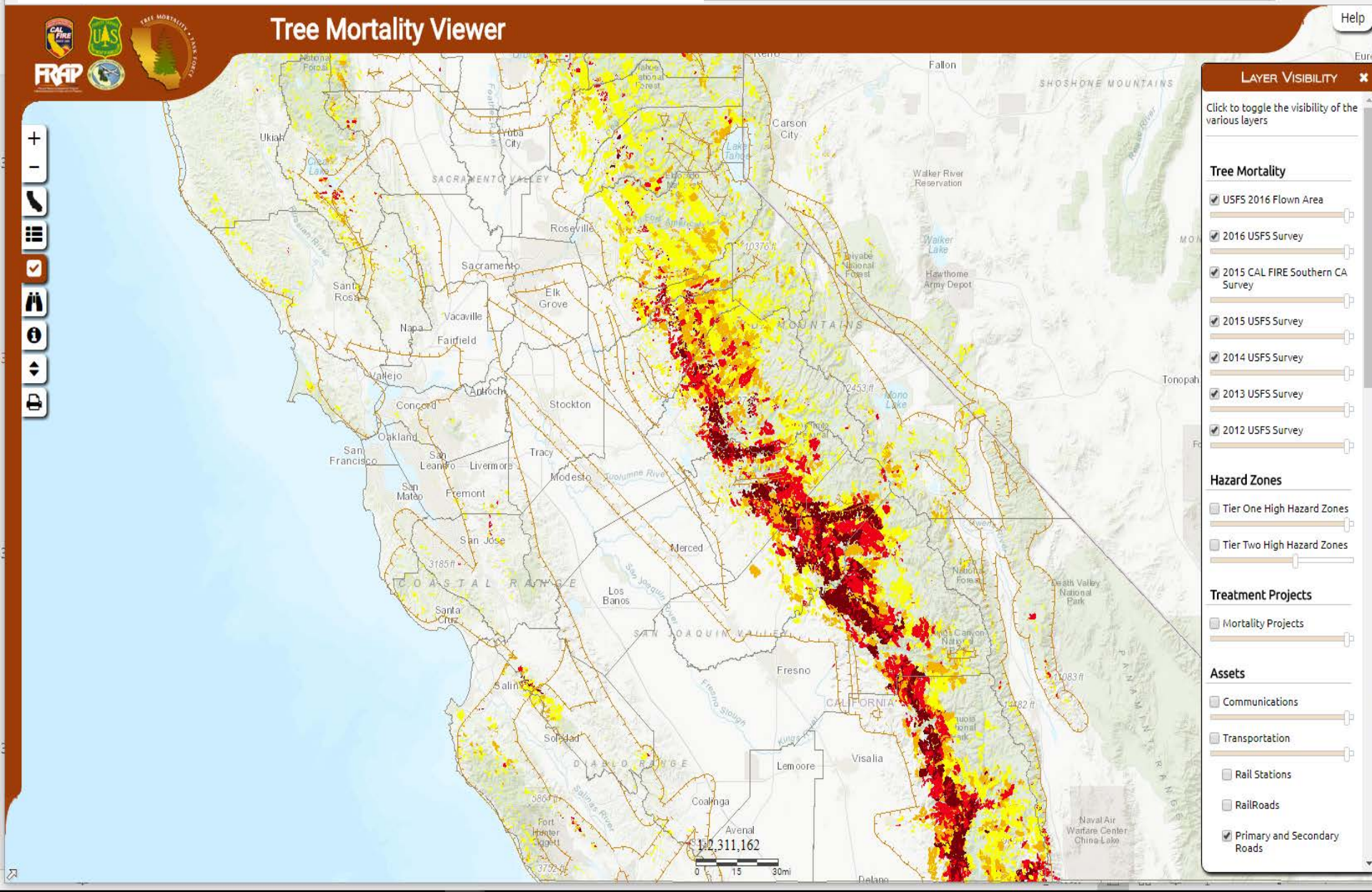
Location in Madera County before and after tree mortality began spreading.
Photos: Margarita Gordus, CA Department of Fish and Wildlife

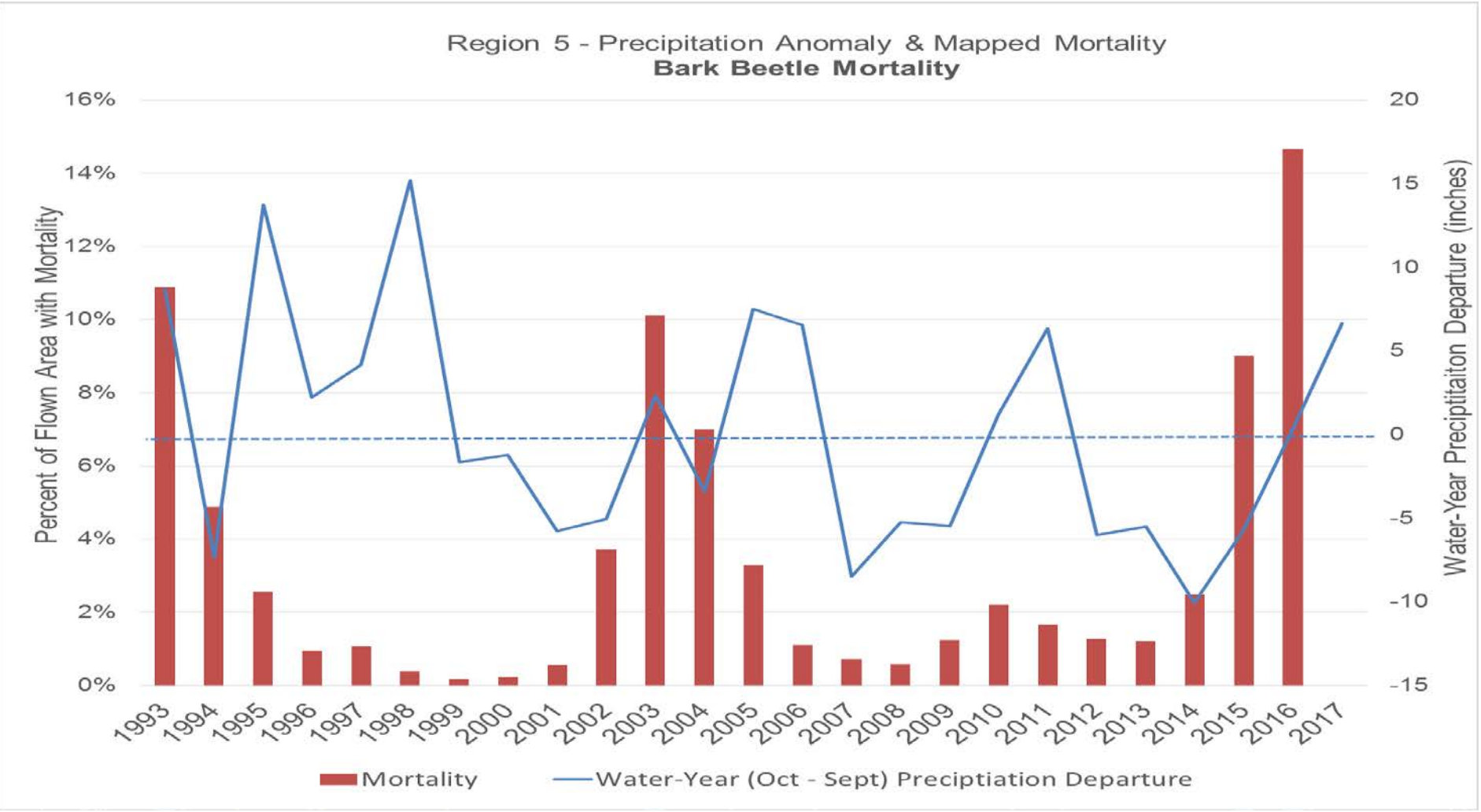
http://egis.fire.ca.gov/TreeMortalityViewer/



Mortality is being caused by native beetles

- Bark beetles are opportunistic, attacking trees weakened by other agents or factors including
  - Drought
  - Disease/infection
  - Injury (including fire)
  - Other insects
- Bark beetles affecting different trees are mostly of different species
  - Pines – western pine beetle, pine engraver, Jeffrey pine beetle
  - Firs – fir engravers
  - Cedars – most mortality is probably directly due to drought
- Bark beetles attack only mostly living trees (different beetles attack dead trees – wood borers)

Bark beetle outbreaks follow precipitation patterns



Bark beetles are tiny insects - the size of a grain of rice

Western pine beetle has been the primary insect killing ponderosa pines

Bark Beetles attack specific locations

- Bark beetles specialize by location on the tree – top, middle, and base.
- Beetles attacking the top and bottom of pines rarely kill the tree by themselves

Pine Engravers
Woodborers

Western Pine Beetle;
Mountain Pine Beetle;
Jeffrey Pine Beetle

< 6 inches/horizontal:
- Pine engravers

Woodborers

Red Turpentine
Woodborers

Indicators of attack

- **Boring dust**
  - Mix of bark/wood shavings and frass (excrement)
- **Pitch tubes**
  - Resin accumulation at point of attack

Western Pine Beetle

(*Dendroctonus brevicomis*)

- Attacks and kills ponderosa & coulter pine
- Attacks midtrunk, then spreads up and down; may attack in conjunction with other pests
- 2-4 generations / year
- Adults fly late spring-late Oct

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 lodgepole, ponderosa, sugar, and western white pines
- Generally attacks mid to lower trunk
- 1-2 generations / year
- Adults fly May-Oct

Tree trying to “pitch out” attack

Jeffrey pine beetle

(Dendroctonus jeffreyi)

- Attacks only Jeffrey pine
- Much larger beetle than the mountain or western pine beetle
- Attacks large trees midtrunk
- Emerge as early as April
- Up to 2 generations / year
- Long J-shaped galleries
- 2nd generation larvae may overwinter, emerge in Spring

Red Turpentine Beetle

(Dendroctonus valens)

- Attacks a variety of conifers, but most problematic to sugar and ponderosa pines
- Attacks low on trunk
- Creates large pitch tubes
- Not primary killer
- One generation / year is typical but the life cycle may be longer or shorter depending upon location
- In warmer parts of the state, attacks may be initiated at nearly any time of the year, although most attacks occur in the spring and summer

Pine engraver

(*Ips paraconfusus*)

- Attacks pine trees & green slash
- 1 to 5 generations / year
- Adults fly spring-fall
- Attacks pines near top of trunk; makes wishbone-shaped galleries
- **Can breed in slash and firewood left untreated**

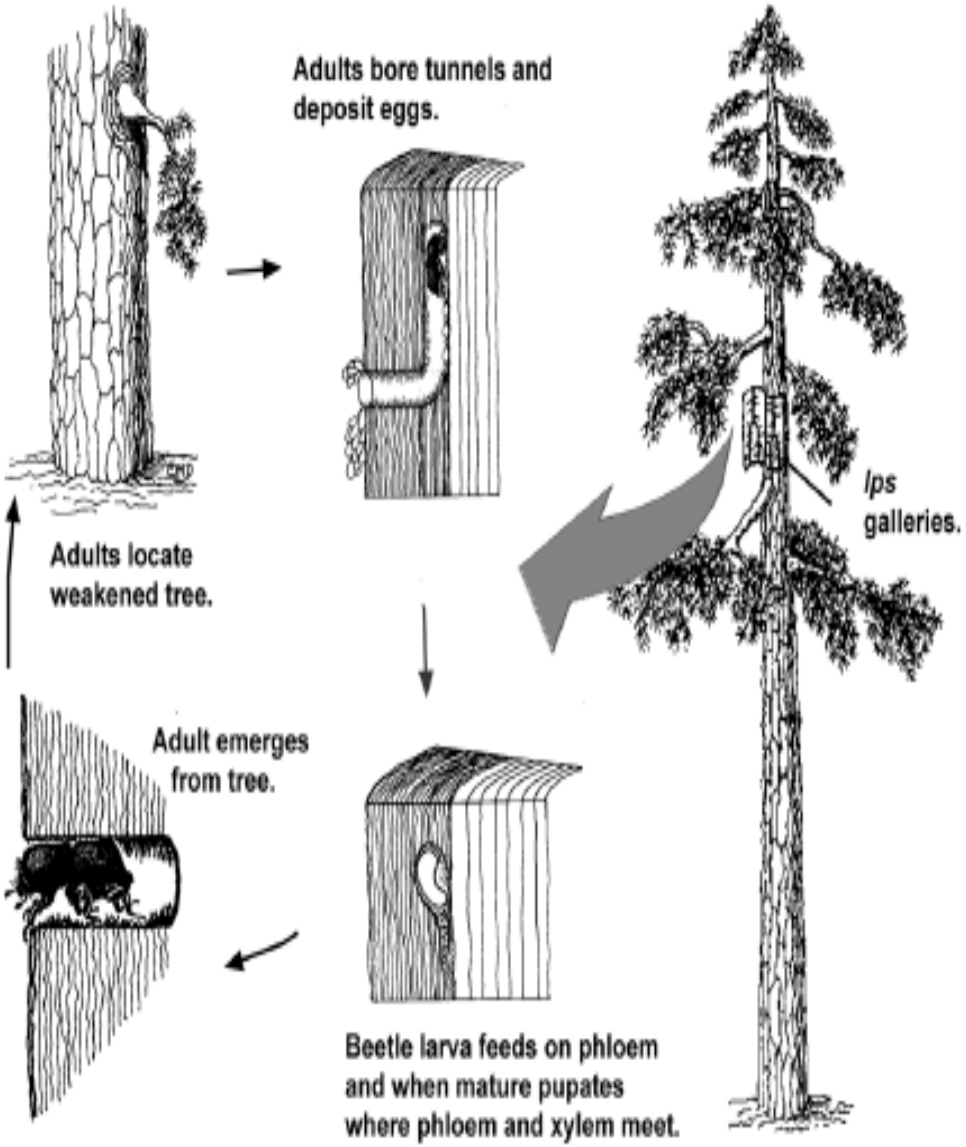
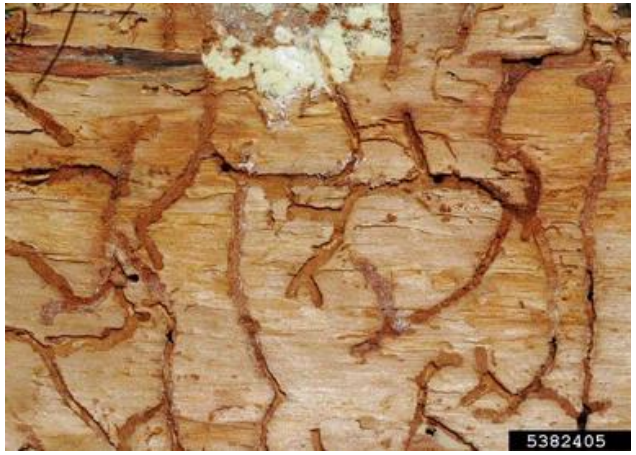


Figure 3. Life cycle of the California fivespined ips, an engraver beetle.

Fir engraver (*Scolytus ventralis*)

- Attacks white and red fir
- No pitch tubes
- 1 to 2 generations / year
- Overwinter as larvae; adults excavate deep and long, two-armed galleries across the grain of the sapwood

Each bark beetle species has a characteristic gallery pattern



Western Pine Beetle

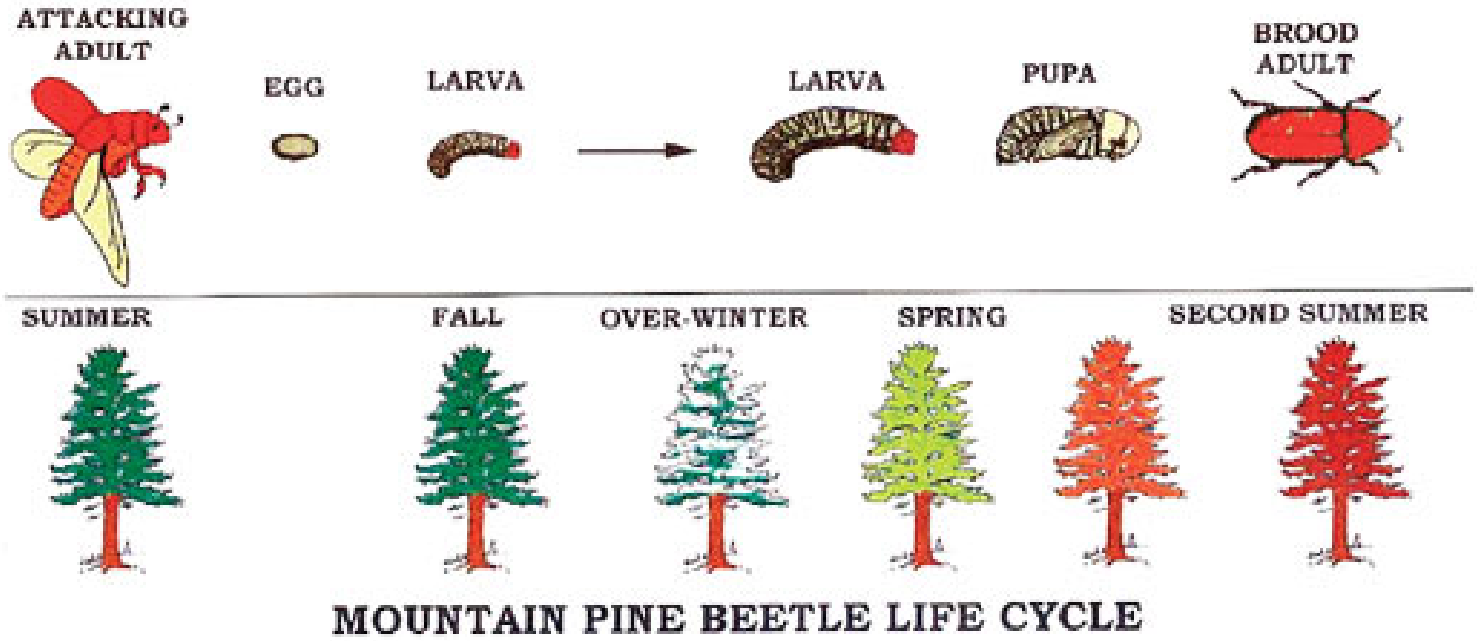
Mountain Pine Beetle

Fir Engraver

Pine Engravers

Beetle life cycle

- Beetles burrow into the bark and dig galleries to lay eggs in. This girdles the tree and kills it.



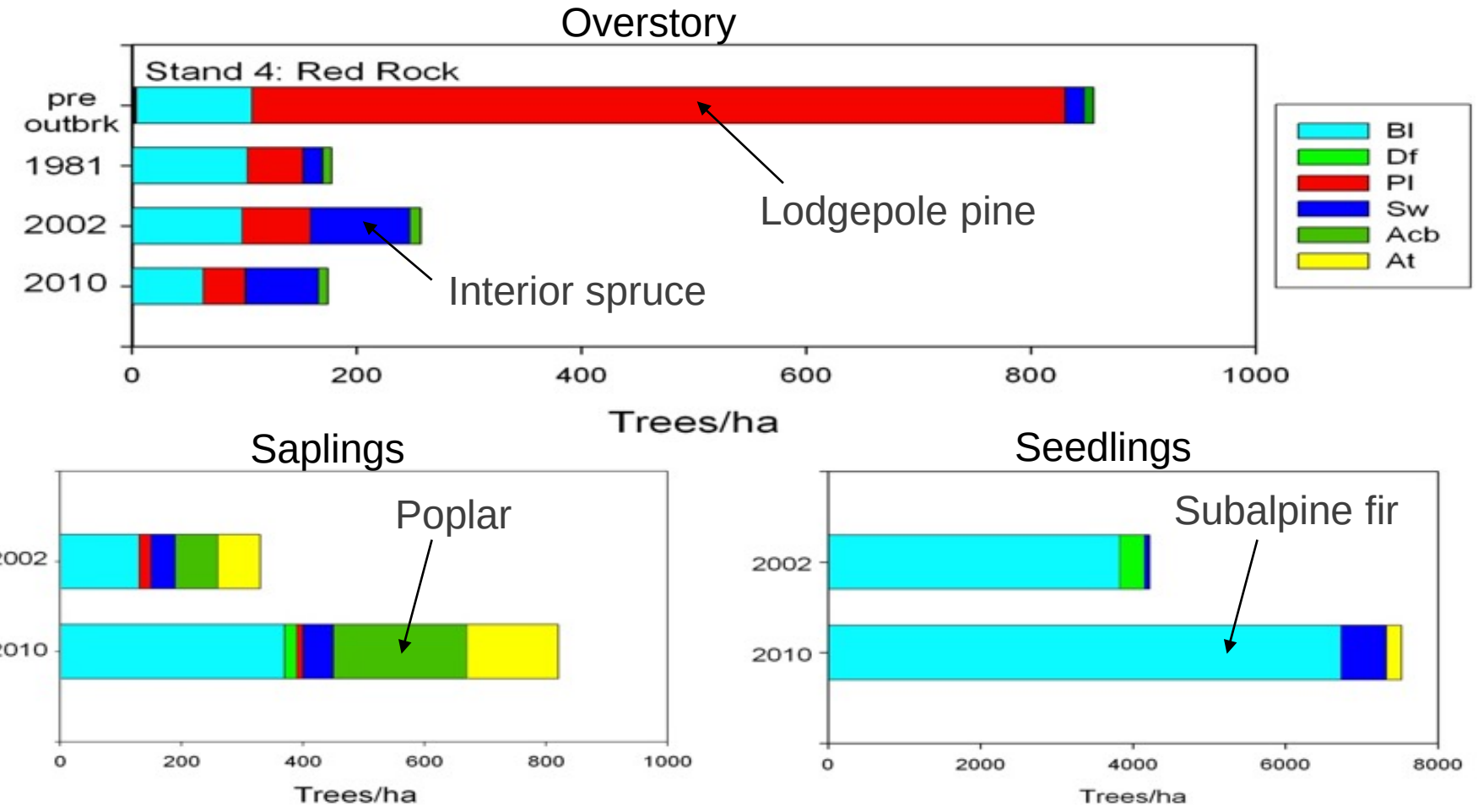
MOUNTAIN PINE BEETLE LIFE CYCLE

Western Pine Beetle produces several generations/year

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

In British Columbia – mountain pine beetles shifted forest from mostly lodgepole pine to mostly spruce and fir



Axelson et al. in preparation

93% Overstory Mortality

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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

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

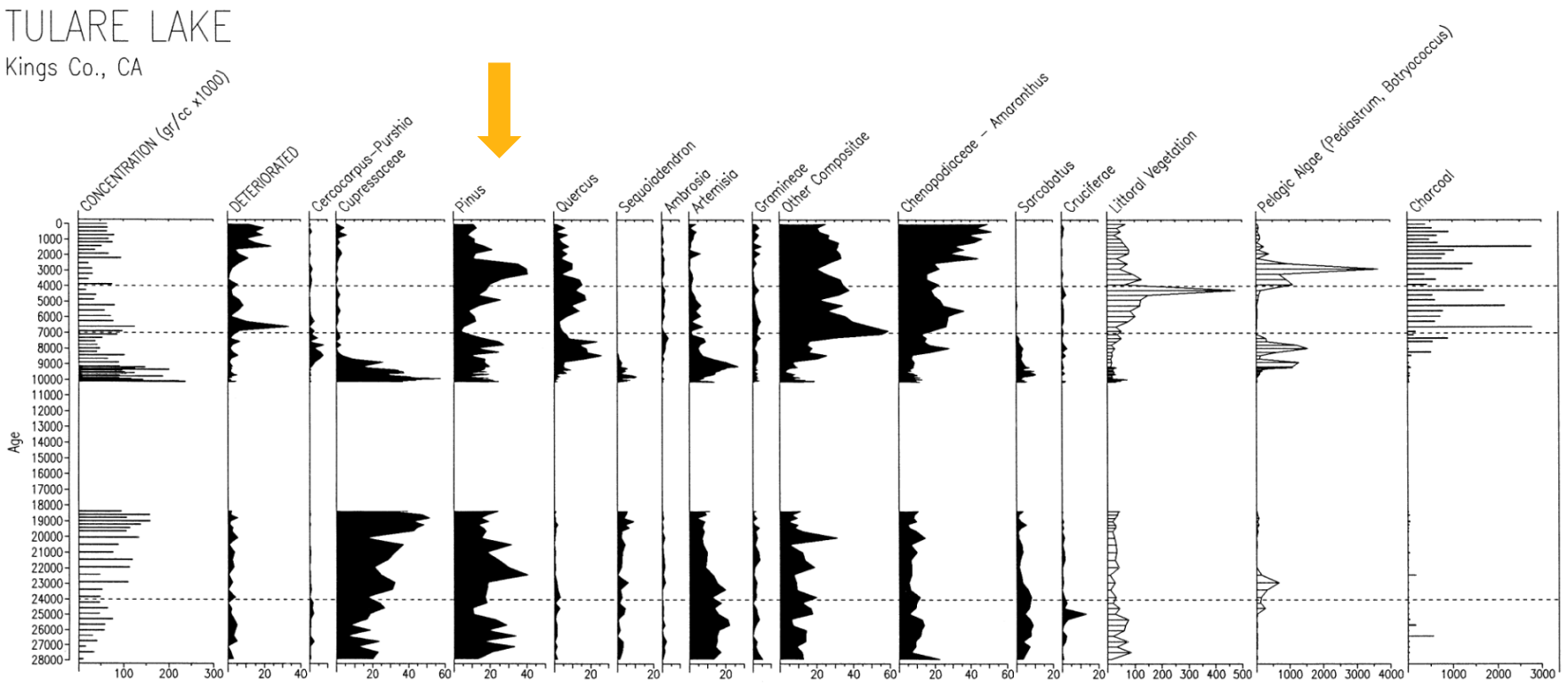


Fig. 3. Percentage pollen diagram for selected (abundant) palynomorphs from Tulare Lake core 2. Types right of Cruciferae are not included in the pollen sum (divisor for pollen percentages). Horizontal lines denote important events in the record (not zone boundaries) the lowest line at 24,000 yr B.P. 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

Nurture existing trees

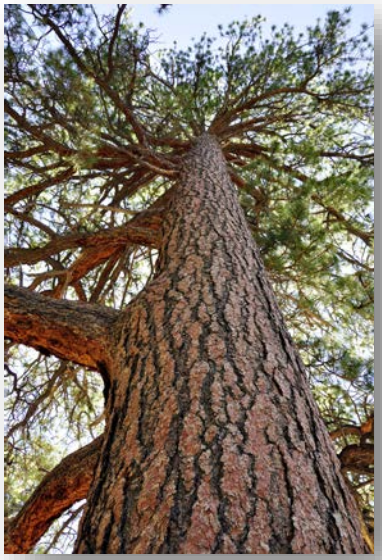
- If you have a significant number of trees left, you may not need to replant.
- Thin trees so that available sun and soil moisture is focused on the healthiest trees.
- Water where trees are receiving more sun to reduce stress.
- Clear out competing shrubs, grass and other vegetation.
- Digging up natural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

Replanting

- Spacing – at least 10-14 feet apart.
- Defensible space – Trees and flammable vegetation should be kept at least 5 feet from the home and thin within 30 feet.
  - 30-100 feet zone, trees should be widely spaced so their crowns don't touch when mature. Trees can fill in to a more natural looking forest 100 feet from the home.
- Power line clearance - Trees should be planted at least 10 feet from power lines and other utility lines.
- Road right of way - Trees should not be planted within the road right away.
- Sun availability – Plant pines where there is now a lot of sun. Future solar energy generation should also be assessed before planting.
- Views – Consider future views and don't plant tree that will block them.

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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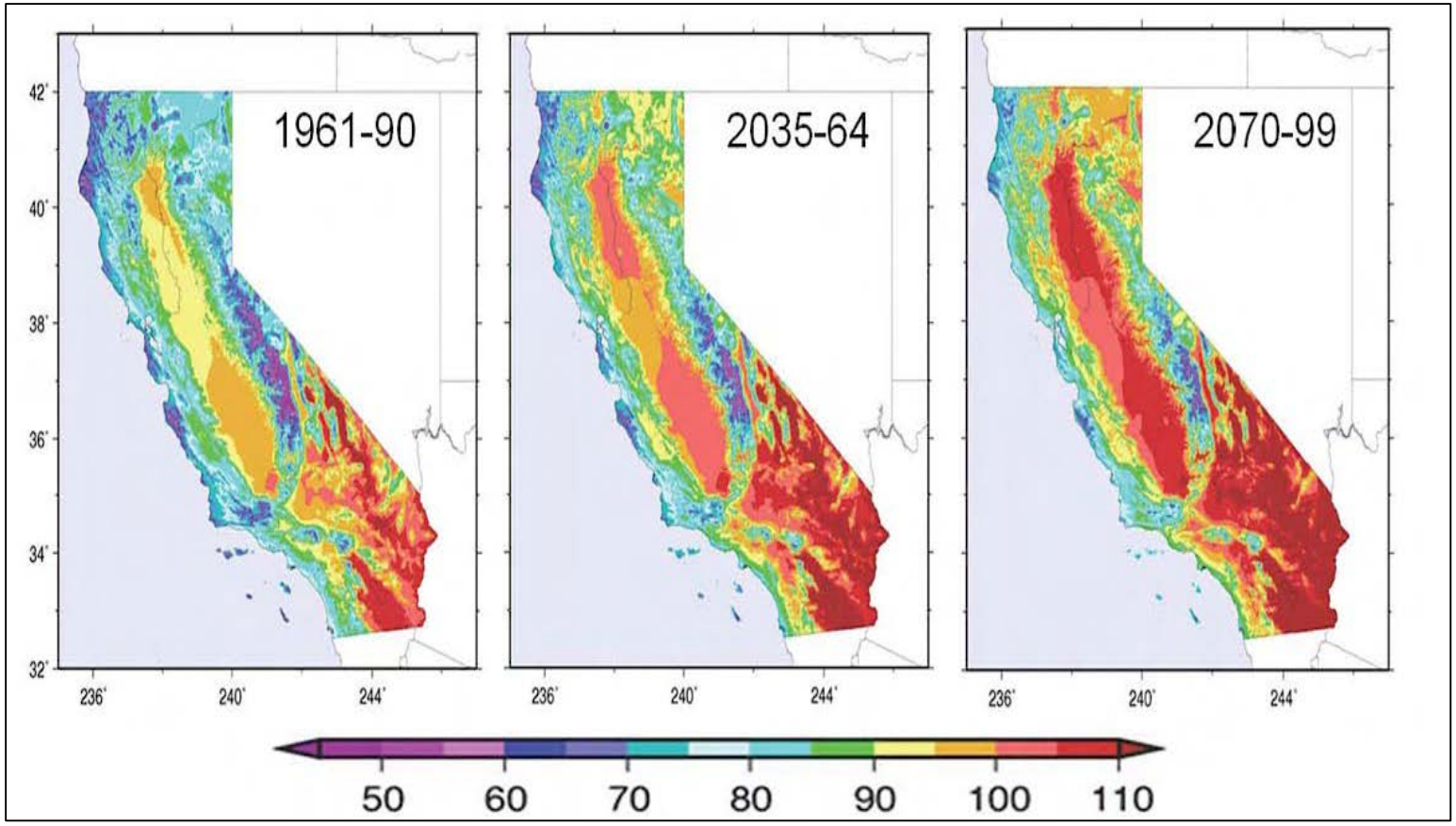
Replanting tree choices

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



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

Climate Zone: / Species	10 Riverside	11 Yuba City	12 Stockton	13 Fresno	14 Barstow	15 El Centro	16 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		•			•		

https://selectree.calpoly.edu/

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About SelecTree

Right Tree Right Place

Utility Precautions

Browse securely

SelecTree: A Tree Selection Guide

Search for trees Enter a tree name Search

- Tree Characteristics Glossary
- Search Help

> 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

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!

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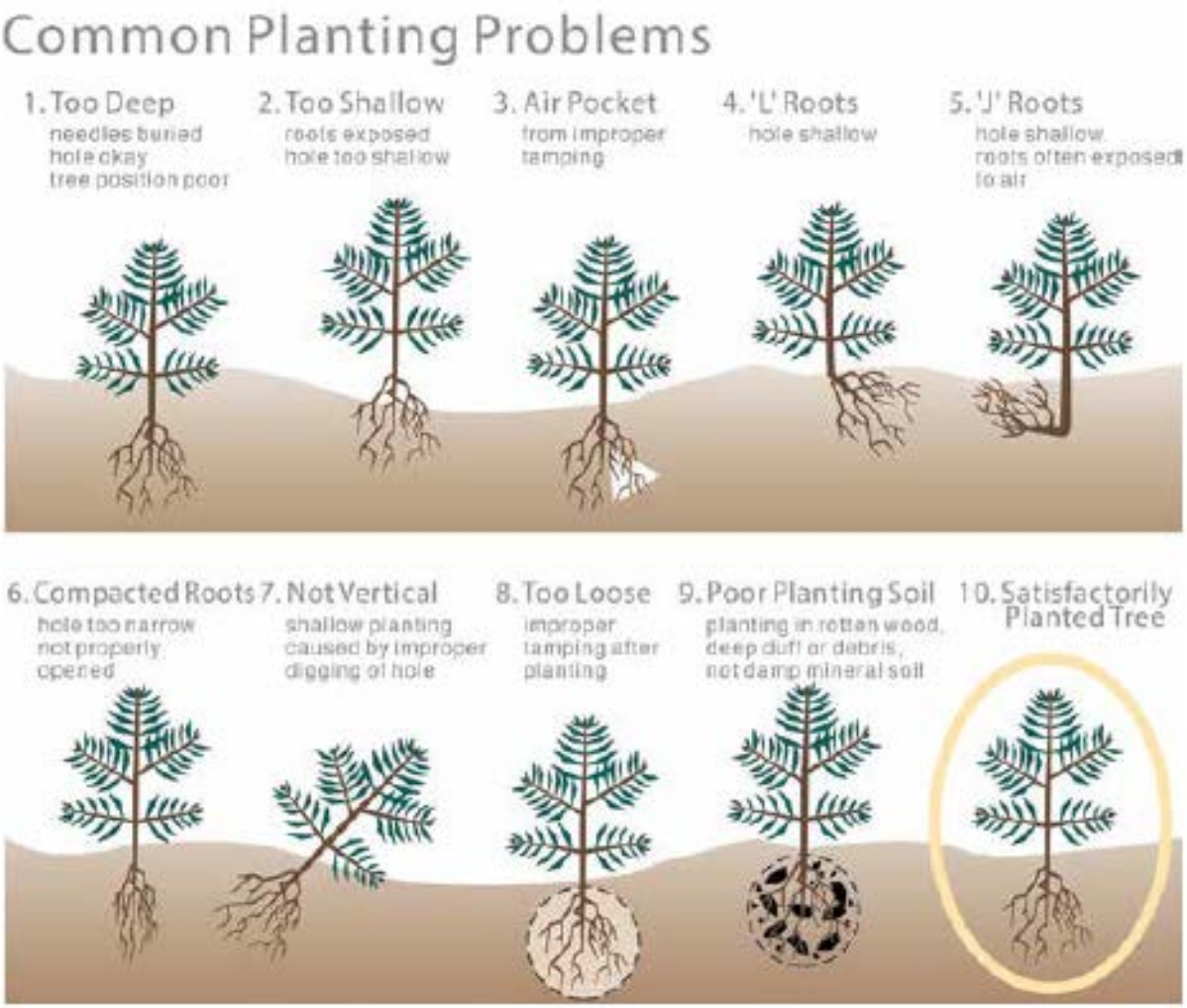
Replant – size options

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.



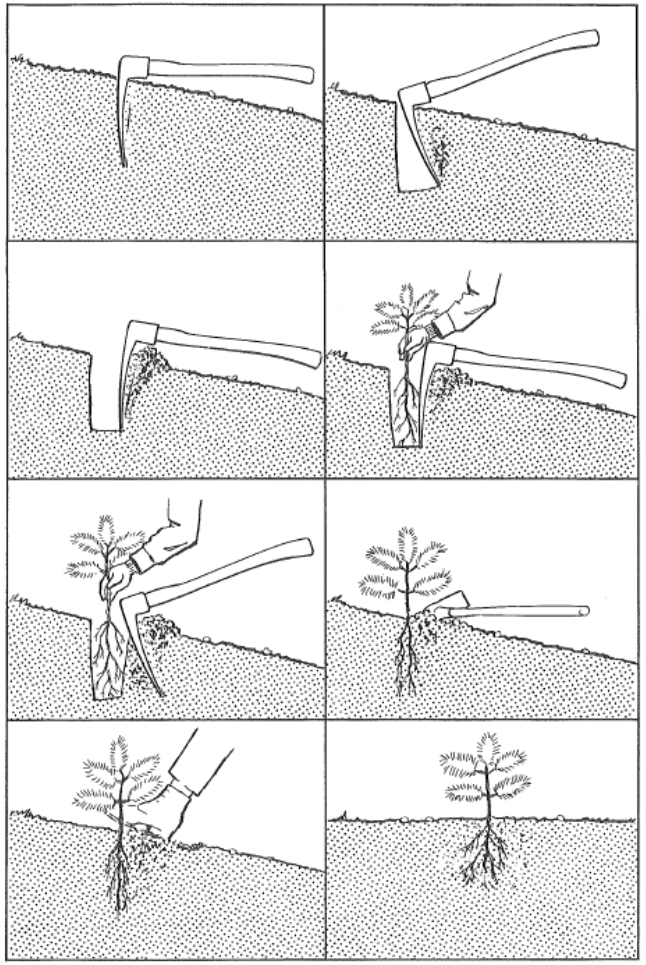


Figure 18. Steps in tree planting, using the western planting tool.

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

Landowner assistance programs

- USDA Natural Resources Conservation Service - Environmental Quality Incentive Program (EQIP)
- Farm Services Agency
- Your county Tree Mortality Task Fore
- CalFire - California Forest Improvement Program (CFIP)

USDA Natural Resources Conservation Service

EQIP

Forest Tree Mortality Fund Pool

- The purpose of the Forest Tree Mortality EQIP Fund Pool is to provide immediate resource protection in drought-affected conifer forestlands where elevated levels of forest insect tree mortality has occurred or where forest insects are an imminent threat to forestlands. Visit the ***Forest Tree Mortality webpage*** for more information.

CalFire - California Forest Improvement Program

CFIP

- Reimburse landowners 75% to 90% of cost for allowable activities:
  - Management plan development, registered professional forester supervision, site preparation, reforestation, tree shelters, pre-commercial thinning, pruning, release, follow-up, habitat improvement/land conservation/ wildlife/ fisheries.
  - Landowners must have 20 acres minimum private forestland that can support at least 10% native tree canopy.
  - Landowner must agree to keep in forest for a minimum of 10 years. Requires the RPF and CAL FIRE Forestry Assistance Specialist (FAS) to work with the landowner. Visit the CalFIRE site for more information.

Local Task Forces

- Add information about what local task forces may be offering in your county.

Acknowledgements

This program has been sponsored by the University of California Division of Agriculture and Natural Resources along with the University of California Master Gardener Program.

Presentation

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