



# Bark beetle mortality – what to plant next

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# Presentation Goals

- Why is this happening - background on drought in the Sierra
- What is happening - overview of mortality in Sierra
- What can we do about it – depends on scale
- What comes next – to plant or not at neighborhood/ landscaping scale



# Why is this happening?

- Bark beetles successful due to forest condition and drought
  - 100 years of fire suppression has led to overcrowded forests
  - Warm drought caused moisture stress so trees couldn't defend themselves

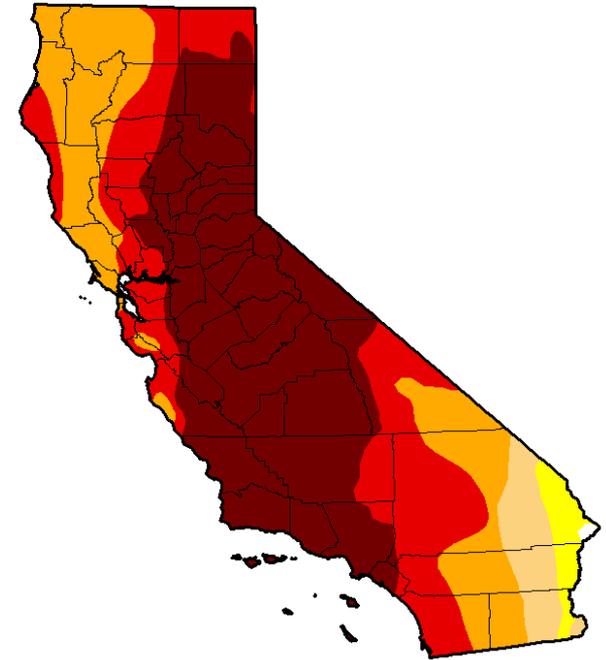


# Warm drought

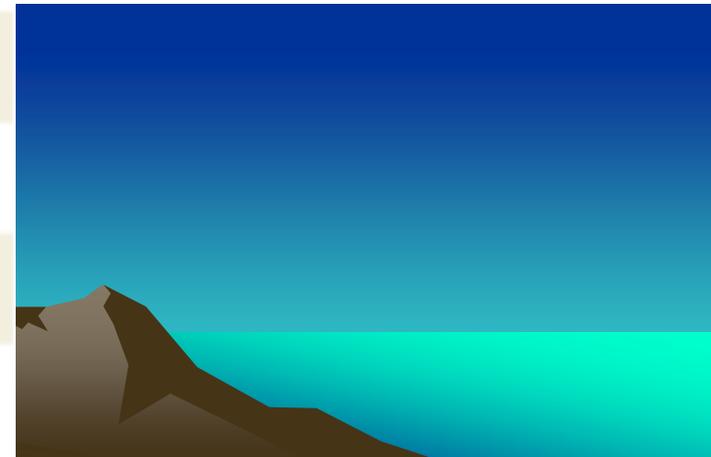
## Drought Intensity:

- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)

October 27, 2015



Week	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current <a href="#">2016-10-25</a>	8.96	91.04	81.12	61.80	42.80	21.04
Last Week <a href="#">2016-10-18</a>	7.77	92.23	81.12	61.80	42.80	21.04
3 Months Ago <a href="#">2016-07-26</a>	0.00	100.00	83.59	59.02	42.80	21.04
Start of Calendar Year <a href="#">2015-12-29</a>	0.00	100.00	97.33	87.55	69.07	44.84
Start of Water Year <a href="#">2016-09-27</a>	0.00	100.00	83.59	62.27	42.80	21.04
One Year Ago <a href="#">2015-10-27</a>	0.14	99.86	97.33	92.27	71.08	46.00



# Moisture stress to trees

**Canopy Water Content (CWC)** is total amount of liquid water in foliage of canopy

- correlated with leaf water potential under stress
- indicator of progressive drought effects on canopies
- Indicator of vegetation flammability
- Liters/square meter canopy

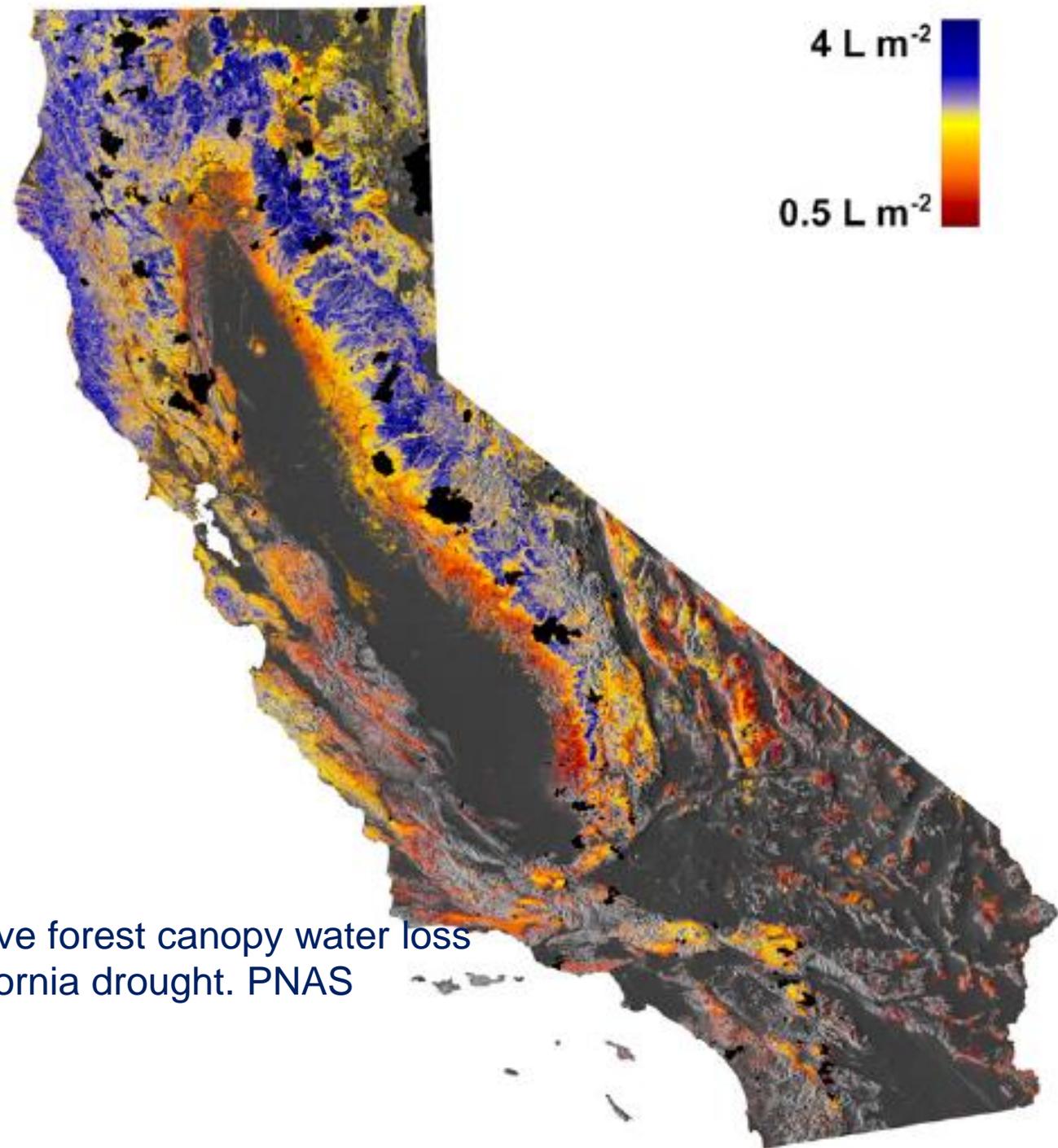
Carnegie Airborne Observatory (CAO) conducted laser-guided HiFIS high-fidelity imaging spectroscopy (HiFIS) + 3D forest imaging via light detection and ranging (LiDAR)

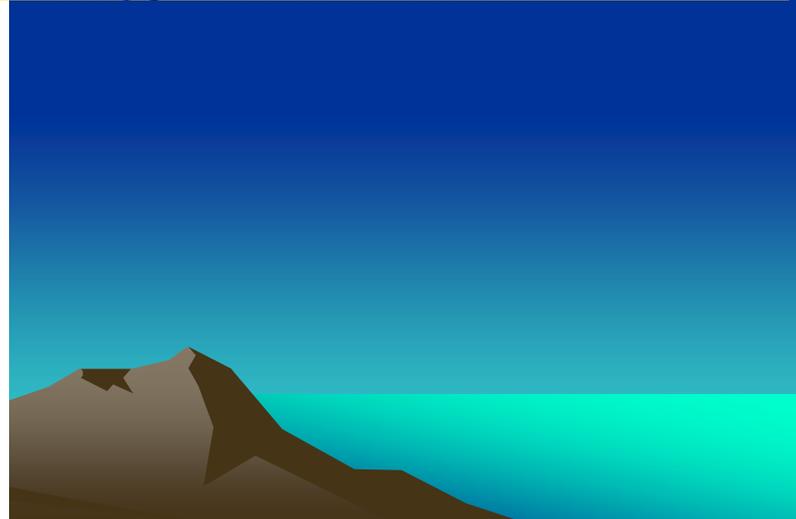
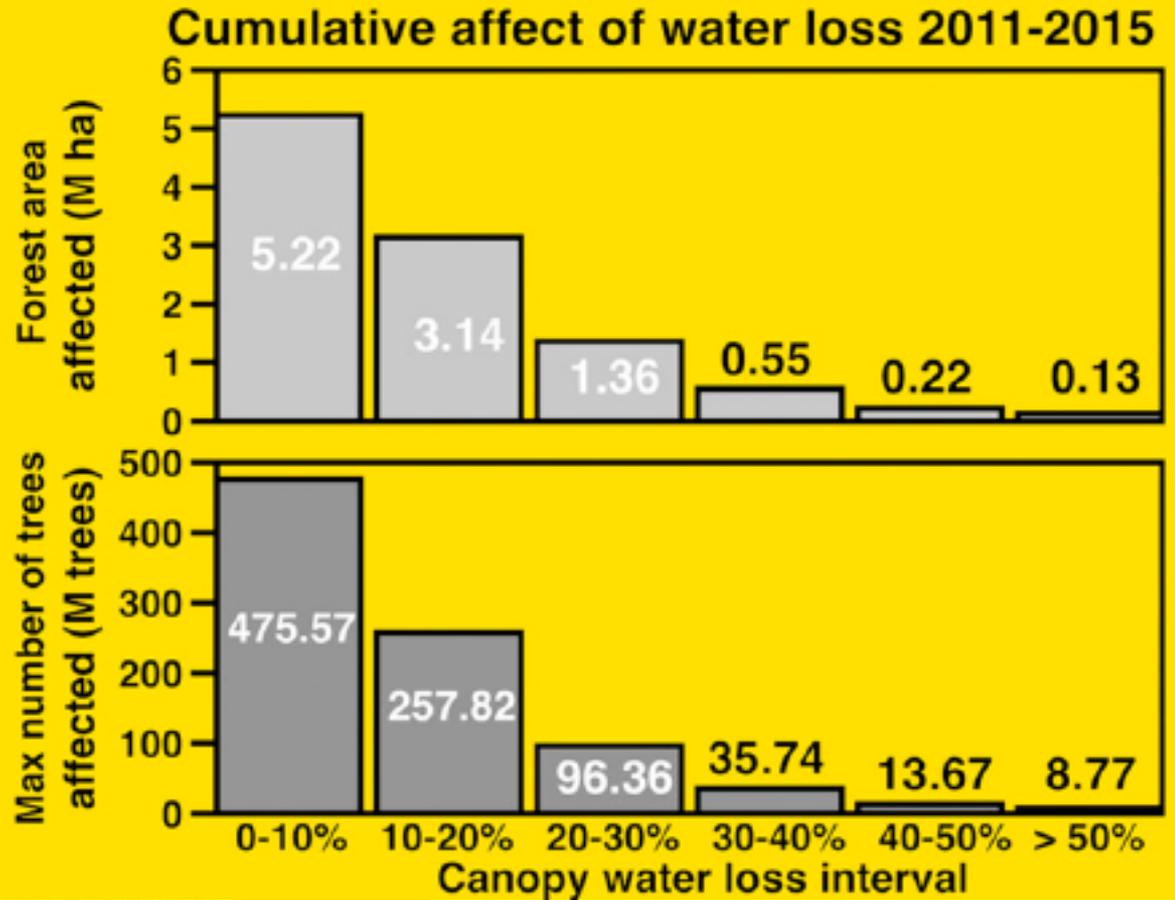
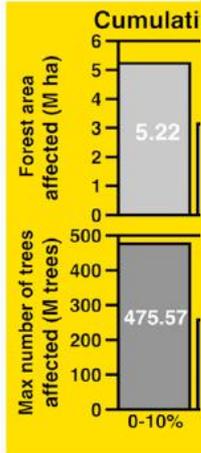
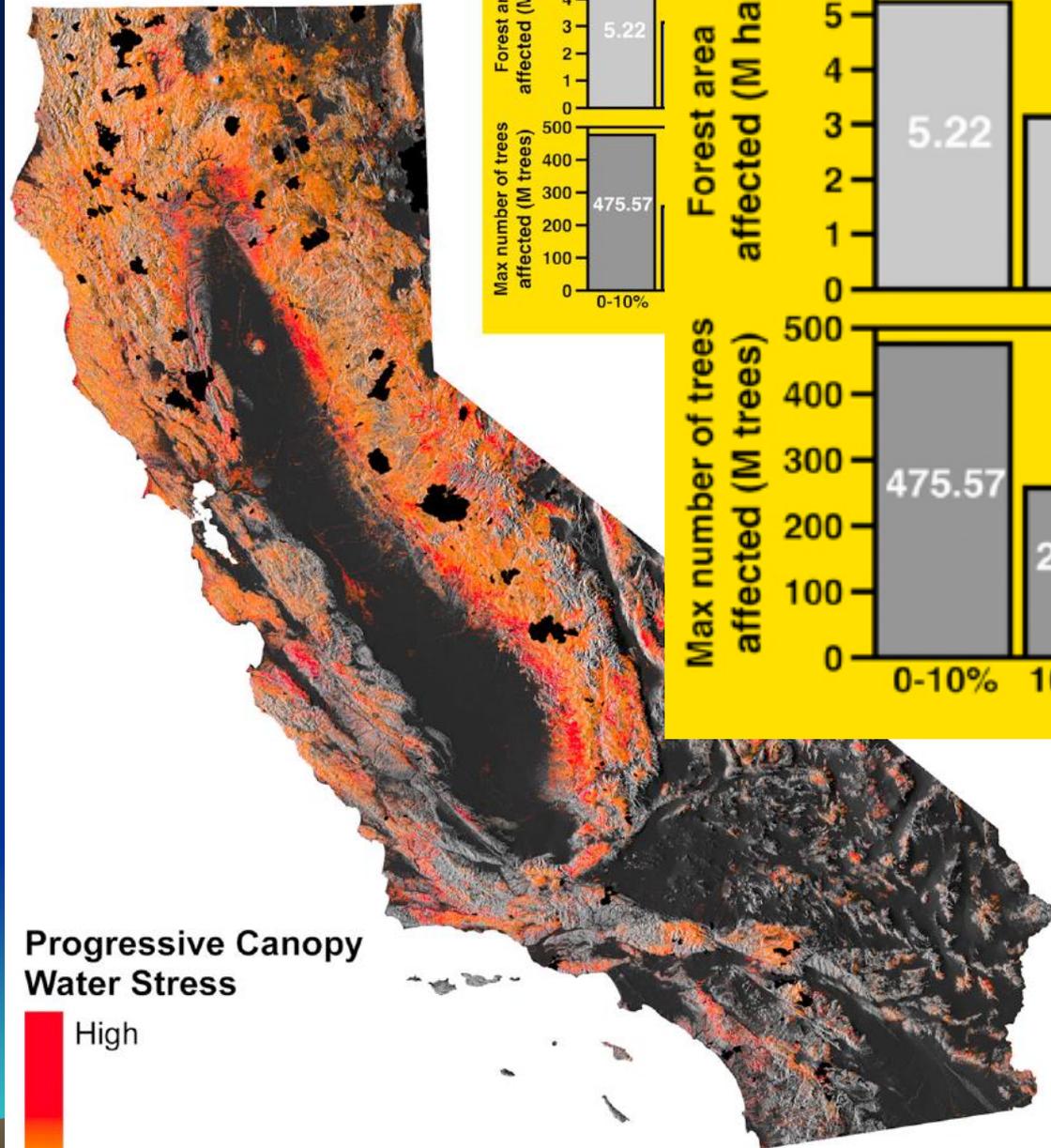


CWC in liters  
per square  
meter in August  
2015.

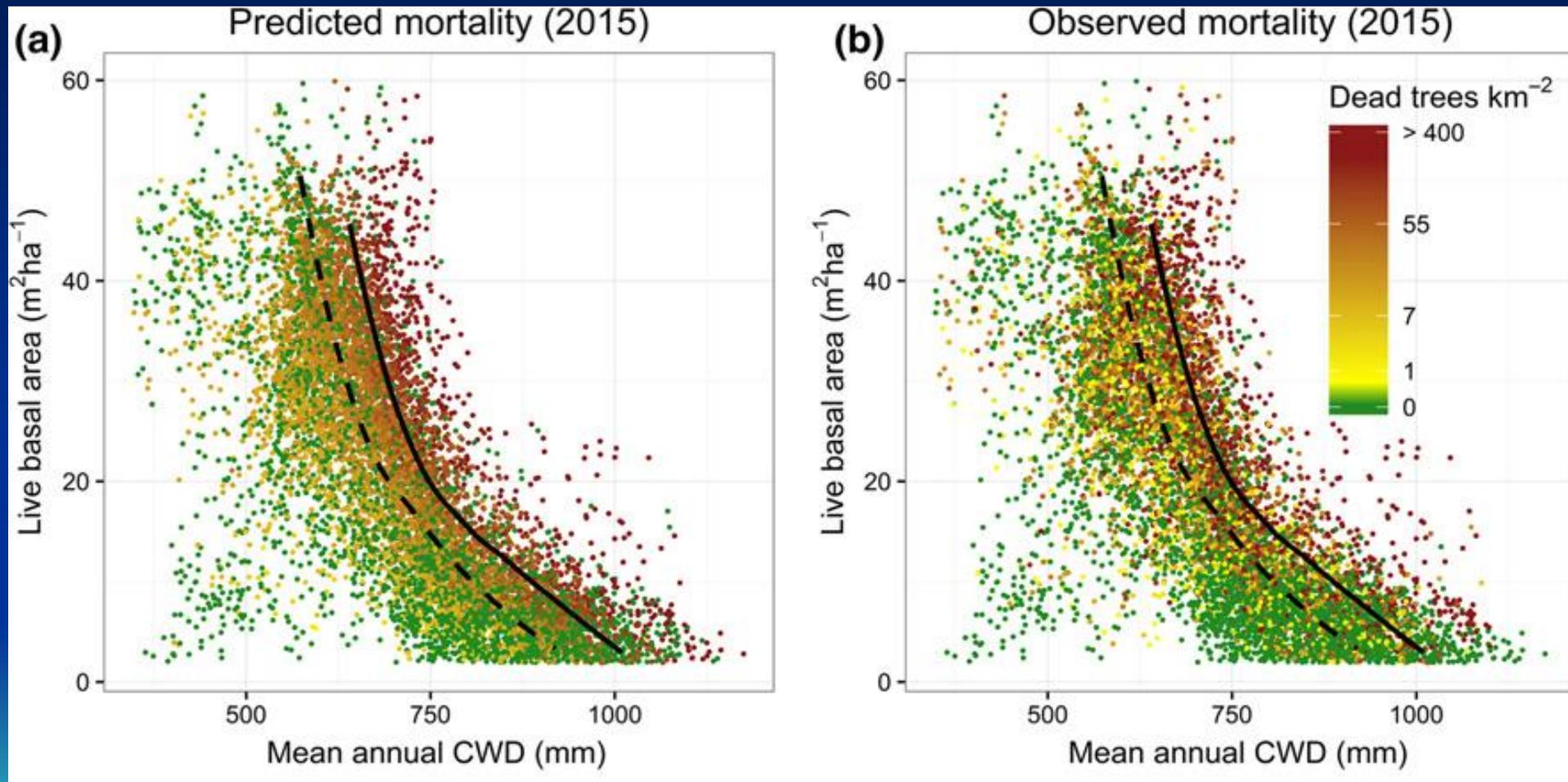
Black areas  
indicate fires  
reported  
between 2011  
and 2015 by US  
Forest Service

Asner et al 2015. Progressive forest canopy water loss  
during the 2012–2015 California drought. PNAS



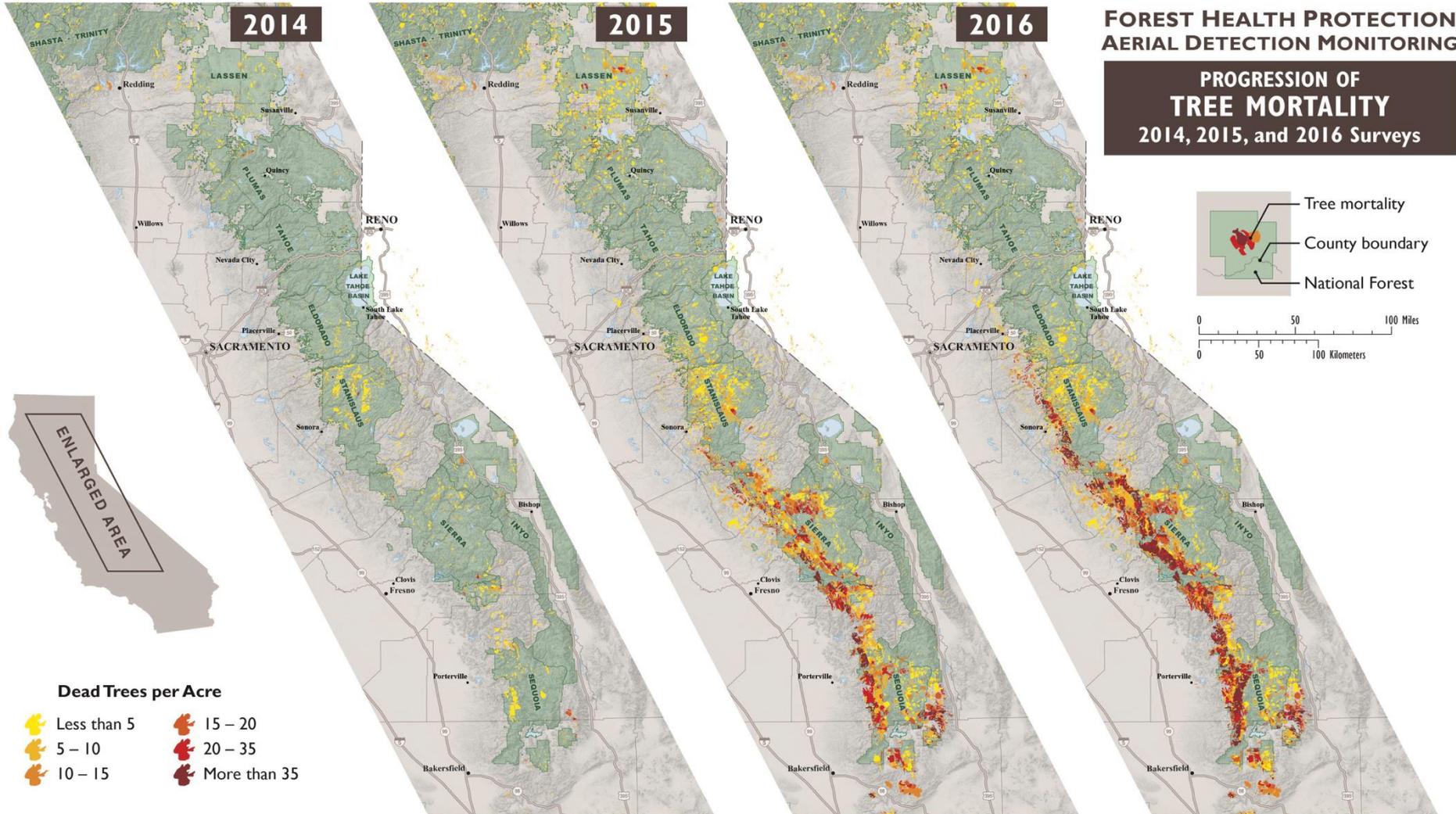


Mortality highest were trees at high density and climate water deficit the highest.

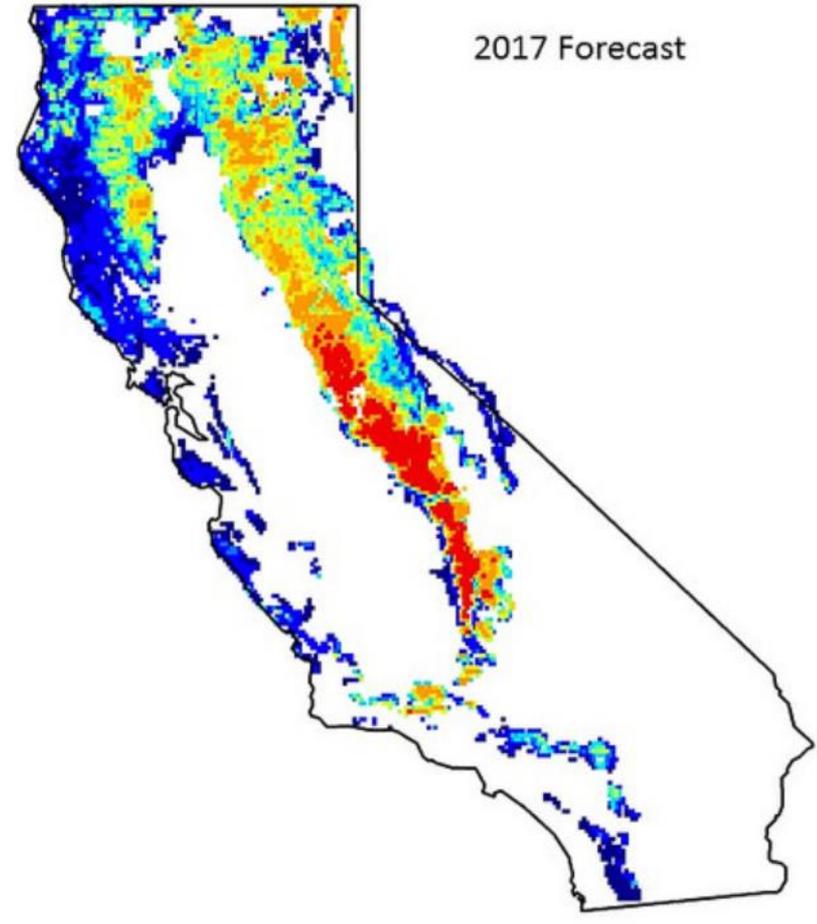
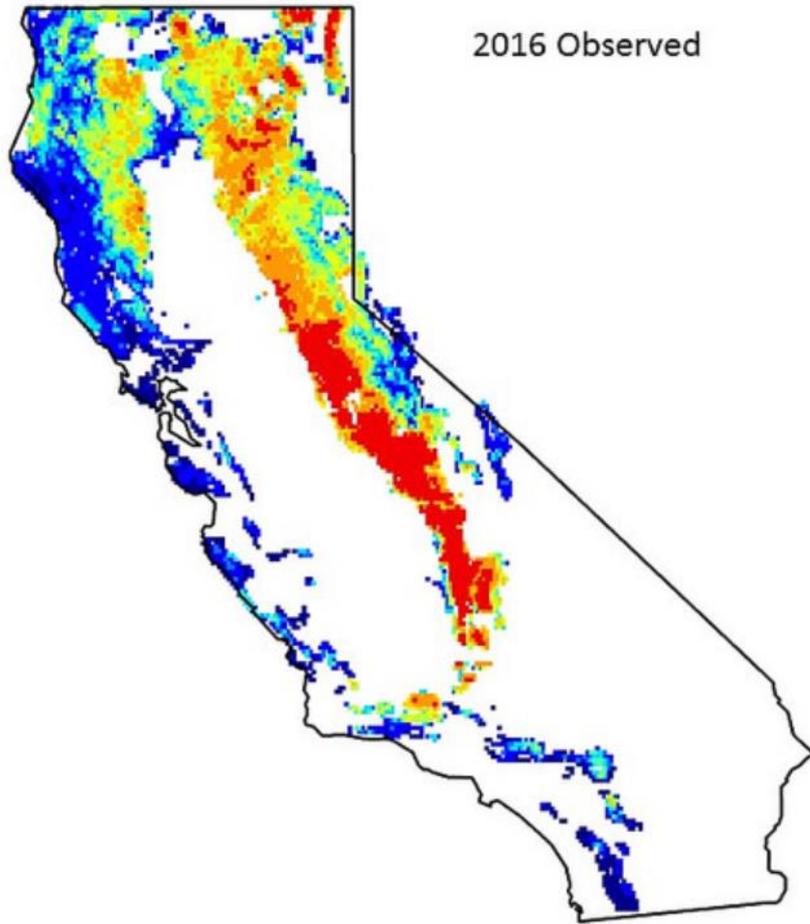


Young et al. Long-term climate and competition explain forest mortality patterns under extreme drought. *Ecology Letters*, (2017) 20: 78–86

# What is happening? Progression of mortality in CA



# 2016 observed mortality (left) 2017 forecasted mortality (right)



Map forecast suggests that bark beetle-caused mortality should subside in many parts of California

# What can we do to prevent mortality – depends on scale

- Forest scale
  - Plant species adapted to site, thin/ burn
- Neighborhood scale
  - Plant species adapted to site
  - Tree care and watering
  - Thin to appropriate density
  - Pesticides



# What species might remain

- 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
- 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



# Neighborhood scale options - nurturing existing trees

- Thin trees out to healthiest.
- Water in summer to counter stress
- Clear out competing shrubs, grass and other vegetation
- Digging up natural seedlings and moving them is not often successful



# If I need to replant - should I replant pines? YES

- Native trees best adapted to local climates (may not be tree in farthest south and lowest elevation part of range – may want to favor oaks instead)
- Have persisted in Sierra for 1000s of years
- Young trees not susceptible to beetles until 5 inches in diameter
- Pines may not regenerate well on their own



# What to replant - saplings



Much more expensive to purchase and maintain so best for select locations near the home for visual screening or wind breaks.

- Require soil amendments and weekly watering in the dry season for the first few years.
- May not gain that much growth for the money

# Seedlings



Container grown – much less expensive to purchase

- May require some care including watering during the dry season.
- Planted in the early spring or late fall during periods of high soil moisture.

Bare root – Least expensive option

- Do not require soil amendments or watering
- Planted during periods of high soil moisture.
- Least expensive option for planting numerous trees on large acreages.

# Oaks

Extend very deep roots in their first few years of growth thus are best planted using acorns gathered locally in the fall.

- Very inexpensive – can collect the acorns yourself
- Germination can be high if done right.



# Where to plant trees

- 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.
  - 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.
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Thank you! [sdkocher@ucanr.edu](mailto:sdkocher@ucanr.edu)

