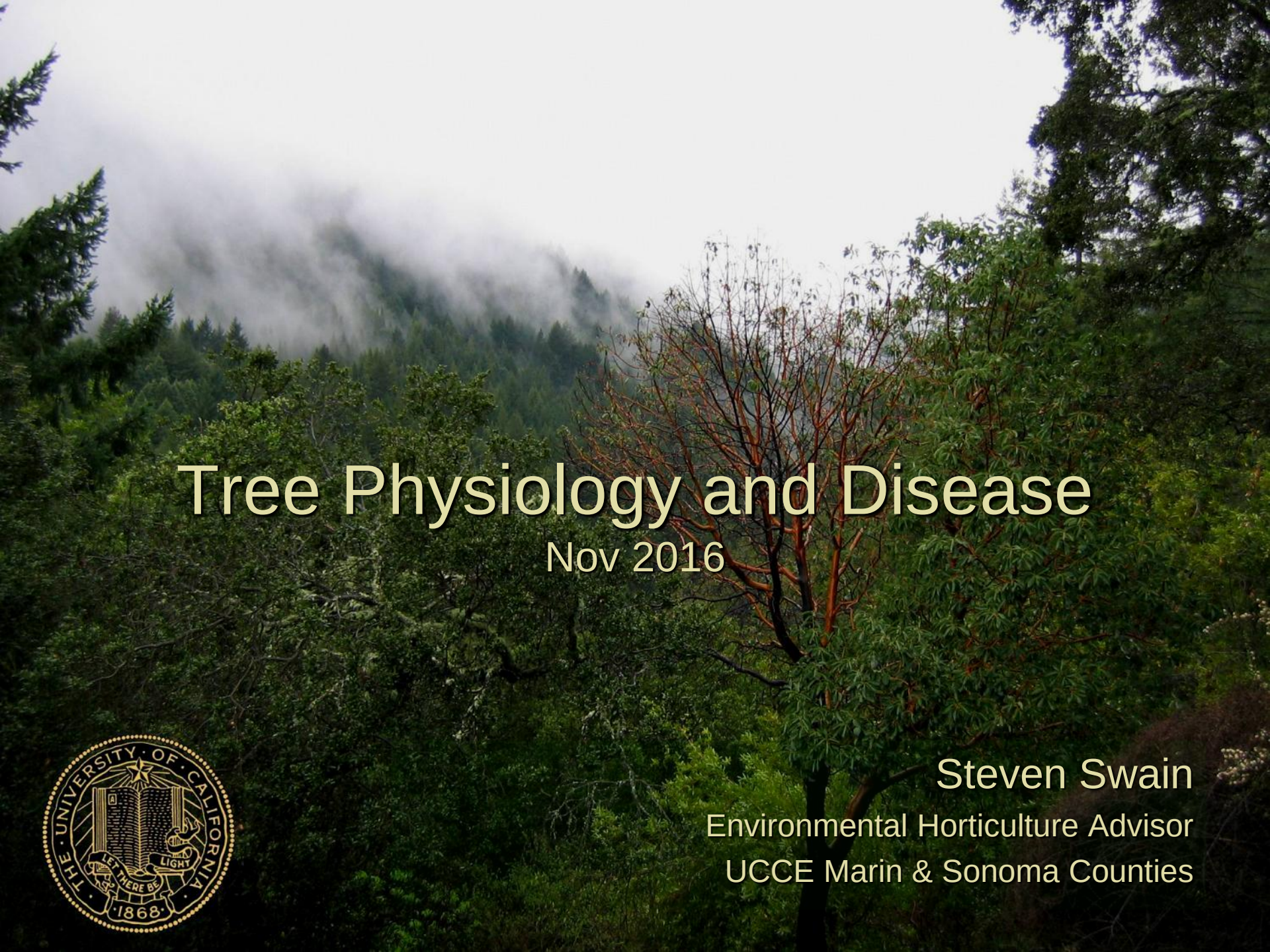

Tree Physiology and Disease

Nov 2016

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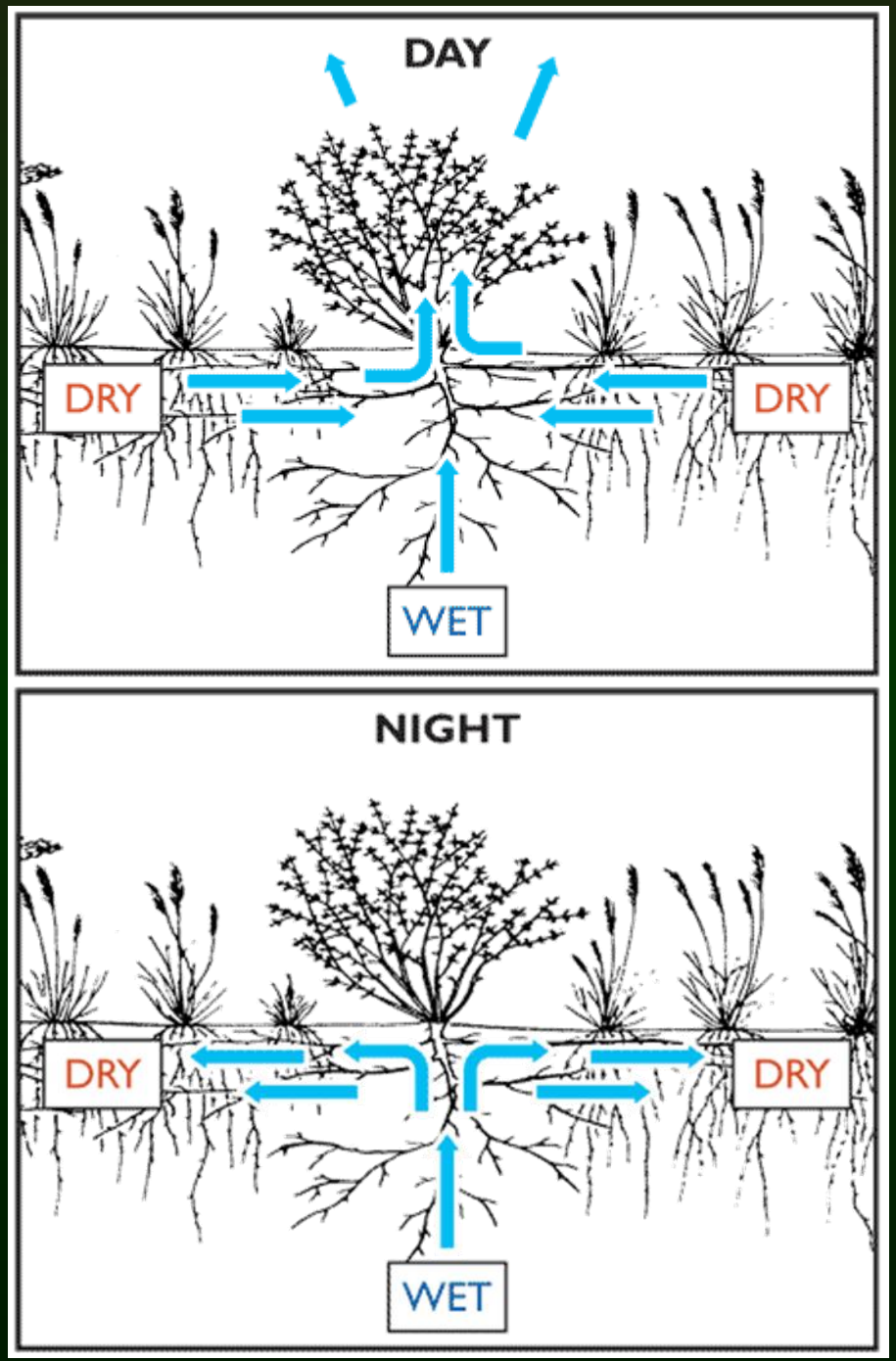
About this presentation …

- Mostly it's about big perennials
  - Expensive, and difficult to replace
    - Property value
  - Extensive root systems have an impact on the landscape
  - We'll be talking about trees, but many of the concepts will apply to other plants too

Water is Life

- Plant Physiology: All of the biological processes that allow a plant to function
- Plants make their food (sugars) from sunlight
  - Red and blue light drive two different photosystems
  - Green light reflected
- Plants metabolize these same sugars to live, grow, and reproduce
  - Must live within an energy budget
- All of this requires water
  - A lack of water requires tradeoffs



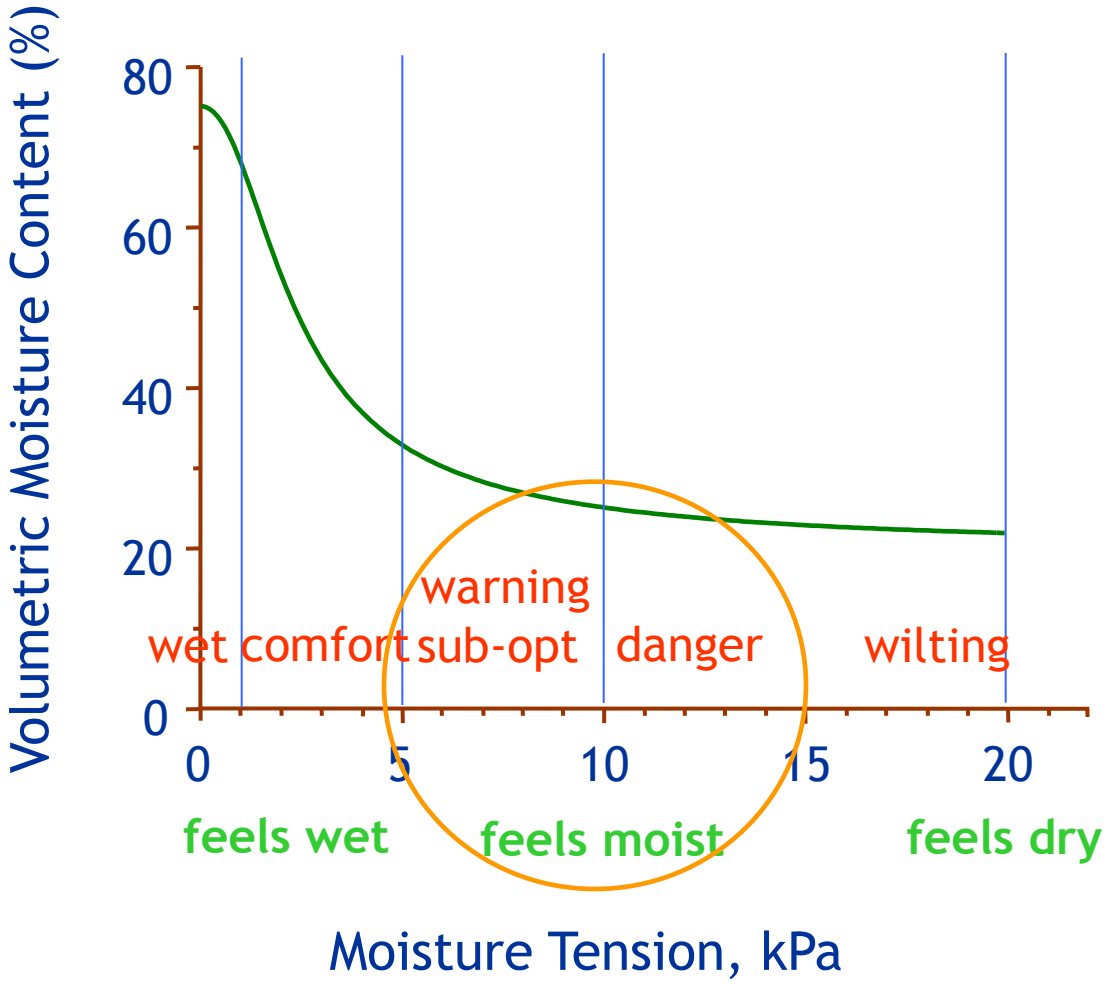
Trees as water managers

- Hydraulic lift
- Uptake from sinker roots during day
- Redistribution via mycorrhizae at night
- Soils 12” down stay moist
- Trees are usually the most valuable plants in a landscape
- Trees also alter internal water flows during fire

People as Water Managers

- Usually pretty good
  - … but not always
- All equipment fails
  - Underground
  - Irrigation at dawn
- Watering problems are among the most common landscape maladies

Moisture Retention Curve



- How people are able to sense moisture levels
- Note that clay soils may feel moist, but may already be suboptimal or dangerously low in water!

Graphic adapted from J.H. Lieth

Drought Effects (direct)

- Stomata close
- Cellular water loss
  - Leaves curl, wilt, and/or sunburn
  - Cell membranes pull away from walls

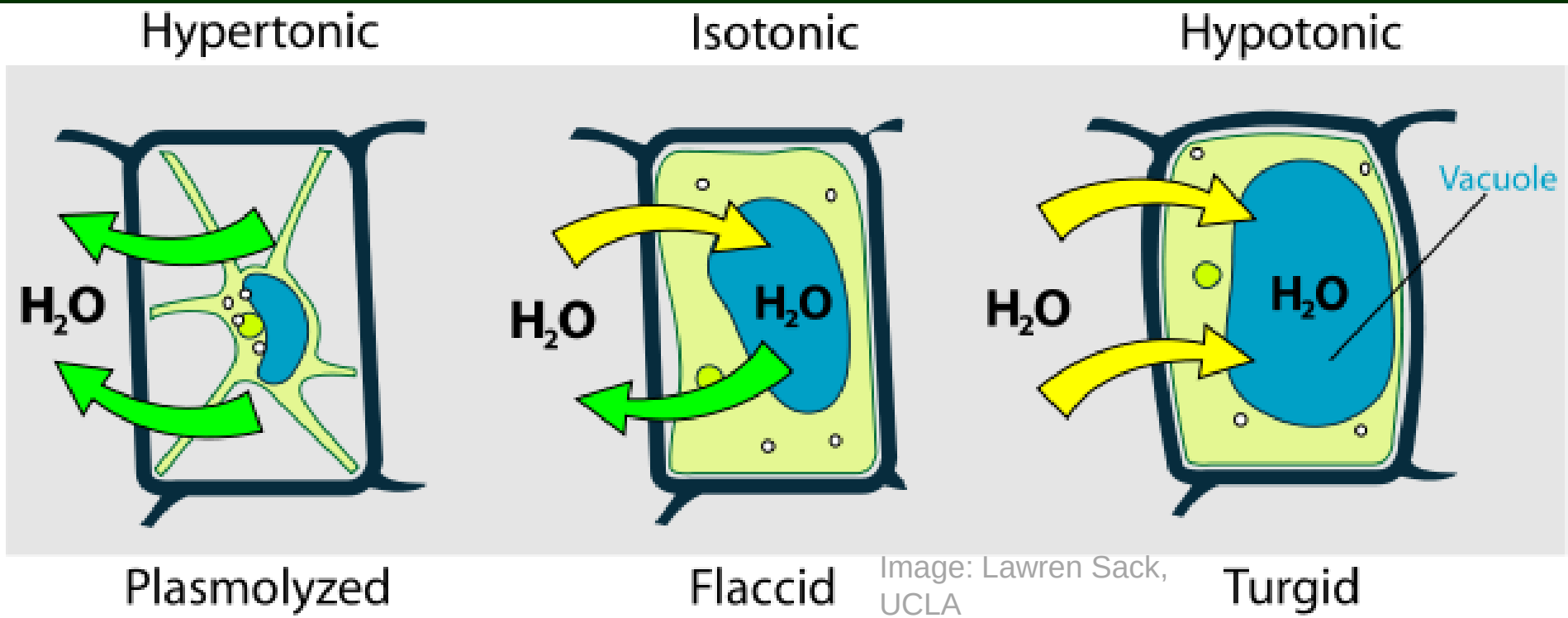


Image: Lawren Sack, UCLA

Photo courtesy Igor Lacan, UCCE Advisor

Drought Response

- Smaller leaves
- Abbreviated growth
- Trees “remember”
- Next years:
  - Fewer leaves
  - Budget (sugar) reallocation to roots
- “Stunted” above ground
  - Maybe bigger below ground!

Drought Response

- Feedback loops between
  - genes & environment
  - metabolism
  - production of:
    - drought specific metabolites
    - chemical defenses
  - may affect tree for life
- Water is key for sugar production
- No water, no defense
  - Sunburn
  - Pests & pathogens
  - Fire

… e.g. …

- Redwood
- Mid summer
- Oakland
- Interior needles browning
- One picture
- Pathogen
  - *Botryosphaeria?*
  - *Phytophthora ramorum?*
  - *Cercospora?*
- Insect
  - Something chewing interior twigs?
- Abiotic
  - *Drought stress?*

Leaf (and needle) strategies

- Deciduous
  - One season
  - Metabolically “cheap” to produce
  - Leaf pathogens gone at end of year
  - Plant must store next year’s leaf energy
  - No photosysnthesis during dormancy
  - Leaf shed very obvious
    - All at once
      - Fall
      - Summer

Leaf (and needle) strategies

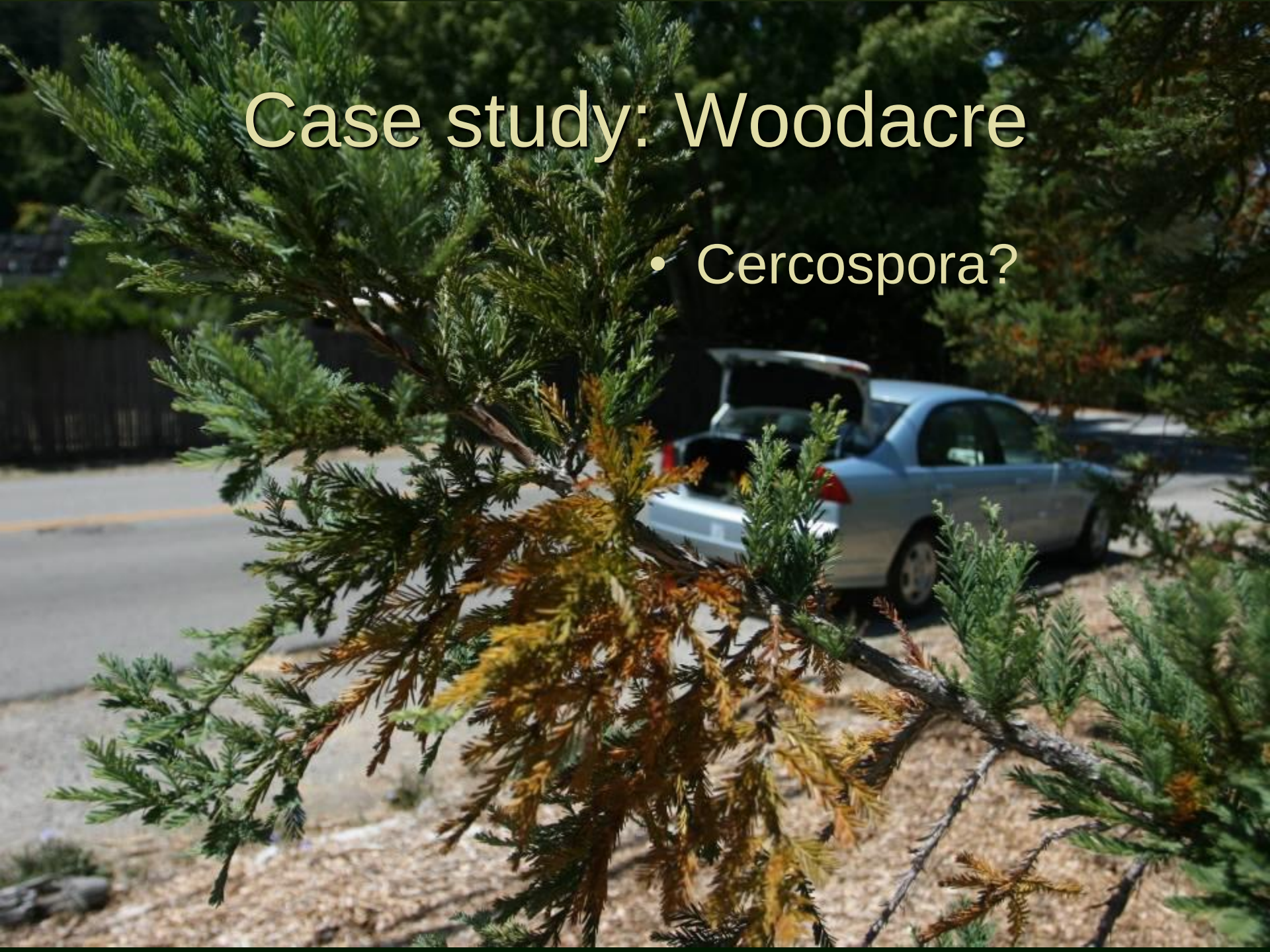
- Evergreen
  - One or more years
  - Metabolically “expensive” to produce
  - Leaf pathogens have year-round food
  - Lower energy storage requirement
  - No dormancy, metabolism possible year round
  - Leaf shed not so obvious
    - Older leaves only
      - Summer
      - Fall
      - Spring

Shedding variation for evergreens

- Timing of leaf drop
- Number of leaves
- Genetic variation from tree to tree
- Year to year variation in growth
  - Rainfall
  - Temperature
  - Sunlight
- More leaves may be shed in good growth years
  - Not intuitively obvious

Case study: Woodacre

- Cercospora?




Case study:
Novato

Botryosphaeria (Diplodia)

- Opportunistic
- Huge host range
  - Oaks (Diplodia)
  - Redwoods, Sequoias, other conifers (Botryosphaeria)
  - Madrone, Manzanitas
  - … and on …
- Improve growing conditions
- Consult UC IPM

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Phytophthora

- Many species thrive in warm, wet soil
  - e.g., P. cinnamomi
  - Many more being discovered
  - Will attack “healthy” trees
- All require water to infect
- Thrive in “Drench and Drought” irrigation
  - Know your plants
  - Monitor your soil
  - Let things dry without stressing the plant

Armillaria (oak root rot)

- Starts as an opportunist
  - As it grows, it gets meaner
- Common in California soils
- Likes:
  - Summer irrigation
    - Consistently warm moist conditions
    - Droughts, hot summers
    - Vineyards
    - Lawns
  - Injured roots
    - Especially larger roots
- Fungicides ineffective

Armillaria

- “Oak Root Rot”
- White mycelia
- Usually bark is soft where disease is advanced
- Smells like fresh mushrooms
  - Often subtle
- Sometimes clumps of tan mushrooms
  - White spores


SPEED
LIMIT
25

Armillaria Management

- … is water mgmt.
  - Timing, amount, and location
  - Let things dry
- Chemical Tx not shown effective
  - Despite labels
- Removal
- Air spade
  - If caught early enough

Oak Twig Blight

- Cryptocline cinerescens
- California native
- Likes warmth, high humidity
  - Nearby irrigated lawns

Oak Twig Blight

- Black pimple like growths on recently killed twigs
- Prune out in dry weather
- Reduce humidity if possible in summer

Beetles that attack oaks

- Bark & ambrosia beetles
  - Pin-sized boring holes
  - Talcum-fine boring dust
    - Wood colored
      - (ambrosia beetle)
    - Rust colored
      - (western oak bark beetle)

Ambrosia beetle

- California native
- Kills drought stressed oaks
- No curative treatment
- Farms a fungus
  - Nee: Ambrosiella (hence the name)
  - Now: Rafaella

Ambrosia beetle

- The last part of SOD
  - Doesn't need *Phytophthora* to kill trees
- See and smell drought stress
  - Outbreaks in drought
  - Deep, infrequent summer water
  - Mulch within drip-line
  - Preventative pyrethroid insecticides?
- Tunnels may flux

Ambrosia beetle

- California native
- Farms the *Ambrosiella* fungus
- They kill drought stressed oaks
- No curative treatment

Oak bark beetle

- Similar lifecycle to oak bark beetles
  - See and smell drought stress
    - Outbreaks in low rainfall years
    - Deep, infrequent summer water
    - Preventative pyrethroid insecticides
- Feed on living cambium

Oak bark beetle

- Tunnels may flux
  - New fungal associate *Geosmithia pallida*
  - Similar to alcohol flux
    - Deadlier (?)
    - Wikipedia says so …
    - Not so deadly in the Bay Area
    - Interaction between stress & environment?
  - Check origin of foam
    - Tunnel: Oak bark beetle (?)

Others?

- Urban Forestry Associates
  - San Rafael find in maple
  - With a yeast (?)
- Breyer Vineyard Management
  - Alder find in Glen Ellen
  - With Neofusicoccum

Conifers and beetles

- Monterey pine
  - Five spined Ips *Ips paracofusus*
    - Attack higher in the canopy
    - Distinctive Y shaped galleries
  - Red turpentine beetle *Dendroctonus valens*
    - Red tunnel entrances at tree base
      - Turn white with age
- Provide summer water

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- Mulch / compost

Conifers and beetles

- Douglas fir invades oak woodlands in normal years
  - Saplings don’t require a lot of water
  - Big trees do

Conifers and beetles

- Douglas fir engraver

Dendroctonus brevicomus

  - Attacks Douglas fir on sub-optimal sites
  - Outbreaks occur in dry years
  - Almost routine occurrence in California
  - Natural stand-in for fire

… another thing about drought.

- Fires are often more intense during dry years
  - Diseased & weaker trees weeded out
  - Thirstier species removed
  - Less competition for remaining water
- Thinning understory can reduce water stress and fire risk
- Fire:
  - Not so good for trees
  - Excellent for forests

“Fire Safe”

- No such a thing as a fire safe plant
  - Even iceplant can burn
- Maintenance, not species selection, is the key to managing fire risk
  - Avoid fire prone species
  - … and yet still …

Scripps Ranch, San Diego, 2003. Image courtesy NY Times

Trees & shrubs are not passive

- They actively manage water, pests …
- Pathogens need an angle to survive
  - Opportunistic pathogens and pests attack stressed trees (we give ‘em plenty)
  - More serious pathogens attack even strong plants, but usually under specific circumstances
    - Warm, moist soils; etc.
- Diagnosing the problem
  - The disease triangle (people as pathogens?)
  - UC IPM (http://ipm.ucanr.edu/)

Management Recommendations

- Assess water status 12” below grade
  - Hydraulic lift
- Let the tree tell you how it’s doing
  - Look at current growth
  - Effects occur over years
  - A tree is the physical manifestation of a dance between its genes, the environment, and time

Thanks!

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- Presentation on-line at:
  - http://ucanr.edu/MarinIPM
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