How Trees Grow and Why They Die

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How Trees Grow & Why They Die

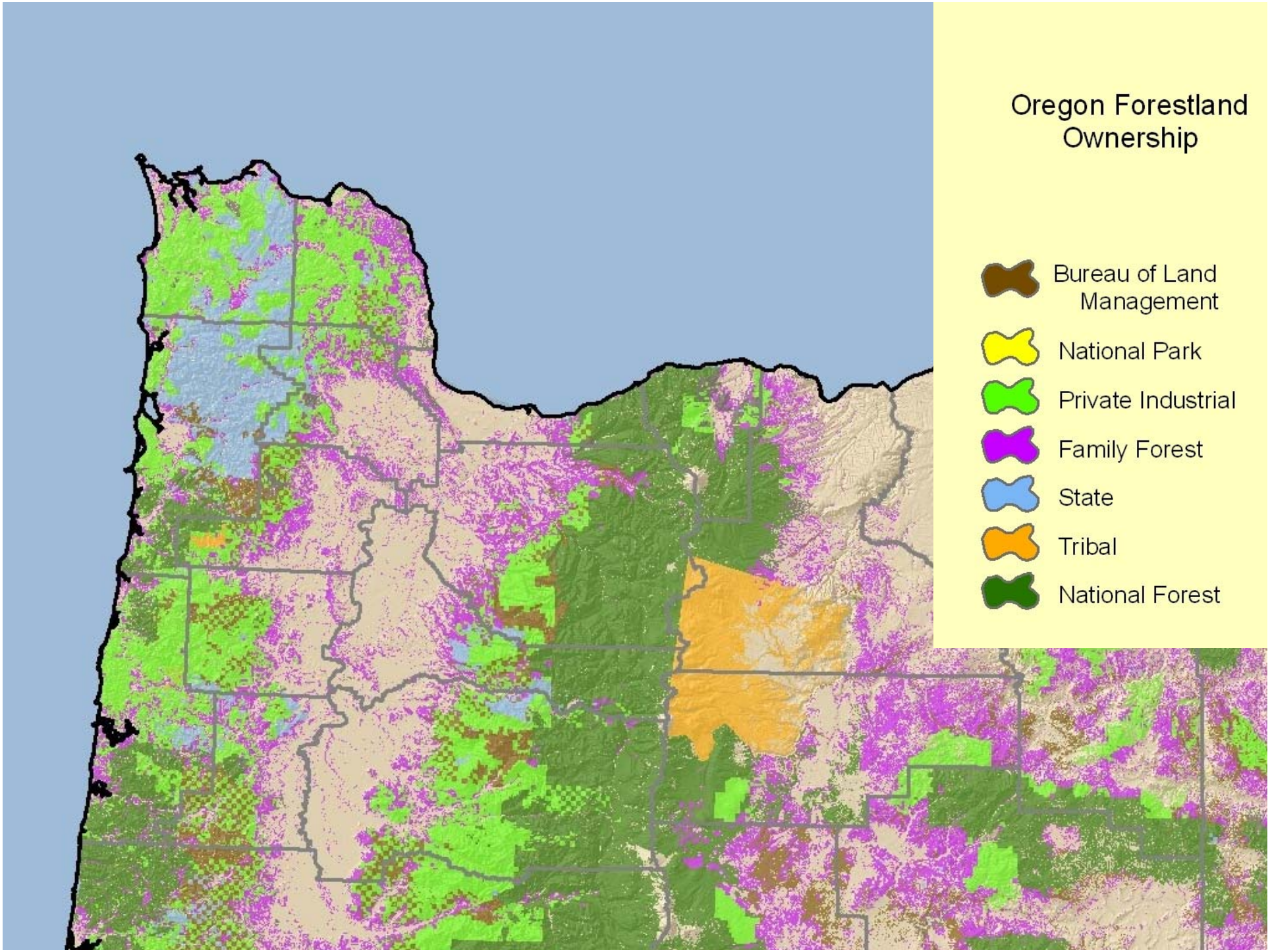
for Master Gardeners

Extension purpose

- Helping people sustain benefits of trees and forests, both urban and rural.

Class Objectives

- Understand importance of sustaining trees and forests.
- Learn principles to apply - How trees grow, why they die, what you can do – focused on current tree health issues.
- Connect with resources to help you with MG tree questions.


Oregon Forestland Ownership
Bureau of Land Management
National Park
Private Industrial
Family Forest
State
Tribal
National Forest

What is a tree?

- Tall, long-lived, woody plant.
- Usually has single main stem
- Succeeds in competition by being the tallest, most dominant life form.

A Tree's Life Mission:

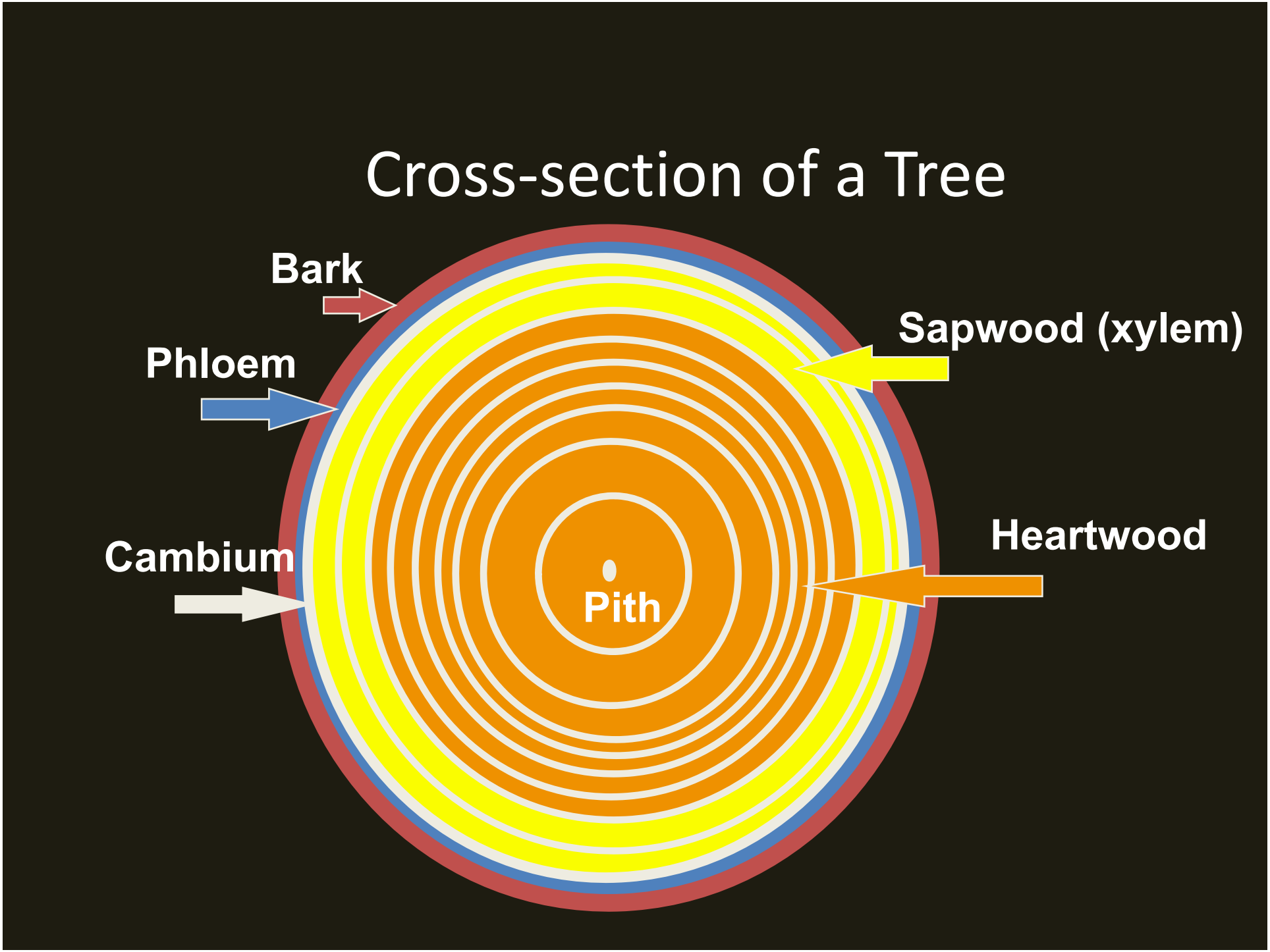
- Get a lot of leaves (needles) in the sun at a "low" cost
- Reproduce
- Handle weather extremes
- Fight off pests

They have to stay in one place, for a long time!

Functions of Tree Parts

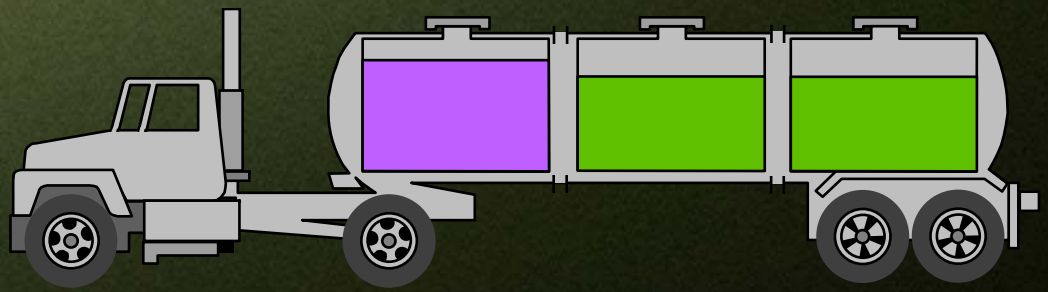
	Support	Transport	Food
Leaves		X	X
Branches	X	X	
Stem	X	X	
Woody Roots	X	X	
Fine Roots		X	X

Cross-section of a Tree



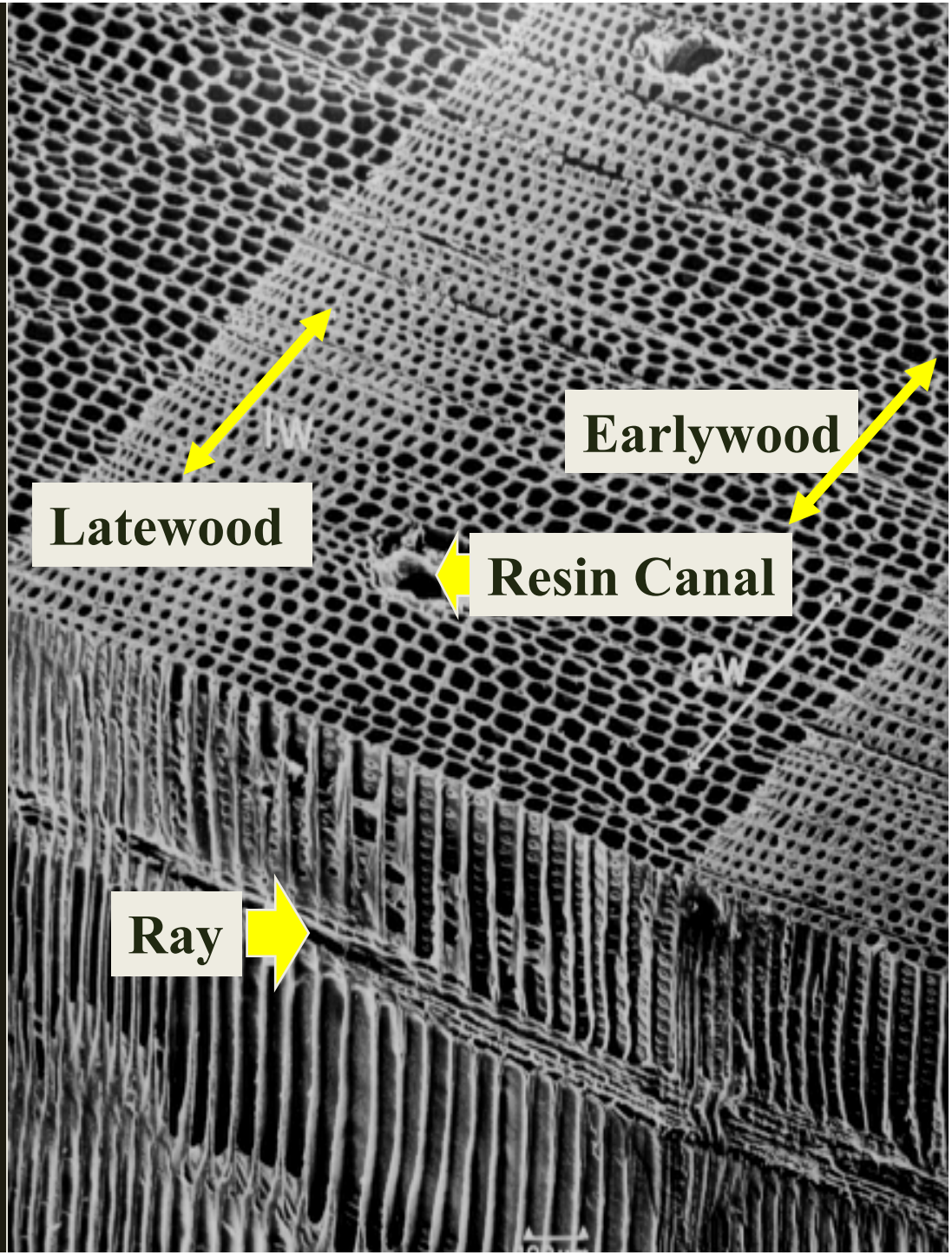
Transport

- Water and mineral nutrients are transported in the xylem (sapwood)
- Food (sugars) are transported in the phloem



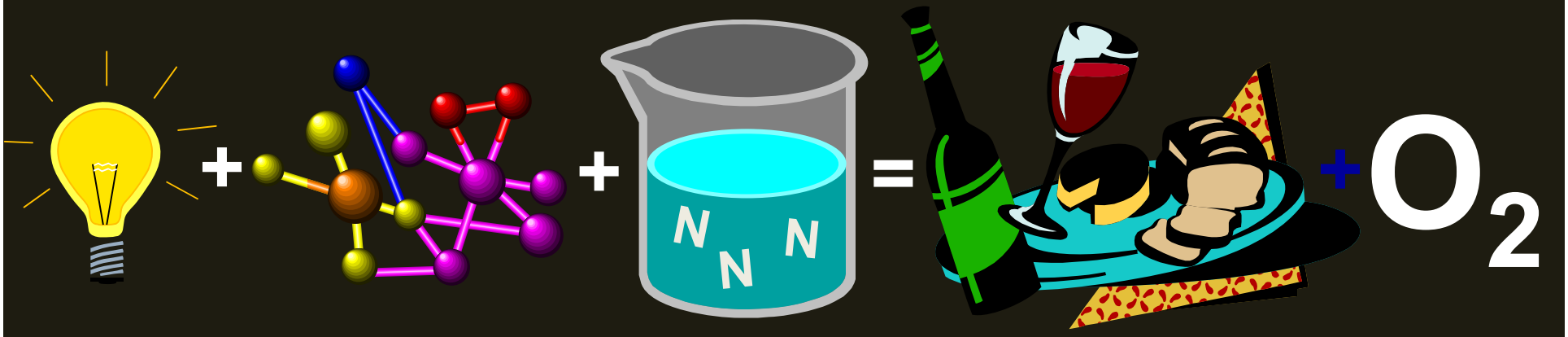
Tree Rings Through the Microscope

From: Core, H.A., W.A.Cote' and A.C. Day. 1976. Wood Structure and Identification, Second Ed. Syracuse Univ. Press.

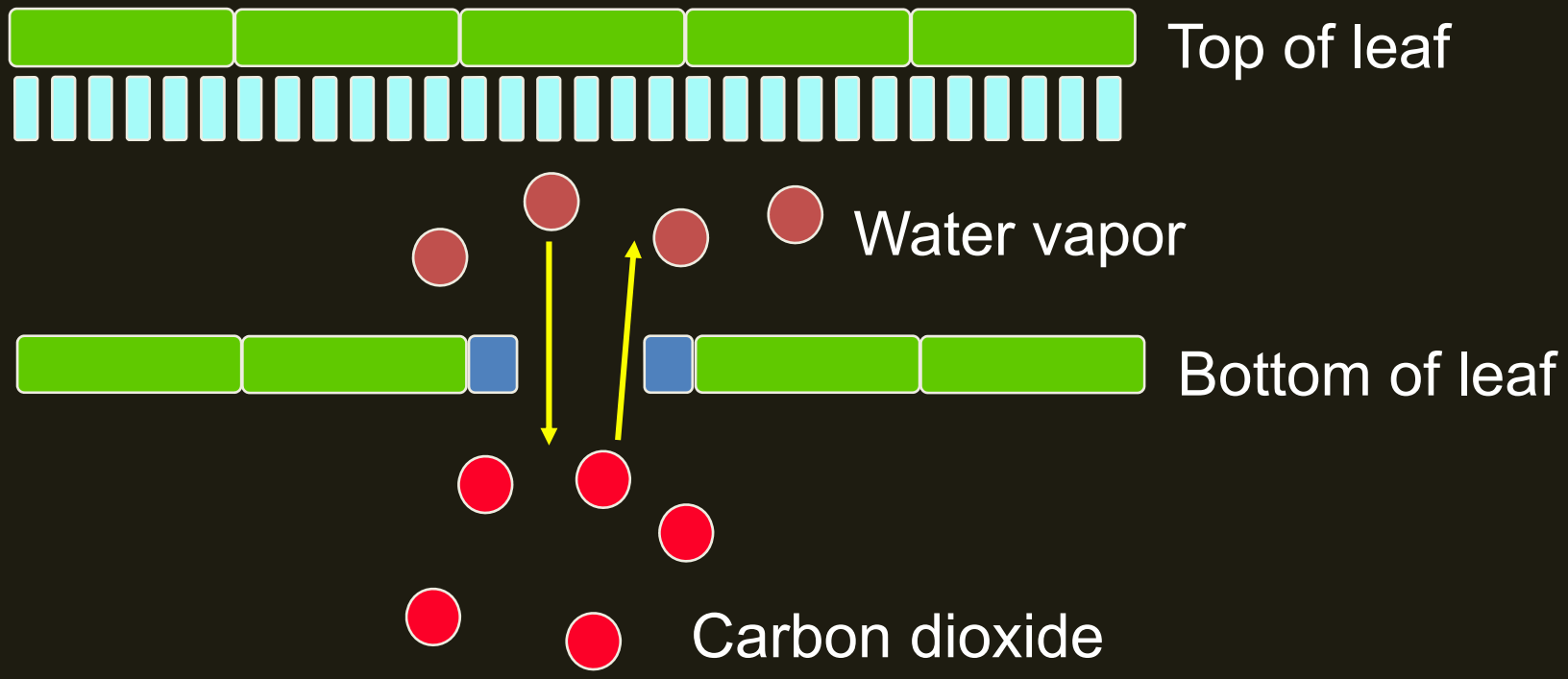


Photosynthesis - Food

Light + CO_2 + Water + Nutrients = Sugars (food) + Oxygen



Leaf Functions

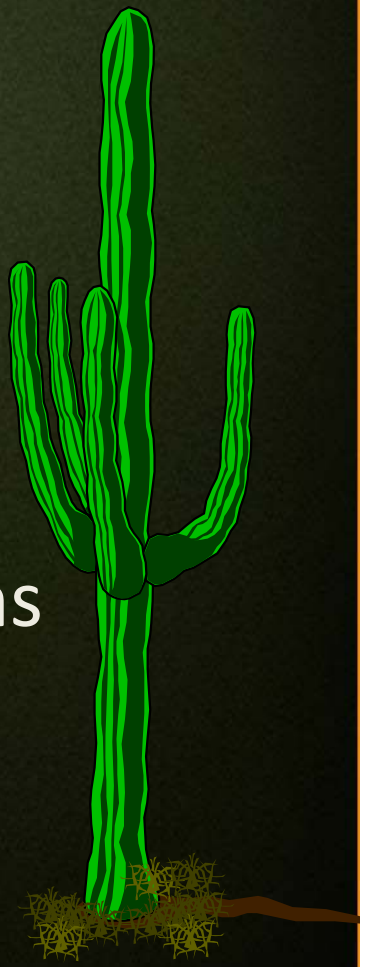


Water exits and carbon dioxide enters the leaf through special cells called stomata

Root & shoot growth occur at different times of the year.

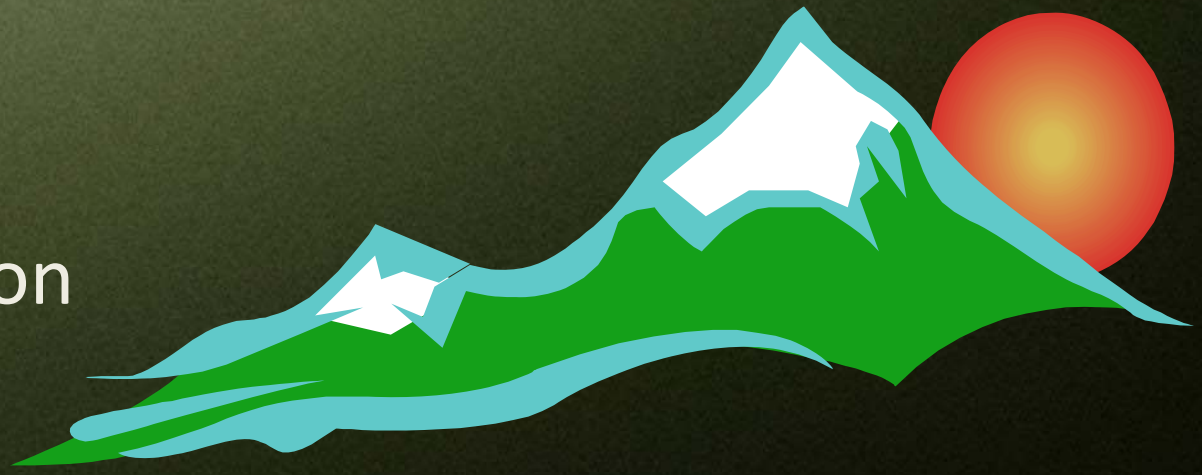
Adaptation

- Trees have adapted to their environment by fine tuning their techniques for light capture and water loss.
- Successful tree care depends on understanding each species adaptations and tolerances to environmental conditions – especially changing conditions.



Site /Environment Considerations

- Soils
- Climate
- Aspect
- Slope
- Elevation



Tree Questions

- What's killing my tree?
- How can I save my tree?
- How do I keep my trees healthy?

What's killing my tree?

Biotic Agents	Abiotic Agents
Diseases – endemic or epidemic	Drought Heat
Insects – endemic, exotic, outbreak	Cold Ice & snow
Humans - physical, chemical, soil damage, change in drainage/flooding, sudden exposure	Flood Wind

What's killing my trees?

- A Complex interaction of biotic and abiotic factors……
  - And a little bad luck.


Drought * stem canker fungus

Red alder dieback
Drought * stem canker fungus

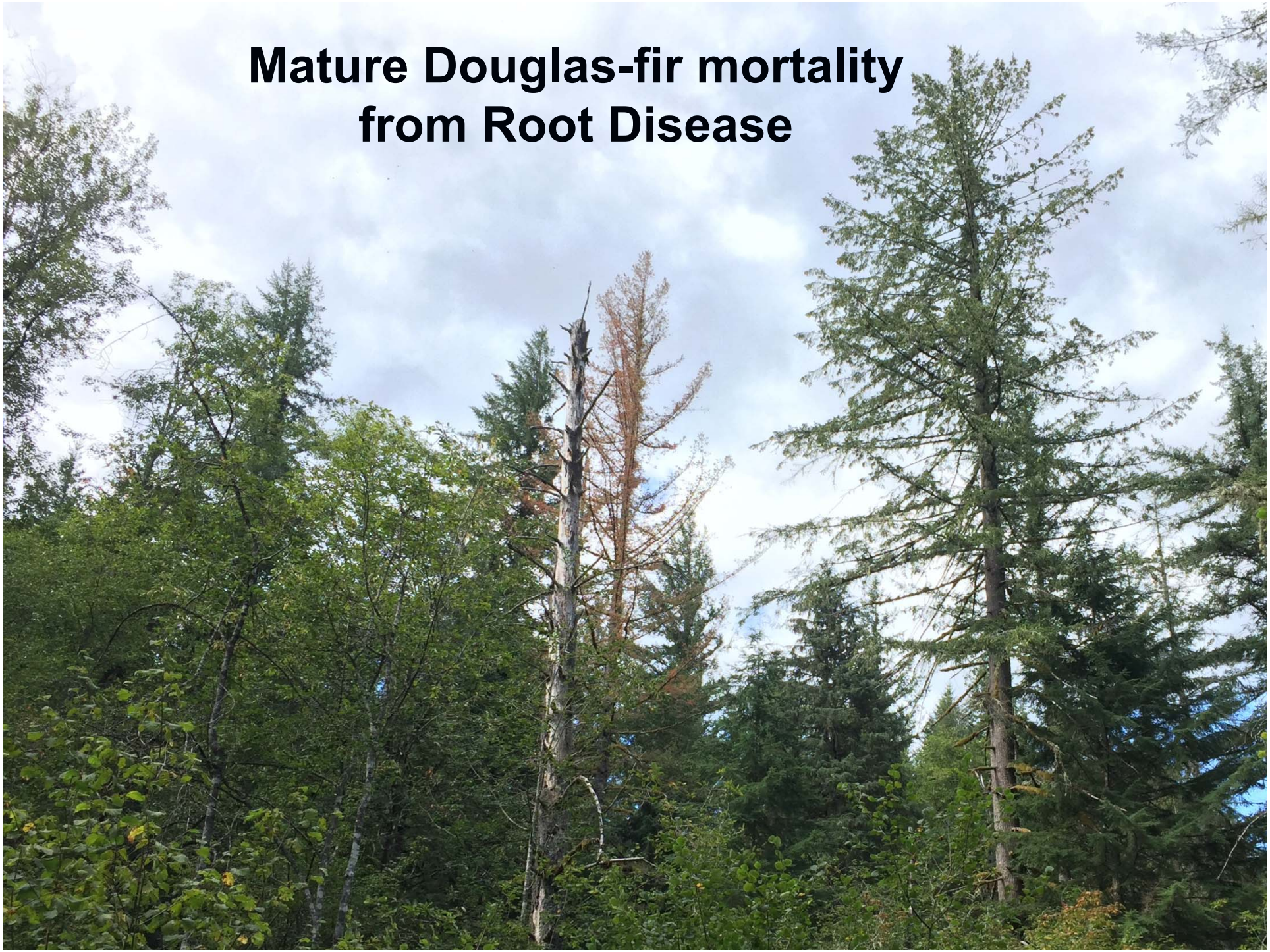
Competition stress * Drought * insects

Storm Damage * Bark Beetles

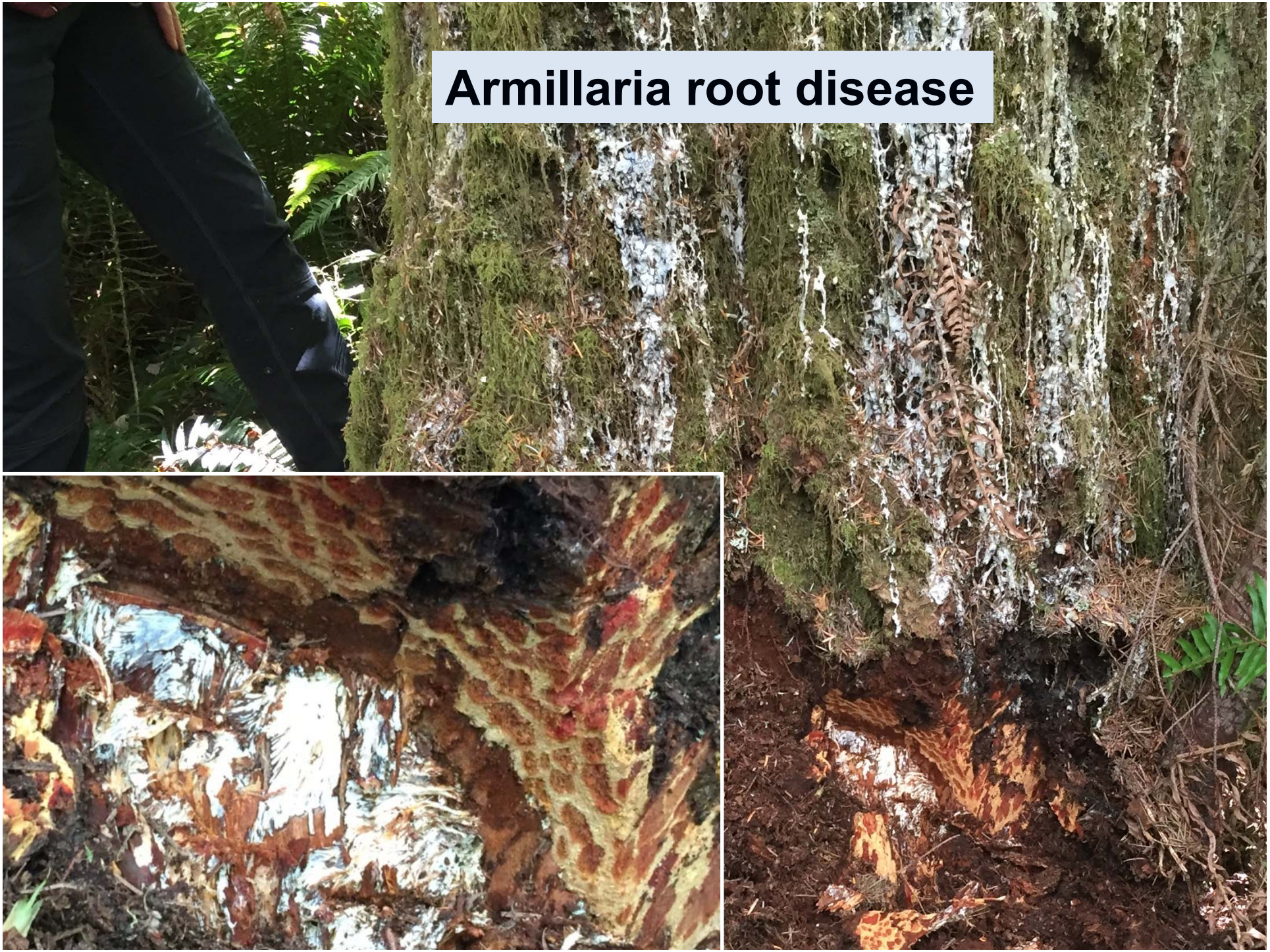
Breeding place for beetles - threatens healthy trees.

Douglas-fir beetle

Mature Douglas-fir mortality from Root Disease



Armillaria root disease

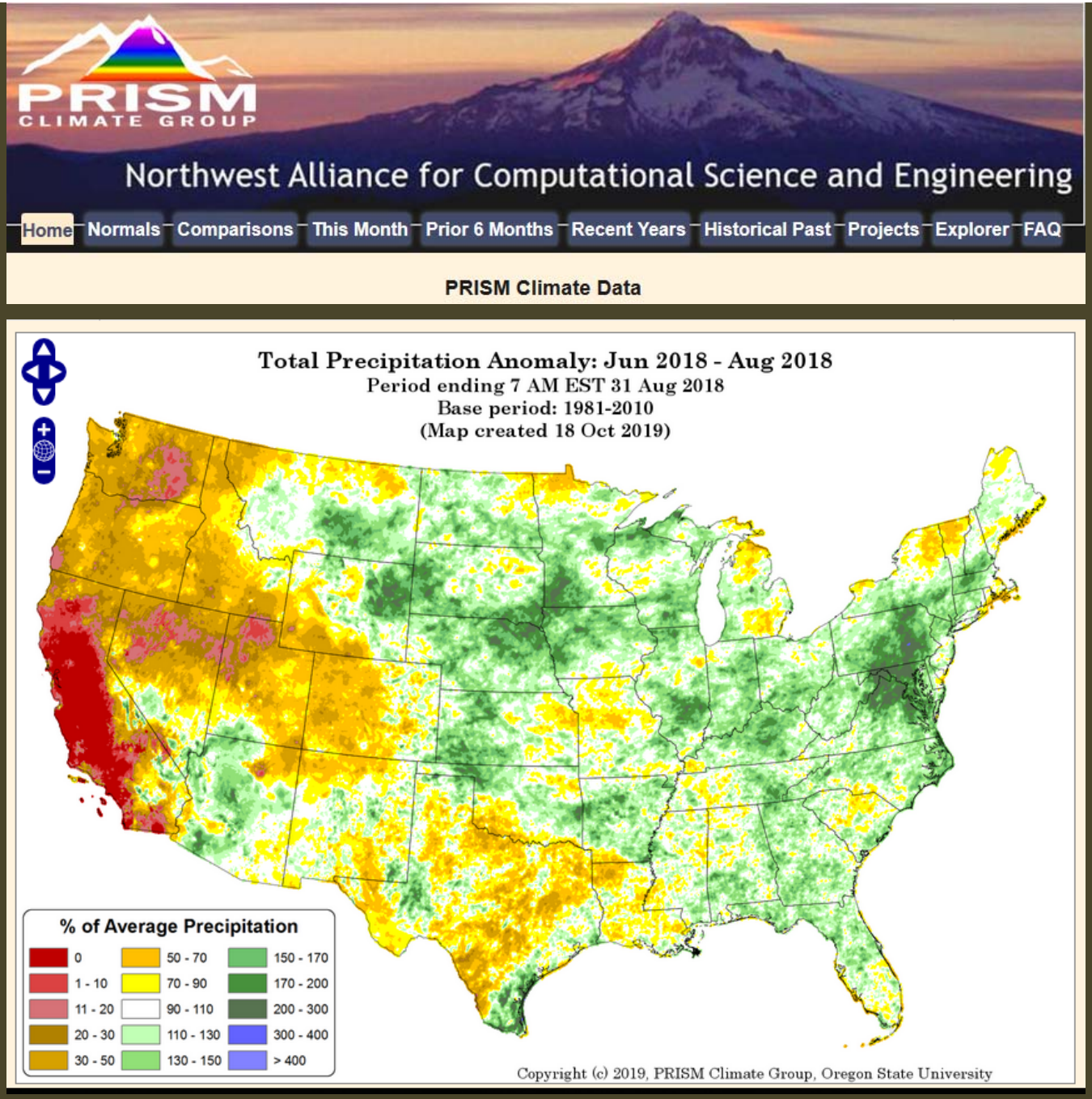


Laminated root rot

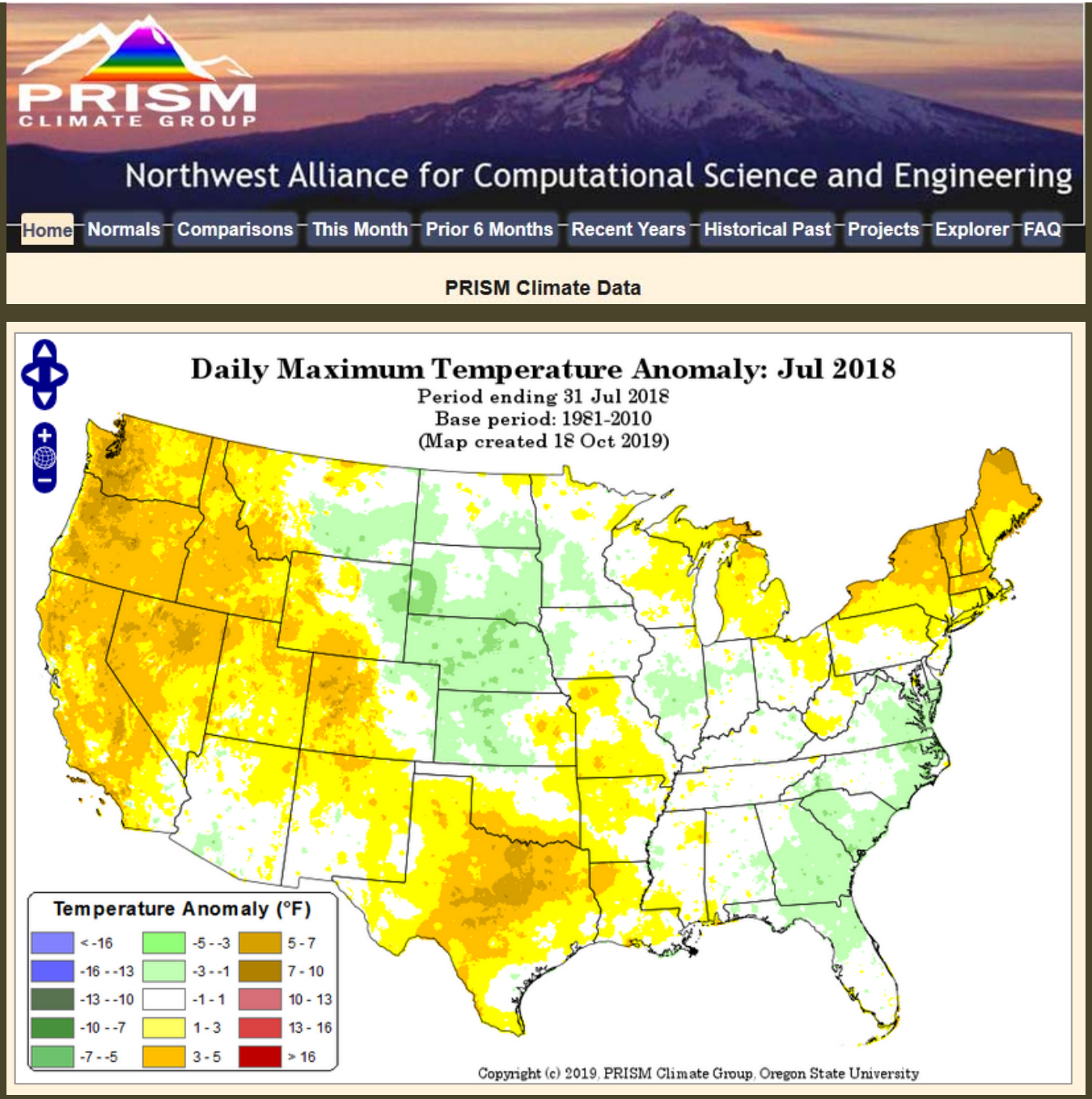

Root rot * Drought * Douglas-fir beetle

Rapid die-off of mature western redcedar ????

NOTE: Report cases of western redcedar mortality to Glenn Ahrens or Amy Grotta.



http://prism.oregonstate.edu/



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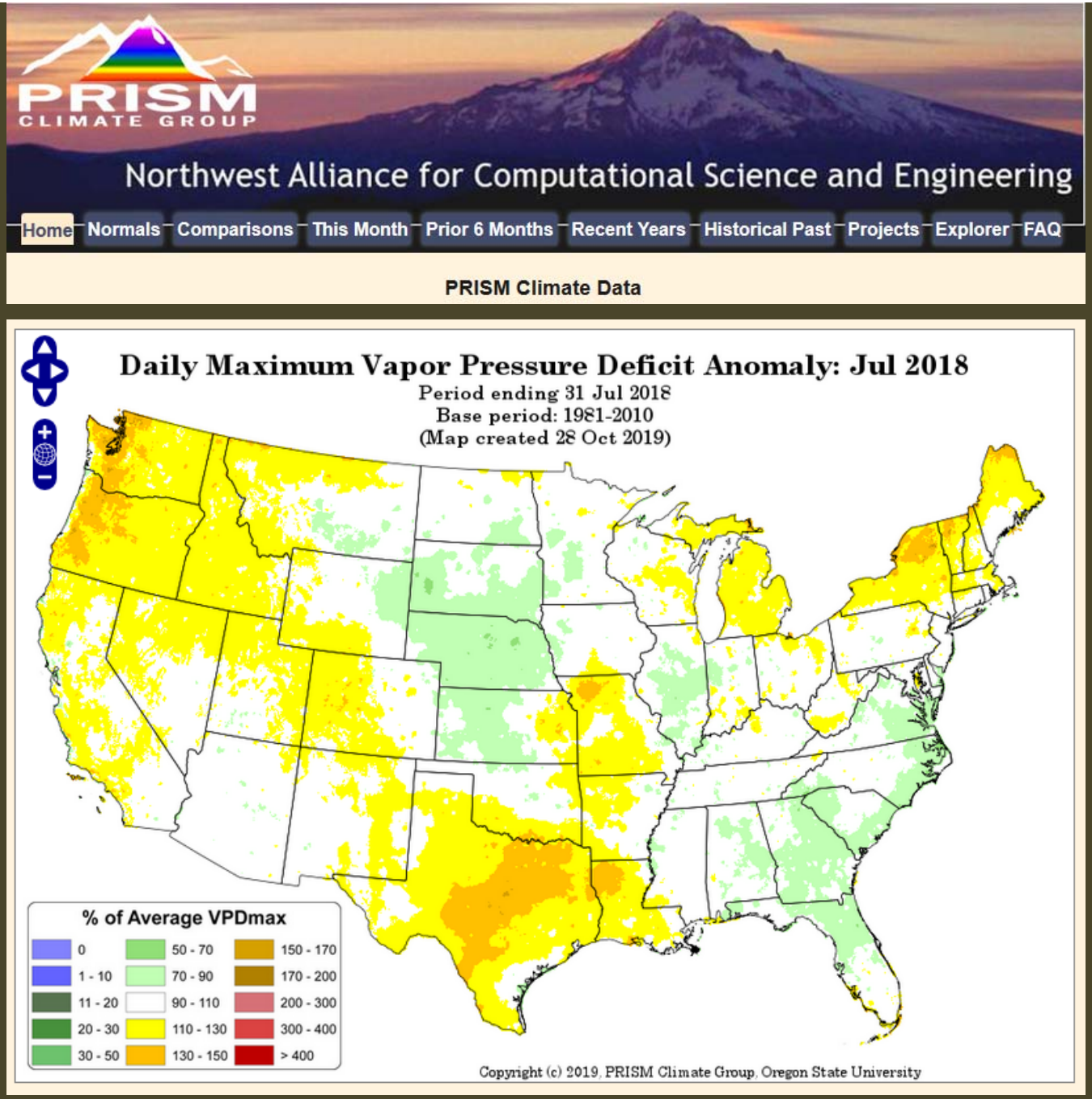


http://prism.oregonstate.edu/

Location

- (•) State & County: Oregon | Multnomah
- ( ) Coordinates: Latitude: 45.4986 Longitude: -122.1576 Elevation: 1673ft (510m)

Data Settings

- [ ] Precipitation
- [ ] Mean dewpoint temp
- [ ] Minimum temp
- [ ] Minimum VPD
- [ ] Mean temp
- [x] Maximum VPD
- [ ] Maximum temp

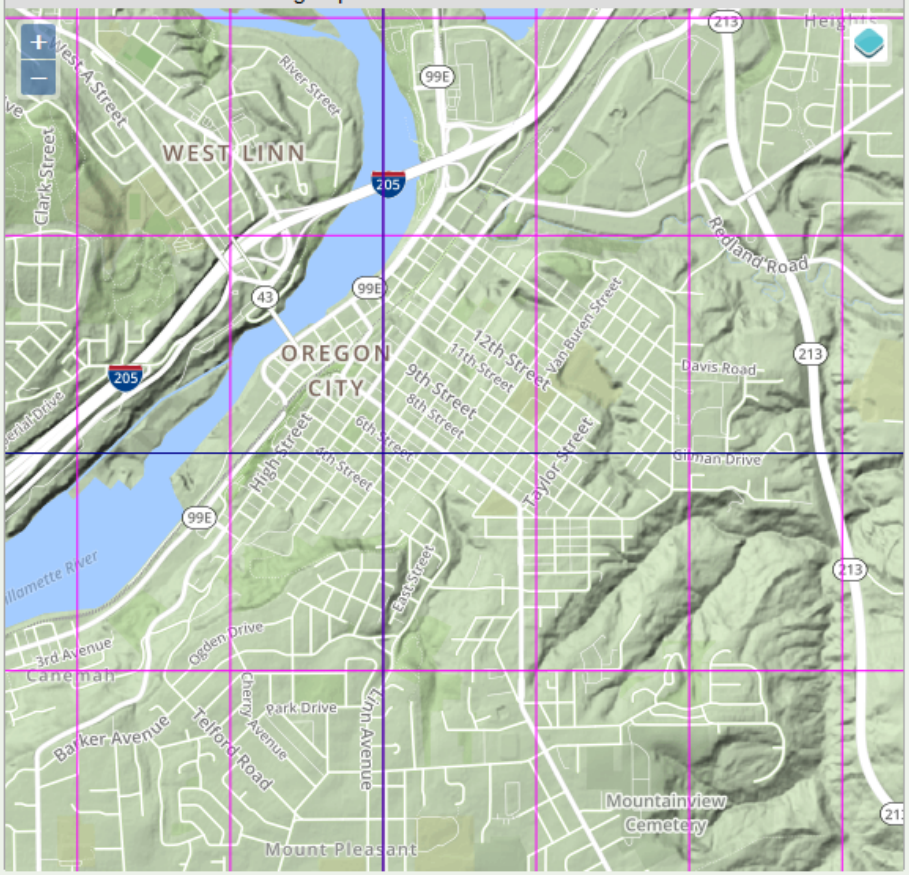
- ( ) 30-year normals, 1981-2010 (monthly and annual)
  Resolution: (•) 4km ( ) 800m
- ( ) Annual values
  start 2017 end 2017
- ( ) Single month values August
  start 1949 end 2019
- (•) Monthly values
  start January 1919
  end September 2019
- ( ) Daily values
  start 01 January 2017
  end 01 January 2017

provisional (likely to change)
Data Stability: (based on selected end date)

Units: (•) English ( ) SI (metric)

- [ ] Interpolate grid cell values (see text)

Click to select. Click & drag to pan. Use mouse wheel to zoom.



Controls

Retrieve Time Series | Download Time Series | Restore Previous Settings

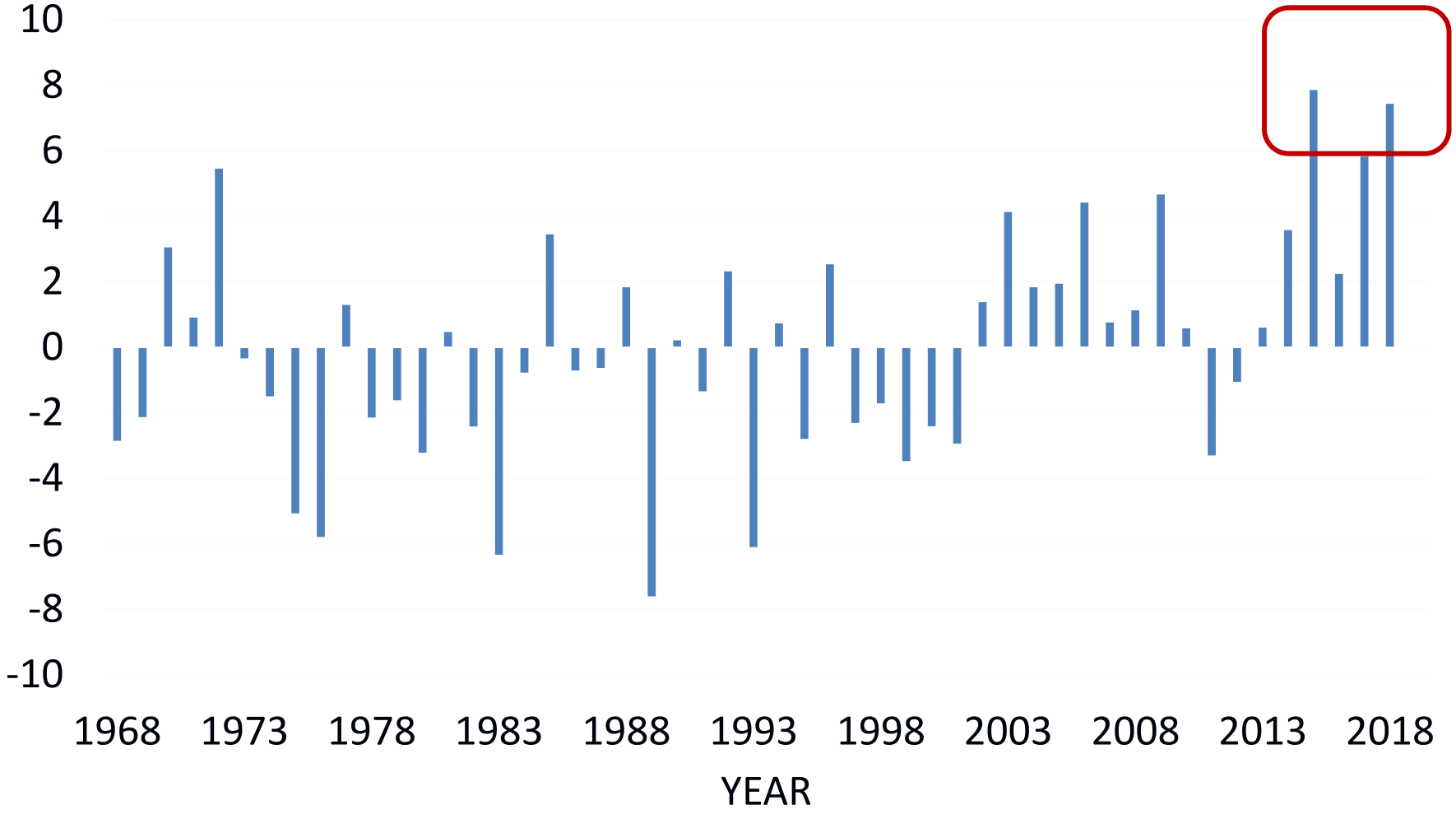
Once settings are complete, **retrieve** the results

http://prism.oregonstate.edu/

Moisture Demand - Departure From Average

July-August VPDmax (hPa)

Molalla, OR, elevation 300 feet



Review of Research on Why Trees Die

Started with: *Characteristics of Trees Predisposed to Die* (Waring 1987)

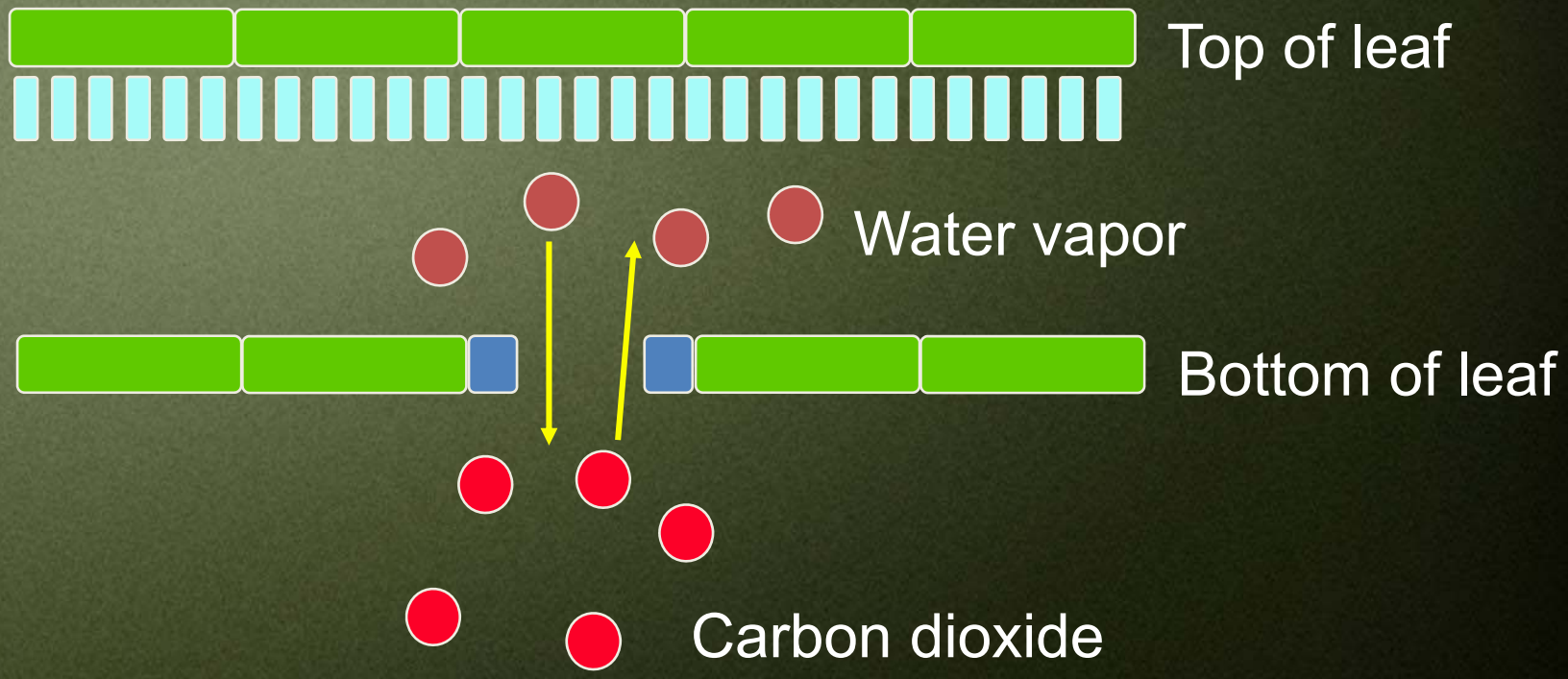
- Loss of Whole-tree Hydraulic Conductance During Severe Drought
- Hydraulic Failure Defines Tree Recovery and Point Of Death
- Individual Traits As Determinants of Time to Death Under Extreme Drought In Pinus
- Multiyear Drought-induced Morbidity Preceding Tree Death
- Emergent Insects, Pathogens and Drought Shape Changing Patterns In Oak Decline
- Predictions Of Massive Conifer Mortality Due to Chronic Temperature Rise

Heat + Drought

Mechanisms of mortality

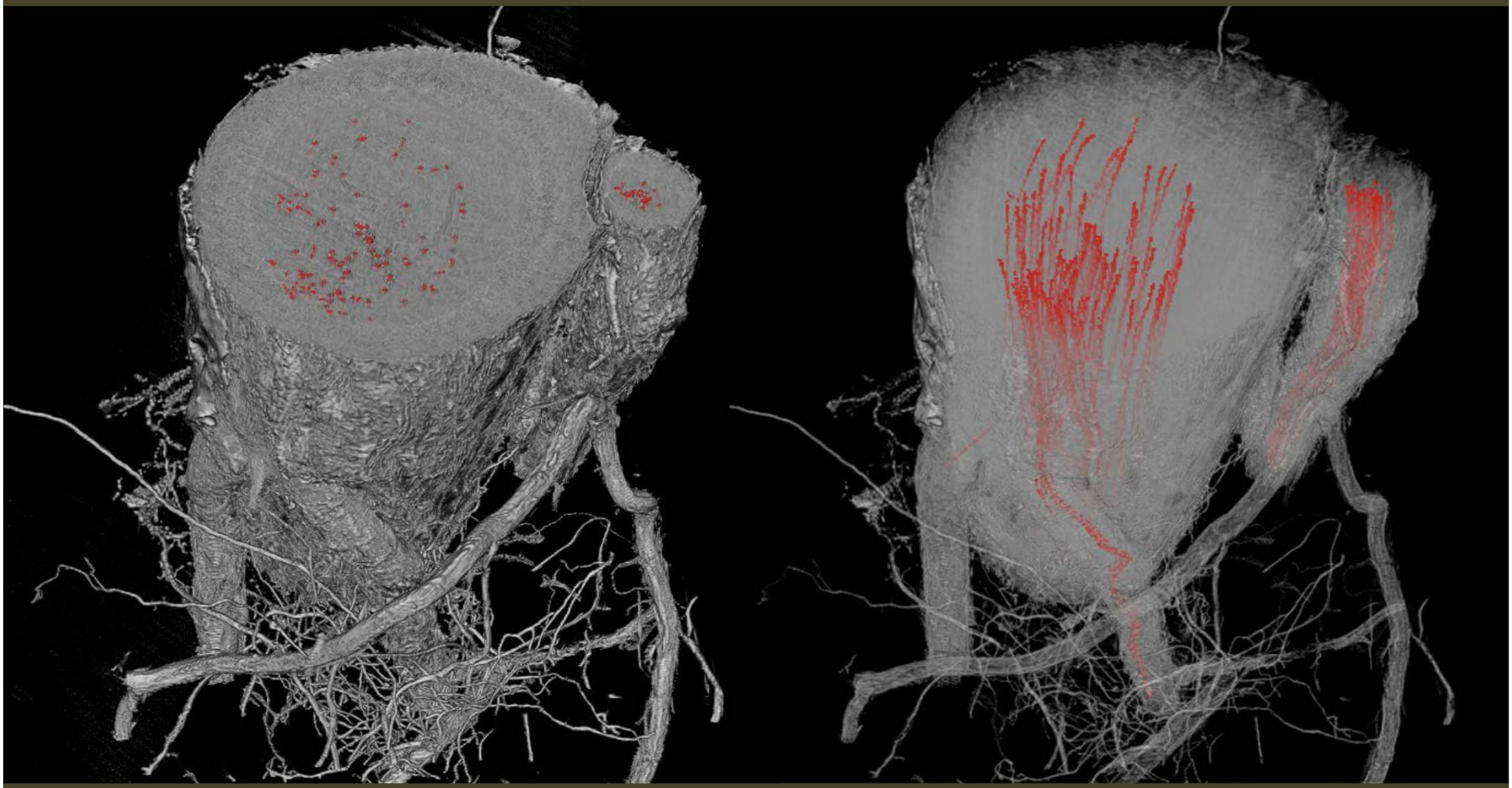
- Hydraulic failure of the water transport system.
- Depletion of carbohydrates (starvation) during stomatal “shutdown” .
- Stress-related vulnerability to disease and insects.

Leaf Functions



Water exits and carbon dioxide enters the leaf through special cells called stomata

“CT Scan” shows failure of water transport system – xylem cavitation



Triggers of tree mortality under drought, Choat et al., Nature volume 558, pages531–539 (2018) https://www.nature.com/articles/s41586-018-0240-x

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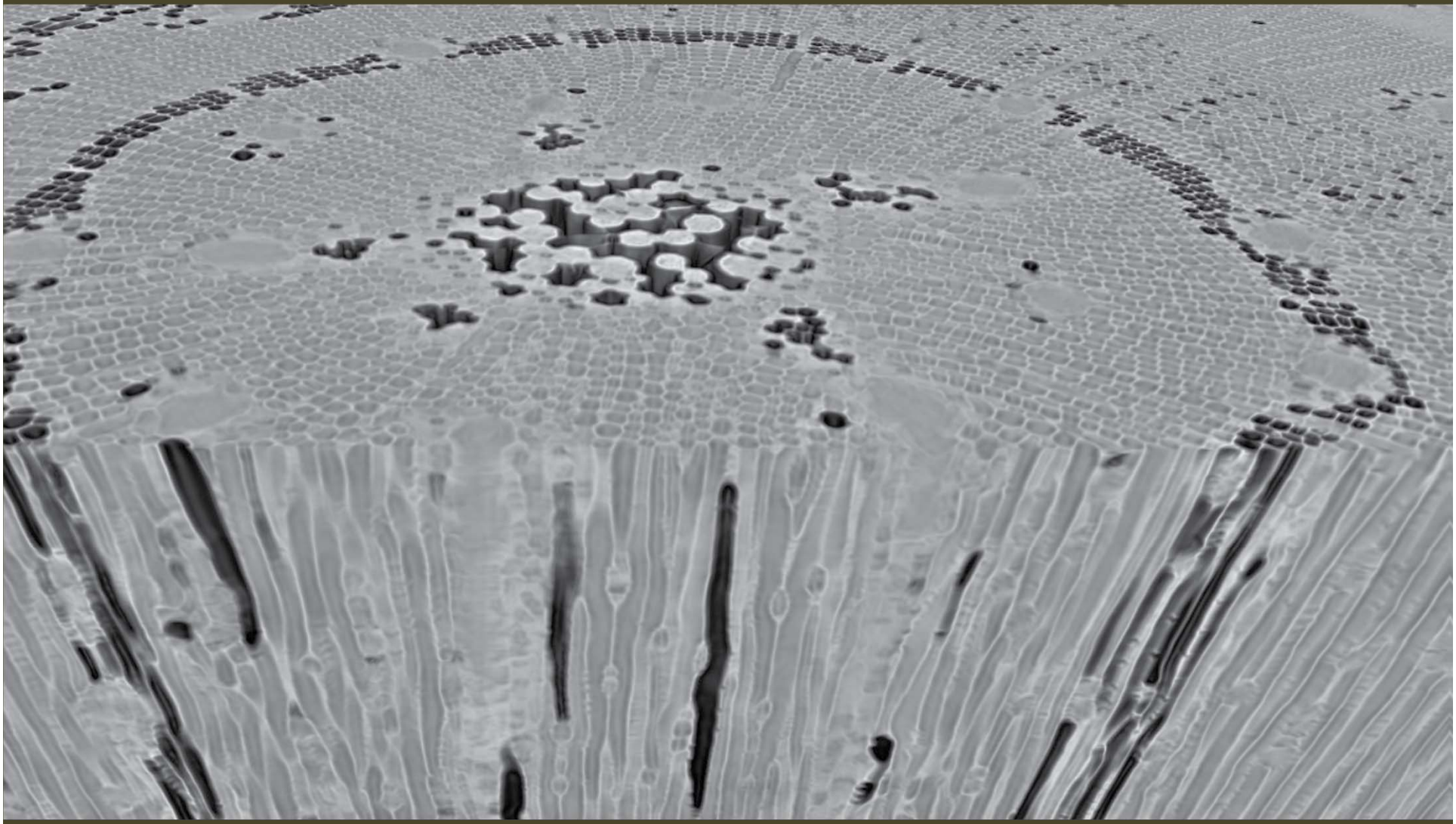
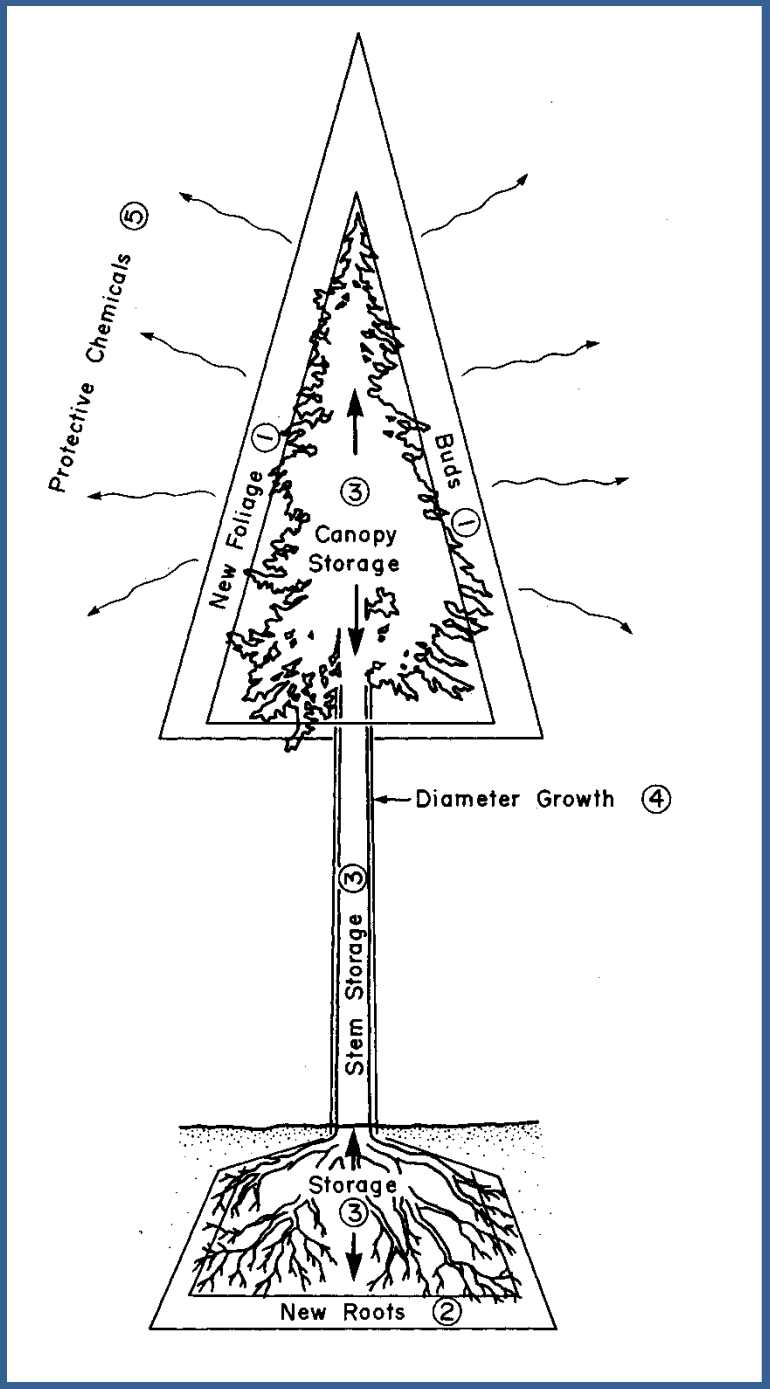


Triggers of tree mortality under drought, Choat et al., Nature volume 558, pages531–539 (2018) https://www.nature.com/articles/s41586-018-0240-x

Allocation of photosynthate

- Maintenance respiration.
- Fine roots and new buds and foliage.
- Reproduction (flower & seed production).
- Storage (roots & canopy)
- Stem growth.
- Protective chemicals.



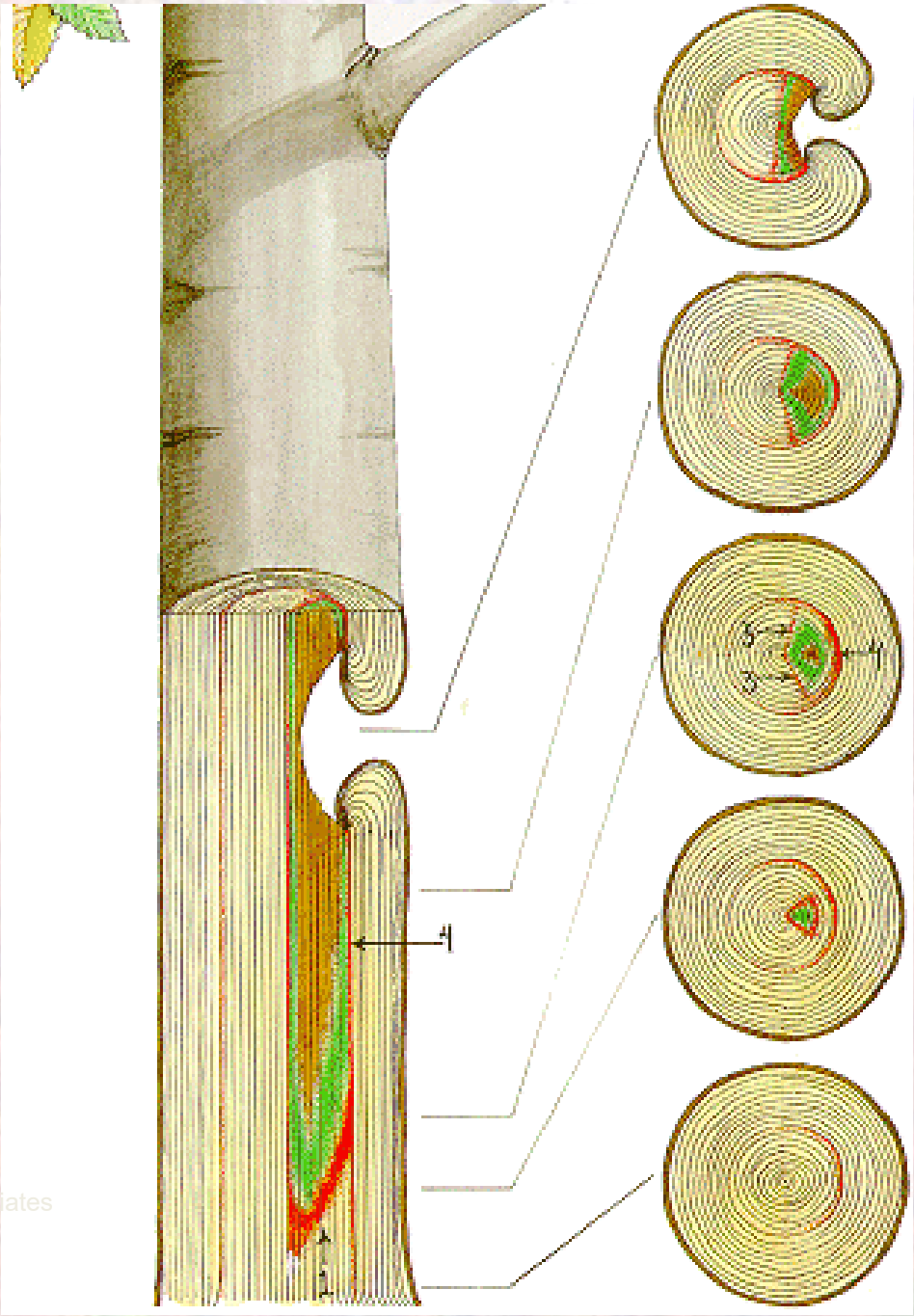
Compartmentalization:

After a tree is wounded, the cambium begins to form a new protective wall – both anatomical and chemical.

Red-Tree response (chemical protective reactions).

Green-Pioneer microorganisms (bacteria, fungi). Wood in this area is usually discolored; its cell contents are altered.

Brown-Position of decayed wood; cell walls are digested.



Western Redcedar Mortality?

- Hydraulic failure of the water transport system?
- Depletion of carbohydrates (starvation) during stomatal "shutdown" ?
- Stress-related vulnerability to disease and insects?

"Hydraulic responses to drought: the higher they fly, the harder they fall"

Drought response strategies define the relative contributions of hydraulic dysfunction and carbohydrate depletion during tree mortality. Mitchell et al. 2013. https://nph.onlinelibrary.wiley.com/doi/pdf/10.1111/nph.12064

Managing for healthy trees and forests

- Prevention – Do no harm.
- Assess soil/site & climate conditions and hazards.
- Choose species that are well-adapted and resilient.
- Maintain tree vigor – adequate growing space.
- Monitor tree and forest health.
- Remove/Sanitize unhealthy trees or debris
- Avoid attracting or introducing pests.
- Apply specific treatments, control measures if available.

Prevention – Do no harm

- Avoid “wrong tree in the wrong place” - match species to site
- Match planting stock type to site and level of care.
- Proper irrigation practices –occasional deep watering, not frequent shallow watering
- Proper fertilization practices – low and slow.
- Proper pruning practices – fall-winter, not too much.
- Avoid development impacts, changes in drainage
- Avoid soil compaction – human traffic, animals, machines
- Avoid physical damage to trees from tools and machines.

Choosing The Right Species

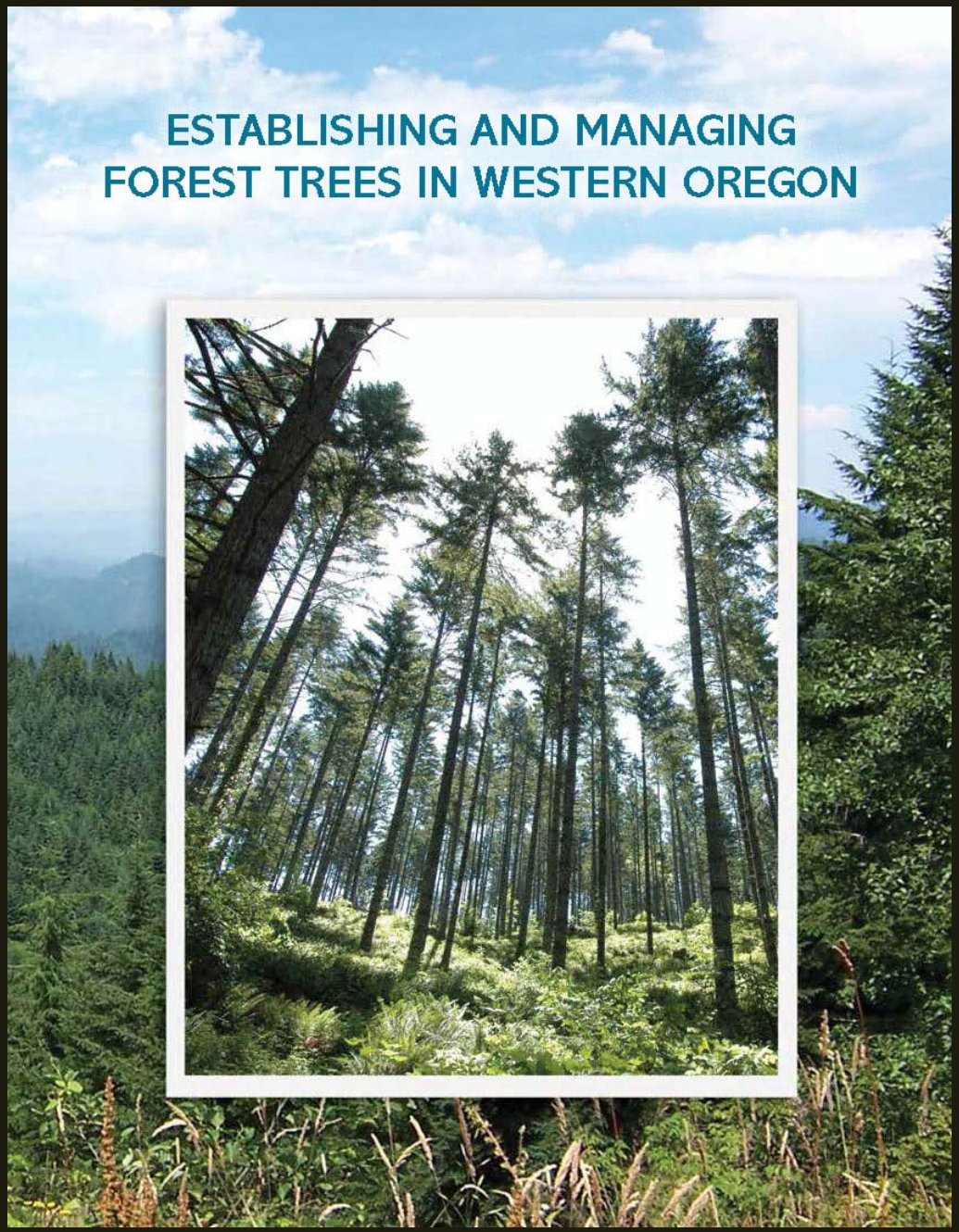
- Each tree species has its own set of adaptations and/or tolerances to environmental stress, insects and diseases.

PERFORMANCE OF NATIVE TREE SPECIES OF THE WILLAMETTE VALLEY

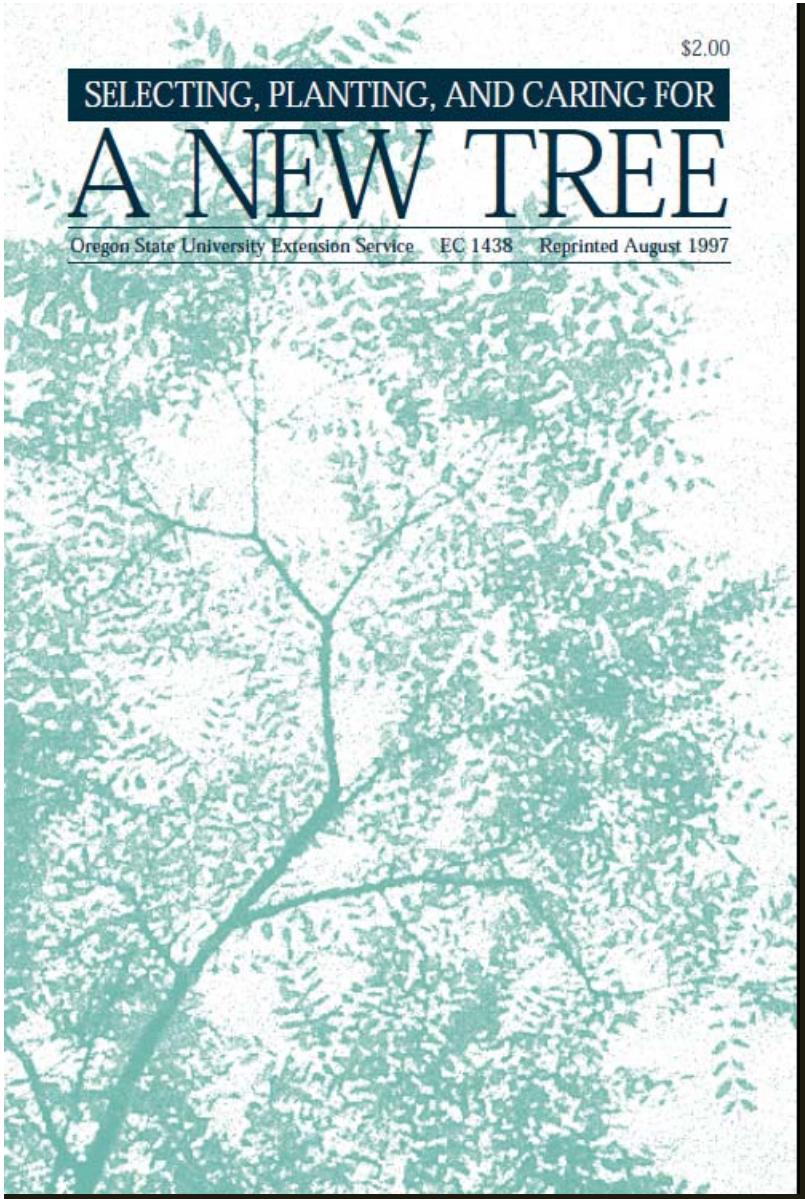
SPECIES	Growth*	Tolerance** to: Low Light	Animals	Wet Soil	Drought	Frost
CONIFERS:						
Douglas-fir	3-4	2	2	2	3	4
Ponderosa pine	2-3	1	4	5	5	5
Grand fir	3-4	4	4	3	2	3
Western redcedar	2-3	5	1	4	1	2
Western hemlock	2-3	5	3	3	1	1
Incense-cedar	1-2	2	3	2	5	3
HARDWOODS:						
Oregon white oak	0-.5	1	4	4	5	5
Bigleaf maple	2-3	4	1	4	3	5
Red alder	3-4	1	2	4	1	2
White alder	2-3	1	2	5	1	2
Cottonwood	1-12	1	1	5	1	5
Oregon ash	1-3	3	2	5	2	5
Chinquapin	1-3	3	5	3	4	5
Madrone	1-2	2	5	2	5	3

* Height growth per year in feet during good growing years.

** Tolerance ranges from 1 = species very susceptible to this factor, to 5 = species not susceptible to this factor.



https://oregonforests.org/pub/establishing-and-managing-forest-trees-western-oregon



Selecting planting and caring for a new tree

https://catalog.extension.oregonstate.edu/ec1438

Portland Landscape planting species list

https://www.portlandoregon.gov/bds/article/71964

OSU Landscape Plants

http://oregonstate.edu/dept/ldplants/

International Society of Arboriculture

http://www.treesaregood.org/treeowner/treeownerinformation.aspx

Manage Growing Space & Tree Vigor

- Ensure that each tree has adequate growing space, light, water, nutrients.
  - Weed management
  - Spacing and thinning
  - Pruning

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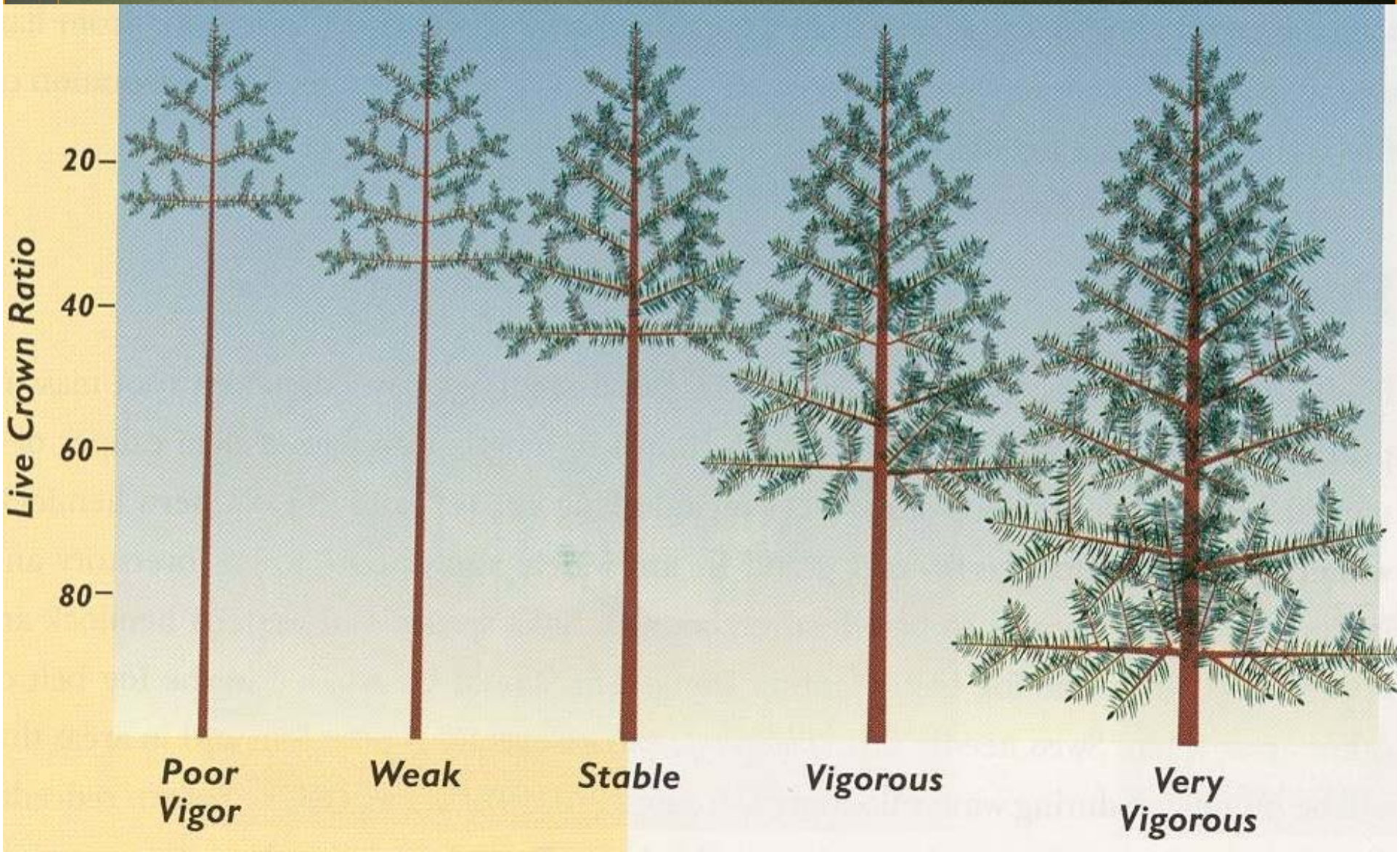
Tree Vigor

Live Crown Ratio - A simple index of tree vigor.



Risk of genetic maladaptation with changing climate?

"Human intervention will be required to ensure productive and adapted Douglas-fir forests in the face of climate change."

"Current populations (of trees) are expected to be poorly adapted to future climates."

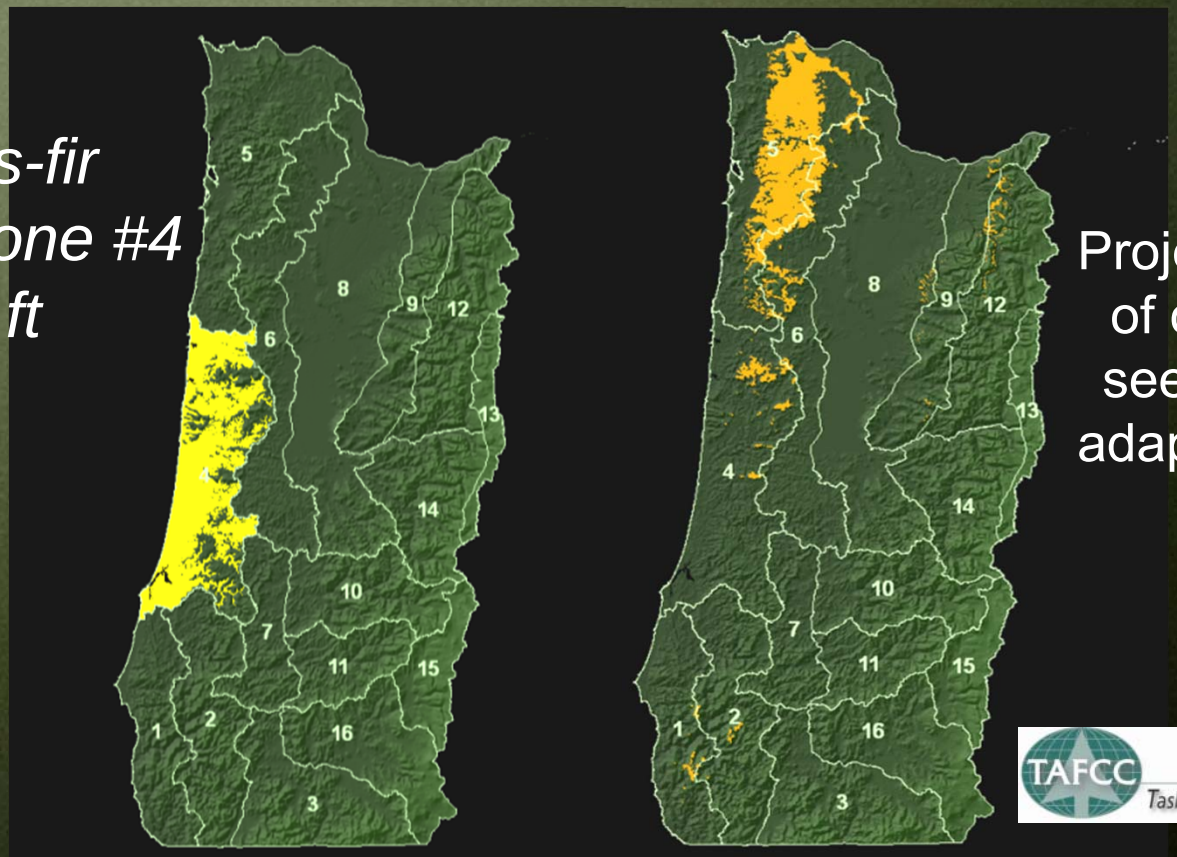
from: *Genetic Maladaptation of coastal Douglas-fir seedlings to future climates.* Brad St. Clair and Glenn Howe 2007.

http://www.fs.fed.us/pnw/pubs/journals/pnw_2007_stclair002.pdf

Select genetic types based on future climate scenarios?

2010 → **2060**

Douglas-fir
Seed zone #4
0-1000 ft



Projected occurrence of climate to which seed source will be adapted in the future.

TAFCC Taskforce on Adapting Forests to Climate Change

Current Climatic Seed zone *Future Climatic Seed Zone?*

POWERED BY ORANGE

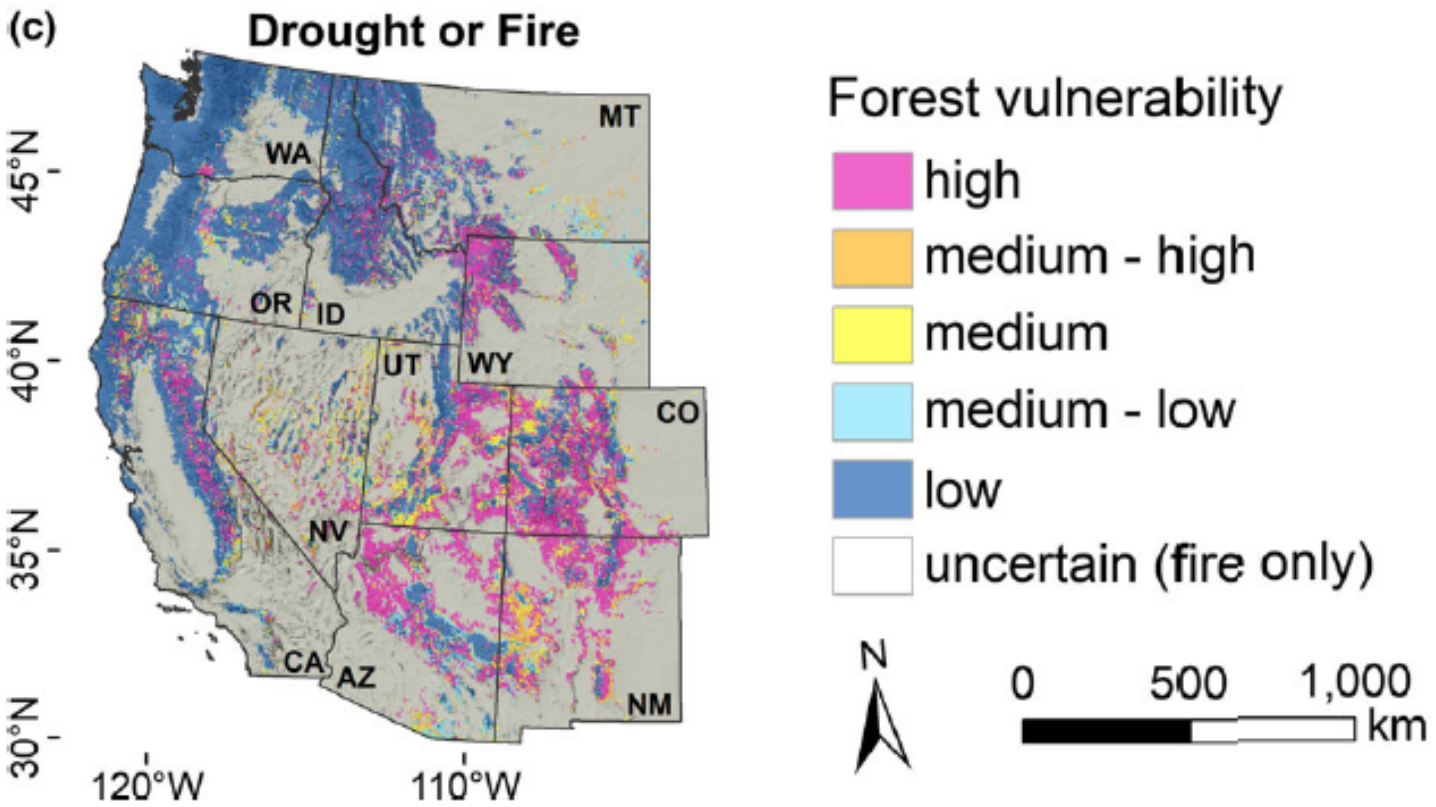
Managing Trees for Climate Change

- Observe your local and regional climate trends.
- Closely monitor tree health and signs of climate stress.
- See how it goes, adapt as things change.

Managing for Climate Change

- Favor more heat/drought tolerant species in planting and thinning.
- Manage for a warmer-drier forest type.
  - Dry Douglas-fir vs. Moist Douglas-fir-hemlock
  - Douglas-fir/P. Pine/Incense cedar vs. Douglas-fir/grand fir
  - Ponderosa Pine/Oak vs. Douglas-fir

Forest vulnerability to drought and fire 2020-2049



Near-future forest vulnerability to drought and fire varies across the western United States, Buotte et al. 2019. https://onlinelibrary.wiley.com/doi/pdf/10.1111/gcb.14490

Sources of Assistance – Service Providers

- Foresters – Urban and Rural
- Arborists
- Landscape Horticulturists
- Tree service companies
- Loggers
- Pesticide Applicators
- Friends and Neighbors

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for Master Gardeners

Class Objectives

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- Learn principles to apply - How trees grow, why they die, what you can do – focused on current tree health issues.
- Connect with resources to help you with MG tree questions.

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References and Resources

This presentation along with references and resources will be posted on our website.

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Questions?

Astoria, OR – Bridge over the Columbia River
Photo: Pat Corcoran