

Life and Death of Madrone in PNW Forests



WASHINGTON STATE
UNIVERSITY

Marianne Elliott, WSU Puyallup
Michael Yadrick, Seattle Parks & Recreation



Seattle
Parks & Recreation
healthy people healthy environment strong communities



The Arbutus ARME is a new organization of botanical and community-powered people focused on expanding research, conservation, restoration and educational efforts related to Pacific madrone trees. The ARME in Arbutus ARME is a shorthand abbreviation of the Pacific madrone's Latin name: *Arbutus menziesii*.



<http://treehugger.libsyn.com/>

Recording to re-broadcast on treehugger podcast, the show focused on the science, practice and humans of ecological restoration. Available on the website listed and on other major podcast portals

Arbutus ARME

Michael Yadrick:

- Madrone ecology
- Range
- Propagation
- Planting and Establishment

Marianne Elliott:

- Wildlife, pollinators
- Pests
- Diseases
- Climate change
- TreeSnap
- Volunteer opportunities



The agenda for the presentation will flow from me to Marianne. I will discuss general ecology and then get into propagation, outplanting and establishment of the species. Then, Marianne will cover wildlife, pests & pathogens, climate change challenges, and explain our efforts at conservation and research into madrone. As well as opportunities for you all to get involved.



Can you pinpoint the madrone in this slide? There are a few look alikes with other broadleaf evergreen plants.

- strawberry tree – same genus different species
- cherry laurel – prunus (cherry)
- Madrone (top right) – indicated by the small serrations around the leaf margin
- garrya elliptica (silk tassel) native range peters out in middle of Oregon Coast Range in Oregon
- pacific rhododendron – Washington's state flower

DEMYSTIFY MADRONE

Arbutus menziesii Pursh
(*Ericaceae*)

madrone, madrona, arbutus

They are all sick

It is hard to grow

It is hard to transplant

Nurseries don't grow it

If a tree is leaning, it is going
to fall over

Don't touch them; they'll fall
over



Part of getting this project off the ground is to re-inspire some hope and composure about the outlook of madrone trees and forests. Although it is a magical tree, we hope to partially demystify urban myths you may have heard (along with my rebuttals):

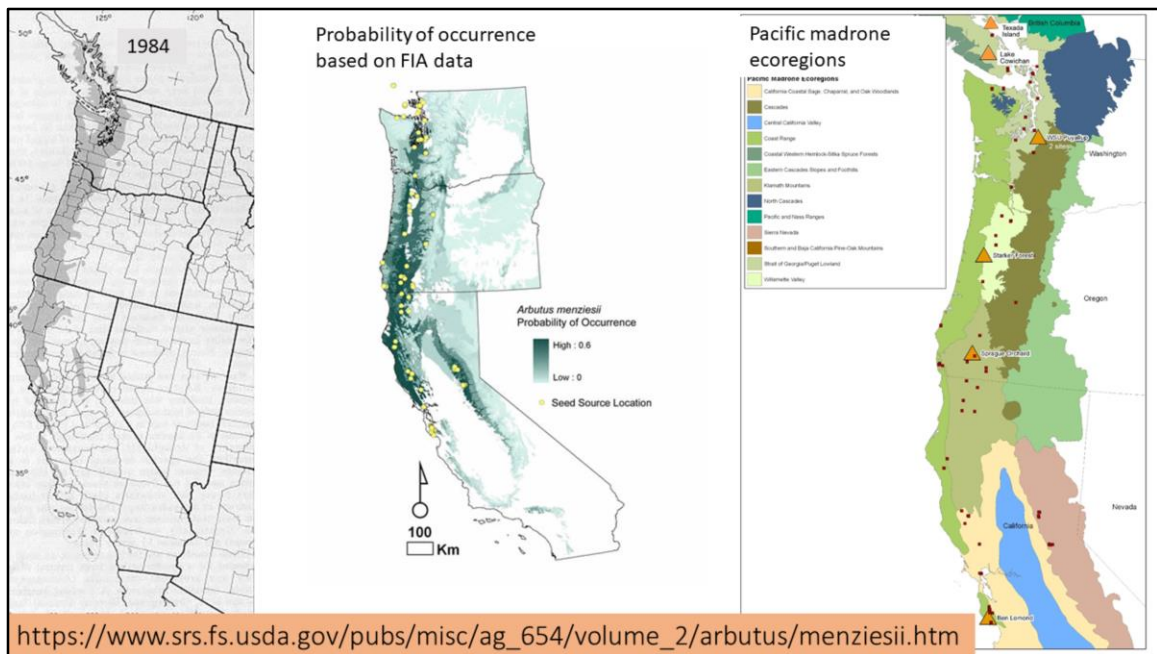
They are all sick. Cankers, lesions and browning leaves are outward expressions of various plant pathogens that transmogrify this already unique-looking tree. Sadly, [the species is on the decline across its native range](#), but *they are not all sick and dying*. We see healthy trees and patches in the city and around the Puget Trough. If you are not a believer, let me know and I will send you some pictures.

If they are leaning, they are going to fall over. The species show a great deal of plasticity as they grow and advantageously reach for available light. A little (or even a big) lean doesn't necessarily mean the tree(s) will fail. [Reputable arborists can properly assess risks associated with any leaner.](#)

It is hard to grow. Some horticulturalists have refined some [propagation methods that are specific to the species](#). We are long overdue to share this knowledge with each other – and always willing to learn more.

It is hard to transplant. We are pleased to be acquainted with many talented greenthumb folks, and our team and volunteers have successfully transplanted plugs/seedlings into larger containers for later planting in greenspaces.

Not a lot of nurseries grow it. Maybe this is because of the reasons mentioned above.... If outside growers cannot provide, we can grow it ourselves – in the greenhouse, or in our backyards!



The Pacific madrone (*Arbutus menziesii* Pursh) tree is the largest member of the family Ericaceae. It is the most distinctive hardwood tree native to the West Coast of North America, ranging from southwestern British Columbia to southern California. In natural forest ecosystems, the tree is rarely dominant, but diagnostic of unique plant communities found on drier, lower elevation sites as well as on coastal bluffs and mountains. Pacific madrone trees are relatively drought tolerant and fast growing, but they do not tolerate extreme temperature changes.

The map on the left is from 1984 and shows the range of Pacific madrone in the darker grey color. One of our goals is to update this map.

The map in the middle shows the suitable range for madrone based on FIA (Forest Inventory and Analysis) data.

Very little is known about the genetics of madrone, including variation in resistance to pathogens and other adaptive traits. The yellow dots are locations where seed has been collected from madrones for the common garden study. These common gardens have progeny from the same 105 trees planted at six locations, shown by triangles on the map to the right. Level III ecoregions are also shown on this map. These are areas with similar climate, biotic, and geological properties.



Madrone associations with other trees from North to South



CONDITIONS

Shade moderate to low tolerance

Adapted to mild winters and drought tolerant

Soil Types bare/thin/mineral to rocky soils

Slopes rocky sites, such as bluffs, up to 5,000 feet

Aspect south facing, common near saltwater

Stand Type light canopy densities with Douglas-fir, ponderosa pine, redwood, oaks, tanoaks

Disturbance timber harvest, postfire environments

Described as a slow-grower, but can be long-lived ~200 years old. 100 feet is about the upper threshold in height. There is a Big Sur madrone in 2014 debuted on the American Forests Champion National Tree Register - circumference of 327 inches, height of 125 feet and crown spread of 112 feet.

Growth can be tall and straight, but we often think of them growing in “low and shrubby” with multiple stems on poor sites especially on south-facing benches and ridges.

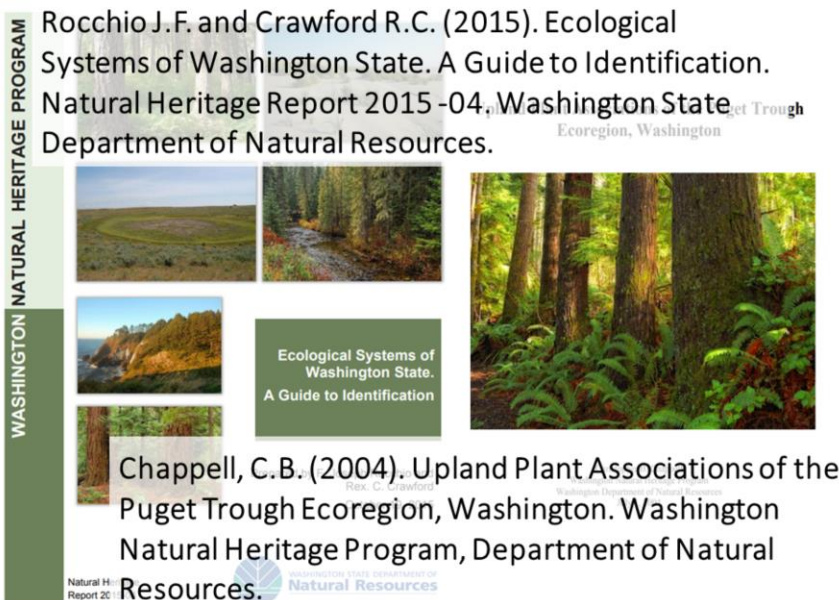
Madrone need well-drained coarse or shallow soils.

Establish in disturbed areas, along road cuts, on bare mineral soil, at the base of trees, or in semi-open forests.

Madrone is likely a “hub for mycorrhizal fungal diversity and connectivity”



The massive, wide-spreading root system is associated with ericoid mycorrhiza. The fungus is characterized by “coils” that form in the epidermal cells of the fine hair roots of ericaceous species. The fungi colonize the root cells and establish hyphal networks around the roots, providing increased water and nutrient absorption while the plant in turn provides the fungus with carbohydrates through photosynthesis. Ericoid mycorrhizal fungi also have hydrolytic and oxidative enzymes that are important in mobilizing nutrients from organic matter and leaf litter. This is a big reason for madrone’s ability to persist through drought and thrive in relatively harsh conditions such as rocky bluffs or soils we may characterize as “nutrient deficient.”



In characterizing different parks and restoration zones, we have designated over 200 acres of Seattle's 2500 acres of forested parkland as Mixed Conifer Broadleaf Evergreen Forests. This forest type [is one of GSP's more uncommon reference ecosystems](#). We honor forests indigenous to the Puget Trough by tapping into data from known plant communities. Then, we apply that information to restorations where we know or think particular forests historically occurred. Much of our information on reference ecosystems comes from the treasure-trove at the [Washington Department of Natural Resources Natural Heritage Program](#).



PLANT COMMUNITIES

PSME-ARME/GASH

Douglas-fir - Pacific madrone / salal

PSME-ARME/HODI/LOHI

Douglas-fir - Pacific madrone / oceanspray / honeysuckle

PSME-ARME/VAOV

Douglas-fir - Pacific madrone / evergreen huckleberry

REFERENCE

a **model**, or target, for the local native ecosystem being restored...

derived from **multiple sources of information**, aims to characterize the condition of the ecosystem...

adjusted as necessary to accommodate **changed or predicted biotic or environmental conditions**....

does not...immobilize an ecological community at some point in time, but rather to optimize potential for local species and communities to recover and **continue to reassemble, adapt, and evolve**.

McDonald T, Gann GD, Jonson J, and Dixon KW (2016) International standards for the practice of ecological restoration – including principles and key concepts. Society for Ecological Restoration, Washington, D.C.



Preservation of madrone forests is key to conserving biodiversity and human health. Further, restoration and management is part of stewardship of the species. This next section I will present is important because we often cannot rely on natural regeneration of madrone forests due to a variety of changing environmental conditions. We often want to add trees our property or replace trees that have been lost in parks.

For propagation, it is helpful to plan ahead to collect local seed. However, a few degrees of global warming may mean that your local trees will not be adapted to establish and move across a fragmented landscape in the future.



Phenology of Flowering & Berry Time

It is possible to purchase seed online AND it is probably advantageous to trade/sell seed to maintain biodiversity moving forward in our changing world.

flowers fragrant, in large
drooping clusters - panicles

calyx is 5-parted surrounding
the urn-shaped, united petals
| petals are 6-7 mm long |
ovary superior | 10 stamens
with pilose filaments near the
base | anthers are awned
from the back to near the tip,
and open by terminal slitlike
pores



Flowering now from April to May! Flowering ends in June across the range.
The blossoms are dense, drooping clusters (terminal **panicles**) of small, white, urn-shaped flowers. Urn=Resembles an upside down rounded vase....



The tree can first produce berries a 3 to 5 years (McDonald 1990 & Roy 1974)

Annual crop intervals

The fruit is a berry is 0.3 to 0.5 in. in diameter, which ripens in the fall ~October, turning from yellow-green to bright red or reddish-orange.

Berries are characterized as “mealy.”

They persist long into winter, which is great food for birds when other food sources are restricted. Also carried away by rodents, deer and wood rats.

Berries have traditionally been used by people for food, cider and decoration

- berries eaten fresh, made into unfermented cider, or cooked and dried for later use

- fresh berries eaten in small quantities - high tannin content makes them astringent

- chew the fresh or dried berries for flavor

- strung to make necklaces or decorations

- used as bait to catch steelhead

Collection & Storage

Wet vs. Dry storage

Store at 34°F (4°C)
for at least 2 years,
and at 1-4°C for
longer periods



Don't encourage people to store in plastic bags.

Seed Collection Time: October - December

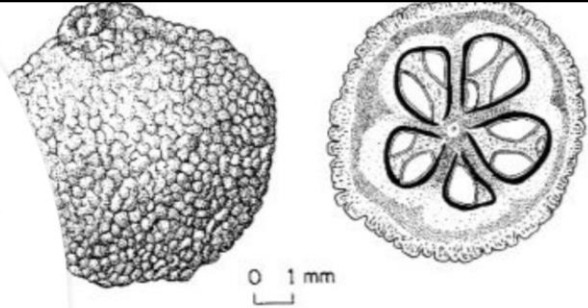
Berries can be dried at room temperature and stored at 34°F (4°C) for at least 2 years,
and at 1-4°C for longer periods

Berry Preparation & Seed Extraction

Soak berries overnight

Separate seeds ~2-40 per berry

DYI soak seeds over winter and spread them in late winter/early spring



Seeds can be separated from the pulp of fresh or dried berries.

Number of seed per berry ranges from ~2-40

To extract seeds from dried berries, berries can be soaked in water (generally overnight)

DYI Alternative is to soak them overwinter and spread them by hand on choice sites in the late winter/early spring



Berry Preparation & Seed Extraction

macerate or blend
 dry at room temp for 1 week
 separate seed from pulp
 air, hand or toothpick
 can store in jars at 34°F

macerate and float off pulp - blended in cold water in a blender at low speed for 2-5 minutes

After maceration, float off the unripe seed and outer parts of the berry.

Spread and dry seed at room temp for one week.

Can store in glass jars at 34 deg F

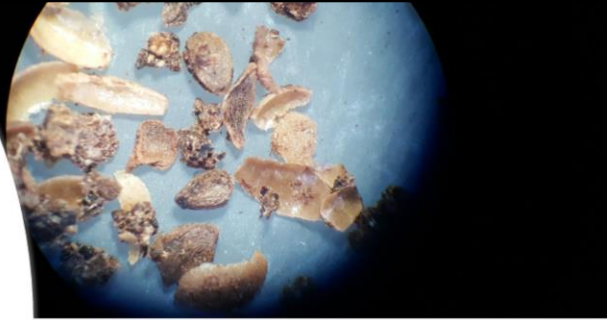
Cold Stratification & Seeding

After-ripening period broken by chilling

20-90 continuous days at 1 to 2°C (36° F)

40 days and 60 days is "good"

DYI stratify outdoors over winter



Temperate plants often exhibit dormancy. An after-ripening period can be broken in nature by chilling. Dormancy within species can differ depending on which elevation or latitude of mother tree.

Breaking dormancy artificially usually leads to increased and more uniform germination and more baby seedlings.

Stratification: cold stratify for 20-90 continuous days at 1 to 2°C will improve germination.

At what point is there diminishing benefit from longer stratification period? 2°C (36° F) to 40 days and 60 days can produce good germination.

DYI Alternative is to stratify naturally outdoors over winter.

Germination: Use sand medium, sow seed 1/16" deep, tamp the soil, keep moist.

Sow in plug trays and top-dress lightly with fine vermiculite.

Germinate at 68-80 deg F

Naturally seedlings succumb to drought(soil moisture), fungus, litterfall, and invertebrates. Damping-off fungi (*Pythium spp.*) can have a large impact on seedlings in the nursery.

Drench with a fungicide to prevent damping-off (optional).

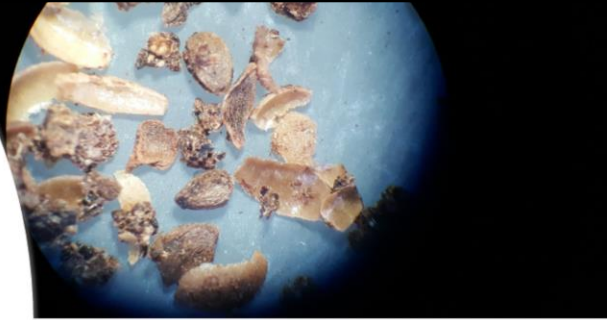
Fertigate weekly at 100 ppm N to start, building up to 300 ppm N at the end of plug stage.

Germination

Use sand medium, sow seed 1/16" deep, tamp the soil, keep moist

Sow in plug trays and top-dress lightly with fine vermiculite

Germinate at 68-80 deg F



Temperate plants often exhibit dormancy. An after-ripening period can be broken in nature by chilling. Dormancy within species can differ depending on which elevation or latitude of mother tree.

Breaking dormancy artificially usually leads to increased and more uniform germination and more baby seedlings.

Stratification: cold stratify for 20-90 continuous days at 1 to 2°C will improve germination.

At what point is there diminishing benefit from longer stratification period? 2°C (36°F) to 40 days and 60 days can produce good germination.

DYI Alternative is to stratify naturally outdoors over winter.

Germination: Use sand medium, sow seed 1/16" deep, tamp the soil, keep moist.

Sow in plug trays and top-dress lightly with fine vermiculite.

Germinate at 68-80 deg F

Naturally seedlings succumb to drought(soil moisture), fungus, litterfall, and invertebrates. Damping-off fungi (*Pythium spp.*) can have a large impact on seedlings in the nursery.

Drench with a fungicide to prevent damping-off (optional).

Fertigate weekly at 100 ppm N to start, building up to 300 ppm N at the end of plug stage.

Transplanting & Outplanting



Transplant to individual containers when large enough to handle
After two months (approx.), transplant plugs into pots for one season, after which they are outplanted to the field.

Transplant seedlings before third year in pots to avoid transplant shock
Can sow seeds/berries directly into site prepared with peat/compost?

Transplanting & Outplanting



Need air circulation, select planting sites on the edges in full sun to partial shade with well-drained soil to minimize fungal diseases. Does not tolerate waterlogged sites. Sun exposure dries the water on foliage quickly, reducing leaf disease. Infrequent, deep watering if needed so not to facilitate root fungal pathogens.

Ideal size at outplanting

Site and soil prep to alleviate compaction

Installation. "Companion" plantings of understory species

Establishment

Wildlife/madrone interactions

- Pollinators
- Habitat
- Food
 - Deer - browse
 - Birds – seed dispersal
 - Slugs – seedling mortality
- Damage
 - invertebrates
 - rodents
 - deer



Animals use madrone trees for a number of purposes. Pollinators feed on the nectar in flowers. Birds use the trees for nesting as well as feeding on berries in the fall. Seeds dropped by birds are an important way for madrone to spread into new areas. Animals like deer and slugs feed on the foliage, and some rodents can kill trees by undermining the roots or chewing bark from the base of the stem.

Madrone is animal pollinated

- Flowering from mid-March until June
- Time of flowering under genetic control
- Bees, butterflies, hoverflies, and hummingbirds attracted to nectar



Many trees in the PNW region are wind pollinated, but madrone flowers are pollinated by animals. Many types of insects, including bees, flies, and ants are attracted to the nectar. If you are lucky you might see a hummingbird visiting the flowers. The timing of flowering is determined genetically and madrones in the southern population may flower earlier than in the north.

Insect damage

Serpentine leaf miner
(*Marmara arbutiella*)

Black vine weevil
(*Otiorhynchus sulcatus* F)



Wood boring beetle
(probably Buprestidae)



Fall webworm (*Hyphantria cunea*)

Damage commonly seen in summer months in SW Oregon.



Insects cause minor damage to madrone trees. Larvae of leaf mining moths feed in the foliage. The fall webworm is a moth whose larvae feed on a range of hardwood tree foliage. The tents full of caterpillars are unsightly in landscape plantings but rarely have an impact on tree health. They are more commonly seen on madrones in southwestern Oregon.

The black vine weevil is common on rhododendrons and other hosts, and can move into a landscape in potted plants from a nursery. Adults feed on the foliage and larvae on the roots.

Wood boring beetles colonize dead wood and can introduce decay fungi into the tree.

Fungal diseases can attack any part of the tree

- Root disease
- Stem and branch cankers
- Wood decay
- Branch dieback
- Foliar blight
- Leaf spots
- Fruit mummies



Most fungal pathogens are native to the western US. Stem and branch diseases and also root diseases are the most damaging. Foliar blight looks bad in some years but is usually not life threatening, unless it's severe enough to kill the terminal buds.

This tree has Phytophthora root disease and branch dieback caused by several fungi. It does not have obvious foliar disease because it's in a dry site in California.

Root disease

- *Phytophthora* (*P. cactorum*, *P. cinnamomi*)
- *Armillaria* (*A. gallica*, *A. mellea*)
- *Heterobasidion occidentale*

Mushrooms of *Armillaria* spp.
inside a madrone tree.

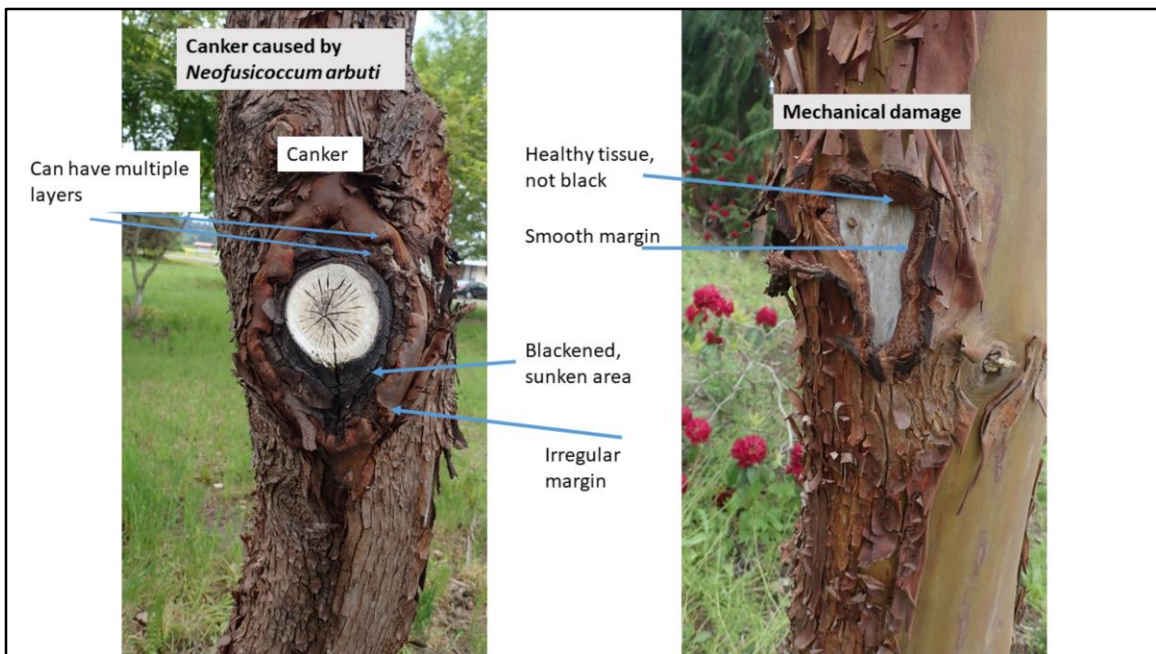


www.shroomery.org



Phytophthora root
disease – a problem
in wet soils.

The most common root rot is caused by *Armillaria*. There are several species that attack a wide range of hosts, and it is found everywhere. It causes a white rot at the base of the tree. Rarely you can see mushrooms in the fall as in the photo. Most *Armillaria* species are not aggressive and are fairly slow moving, only causing problems when the tree is under stress. *Heterobasidion occidentale* occasionally causes root and butt rot on madrone but is more common on douglas fir and western hemlock. If infected hosts are in the area the fungus can move onto nearby madrones. *Phytophthora* root disease is caused by several species of *Phytophthora*. It has swimming spores that attack roots in saturated soils. Root disease symptoms, such as wilting foliage, are the same as drought symptoms because the damaged roots are not taking up water.



The canker fungus *Neofusicoccum arbuti* infects the stem and branches, and can also cause shoot blight. On the woody tissues, most infections occur through injuries from freezing, sunburn, or pruning cuts, but under ideal conditions the fungus can infect uninjured bark. All ages and sizes of madrones are affected with larger older madrones having the most mortality.

Spores are produced in dead bark around the edges of the canker and can spread to other parts of the tree in water or wind. The fungus kills the live bark and sunken cankers with irregular, black margins form. Damage to the bark creates an environment that the spores can colonize, so cankers are often centered on a branch stub or an injured area. Bark damaged from sunscald can also become infected. Rapidly spreading cankers have smooth margins and no callus tissue. Cankers may spiral around, girdling and killing trunks and branches. Non-vigorous trees may decline rapidly and die in a year or two while more vigorous trees may persist for years with multiple cankers.

Notice that the tree on the right that has mechanical damage is forming healthy callus over the wound.

Wood decay

Often associated with insects
– wood borers and
dampwood termites

Cavity nesting birds prefer
trees colonized by wood decay
fungi

Large Pacific madrones often
have heart rot



This large pruning cut was colonized by wood boring beetles, as can be seen from the exit holes in the wood. The beetles can carry spores of bluestain and wood decay fungi. A wood decay fungus is fruiting on the dead wood. Trees can live with wood decay but they will fail if they become structurally weak. The heartwood is not very decay resistant, as a result cavity nesting birds use large madrones with heartrot for nesting sites.

Foliar fungi

- Leaf spot
- Leaf blight
- Blister blight
- Rust
- Sooty mold



Leaf spot



Rust



*Exobasidium
vaccinii* on fruit

"At least 19 different fungi
are associated with leaf
spots on madrone"
Byther, 1999

There are many fungi that have been associated with foliar disease symptoms on madrone and they are poorly understood. Some of them cause severe leaf blight and also infect shoots, causing shoot dieback. Others cause minor symptoms. Different fungi predominate in different years depending on the climate conditions. Some of the fungi colonize the fruits, which may affect regeneration from seed and also food supplies for wildlife. We will discuss a few of the more common ones.

Shoot and leaf blight



"Large, dying branches appear to have a necrotic leading front similar to a cambial killing canker... Limited isolations from such cankers have yielded a species of *Phacidiopycnis*. This fungus was not pathogenic in healthy madrone." Hunt, 1999.

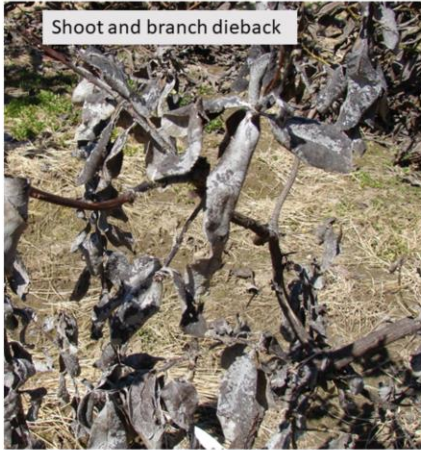
Phacidiopycnis washingtonensis

The fungus was also isolated from leaf spots on emerging foliage, lesions on green shoots, and the petiole and leaf blade of dead, attached leaves.

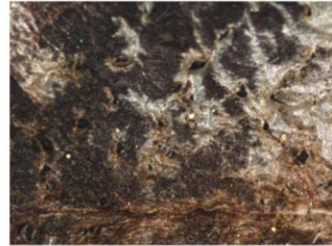
We define foliar blight as blotchy, brown lesions that are usually on the edges or tips of leaves where water collects, but in severe cases can infect the entire leaf. Two fungi are associated with this symptom and predominate in different years, we think depending on whether there has been a cold winter. *Phacidiopycnis washingtonensis* is a fungus that causes rot in apples that are in cold storage and is triggered by cold temperatures. In addition to blight on mature, fully expanded leaves, *P. washingtonensis* also infects emerging foliage in the spring. It can survive in dead, attached leaves and work its way into the shoot. In severe cases the terminal bud can be killed and the branch will not refoliate. It is very difficult to manage a disease like this.

The other fungus, *Phomopsis vaccinii*, is found on a wide range of other hosts including blueberries. Both of these fungi may be present as endophytes and not cause symptoms until conditions are right. Foliar blight is worsened in conditions of high humidity and the most severe symptoms tend to be in the lower part of the canopy. In urban environments, having good air circulation and reflected heat off of a surface such as a wall or road will help to reduce the damage caused by these fungi.

Botryosphaeria spp.



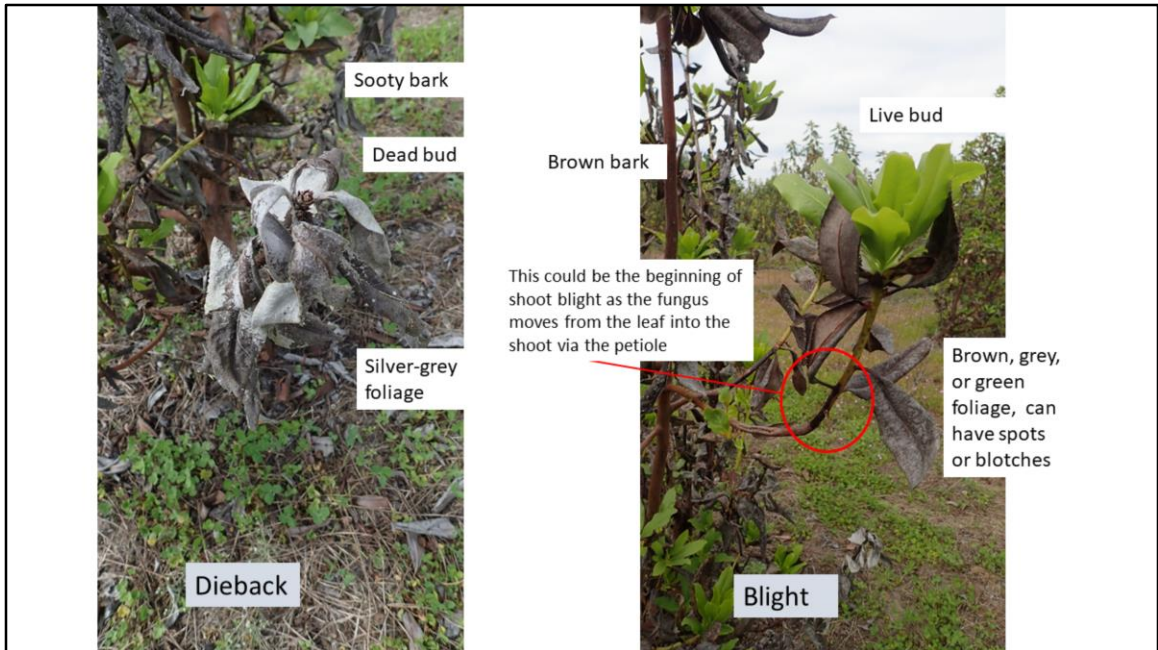
Branches look "burned" or sooty



Pycnidia erupting through leaf cuticle



Branch dieback and canker caused by several *Botryosphaeria* species makes the branches look burned or sooty. Leaves on these branches are silvery because the fungal fruiting bodies are separating the leaf cuticle from the rest of the leaf. These pycnidia produce spores in wet weather. The fungus can live in the wood in a latent, or symptomless phase until the tree or branch is under some kind of stress. This can be shade stress in interior branches, or water stress on branches that have a canker girdling the base. Once branches die back they do not refoliate.



Here are some differences between branch dieback, caused by *Botryosphaeria*, and leaf blight symptoms. The main difference is that the branch can refoliate after leaf blight, but not after branch dieback. Also the foliage is brown from leaf blight and silver from branch dieback.

Fungal diseases are affected by climate conditions

Cold, wet winter/spring:

Symptom expression –
cold damage, foliar blight



Warm, wet spring:

Fungal sporulation,
germination, infection

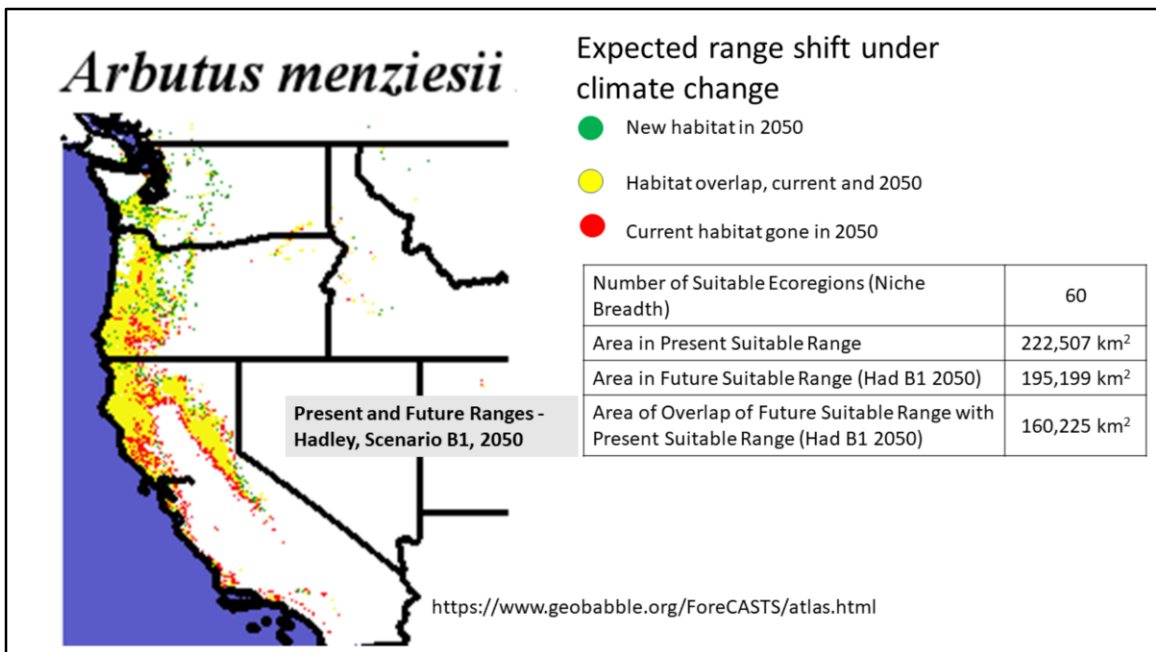
Warm, dry summer:

Drought
Symptom expression –
canker, dieback, root disease



Temperature and precipitation are expected to increase in PNW. This will affect insect pollinators and diseases of Pacific madrone.

Fungal diseases are affected by climate conditions. Fungi need warm, wet conditions for spore production, spore germination, and infection of the host. During hot, dry conditions when the tree is under drought stress, it can't defend itself as well and disease symptoms will appear, such as canker expansion, wilting, and branch dieback. The climate in the PNW is expected to be warmer and wetter in the future, and this will affect diseases as well as insect pests and pollinators on madrone.



In addition to changes in disease on madrone, we expect the range to shift northwards and to the east under climate change. The amount of habitat suitable for madrone is estimated to shrink by about 14% by 2050.

MADRONE HEALTH DECLINE

Climate
Management practices
Fire suppression
Urbanization
Fungi and oomycetes
Insects
Wildlife



There are many factors that contribute to the madrone decline. Fire suppression in natural forests, leading to crowded stands and high humidity increase shade stress and foliage diseases. Soil loss and compaction, mechanical damage, and other urban impacts increase susceptibility to diseases such as canker, heart rot, and root disease. Increase in disease severity we attribute to both extended drought and higher frequency of warmer, wetter spring weather.

But madrones can survive and do well in other environments, such as in the open where there is plenty of light and low humidity. In urban environments this can be near a building that provides reflected heat.

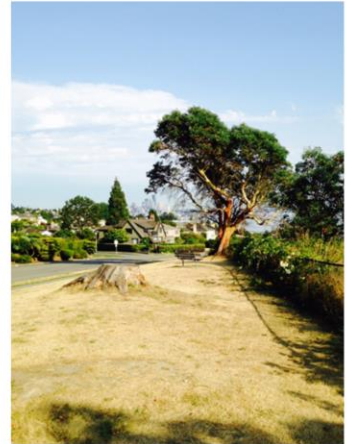
American Forests "Famous and Historic Tree" at Magnolia Bluffs, Seattle, WA



1996




2004



2014

Here are some photos of the Famous and Historic Tree at Magnolia Bluffs Park in Seattle. Some people from American Forests came and collected seed from this tree, and had a ceremony about it. Unfortunately, by 2004 the tree was more than half dead from branch dieback and canker, and by 2014 the tree was removed. Many of the madrones along Magnolia Boulevard are suffering from these diseases. We have learned a lot about what not to do with madrones in the landscape and some best management practices have been developed. For example, madrones have different requirements for water and nutrients than turf, so they do not survive as well in a lawn or similar landscape situation.



TAKEAWAYS

- Focus on sites with **well-drained soils**, rocky soils, south and west aspects.
- In the absence of fire – try **thinning** to reduce canopy competition + **controlling** invasive species.
- Choose sites with **compatible woody vegetation** & mycorrhizal associations.
- ✓ **Avoid** soil compaction/alteration, irrigation, fertilization, pollution, and physical damage.

AVAILABLE NOW

Help Our Nation's Trees!

Invasive diseases and pests threaten the health of America's forests. Scientists are working to understand what allows some individual trees to survive, but they need to find healthy, resilient trees in the forest to study. That's where concerned foresters, landowners, and citizens (you!) can help. Tag trees you find in your community, on your property, or out in the wild using TreeSnap! Scientists will use the data you collect to locate trees for research projects like studying the genetic diversity of tree species and building better tree breeding programs.

Meet the scientists that use TreeSnap data

Download on the App Store

GET IT ON Google Play

Leaderboard
Top Submitters of All Time

- Floradiff Nature Sanctuary**
Submitted 164 observations
- Ben Jarrett**
Submitted 113 observations
- Jared Westbrook**
Submitted 104 observations

Observation Feed
Latest Observations

- Other**
Submitted by Anonymous User
41 minutes ago
- Pacific Madrone**
Submitted by brian caughtlan
2 days ago
- Pacific Madrone**
Submitted by brian c
2 days ago

Tweets
Latest Tweets by @treesnapapp

Tweets by @treesnapapp

WSU Puyallup REC
@WSUPuyallupREC
Did you know you can also help our nation's trees through @TreeSnapApp? 🌳🌳🌳
Tag trees in your area using the #TreeSnapApp and scientists will use that to locate trees for studying and research! #science

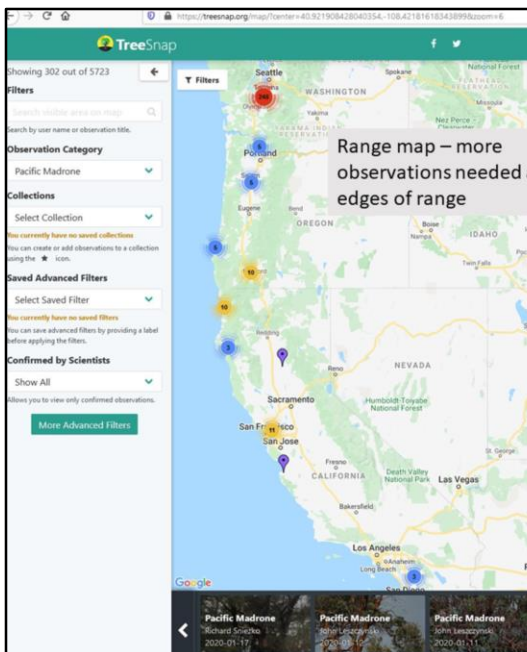
treesnap.org funded in part by [NSF Plant Genome Research Program](#)

<https://treesnap.org/>

We are using TreeSnap to collect data on madrone. This app was developed to help researchers identify trees resistant to invasive pests such as the emerald ash borer, in order to breed resistant trees and protect native populations.

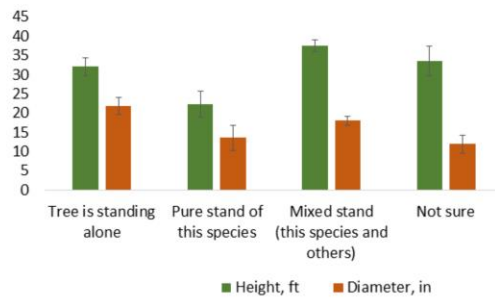
For madrones, TreeSnap data will help with conservation and restoration of the species by recording individual tree health to understand disease tolerance. We also want to identify a true range for the tree because existing range maps are incorrect.

The app is free and available for both android and ios.



What we do with the data

Treesnap Observations (N=322)



Data on growth, health condition, effects of management, etc.

How to get involved

- Use TreeSnap to help us map the range and health condition
- Join the Arbutus ARME mailing list
- Contribute to newsletter – share your madrone stories!

ppo.puyallup.wsu.edu/pmr/

Other ideas? email us
arbutusarme@gmail.com



@arbutusarme

Resources

Chappell, C.B. (2004). [Upland Plant Associations of the Puget Trough Ecoregion, Washington](#). Washington Natural Heritage Program, Department of Natural Resources.

Elliott, M. et. al. (2012). [Range-wide genetic variability in Pacific madrone \(*Arbutus menziesii*\): examining disease resistance, growth, and survival in a common garden study](#).

Kennedy et al. (2012). [Arbutus menziesii facilitates regeneration dynamics](#). Am. J. Bot. 99(10): 1–11.

Lintz, H.E. et. al. (2016). [Quantifying density-independent mortality of temperate tree species](#). Ecological Indicators, 66, 1-9.



Resources

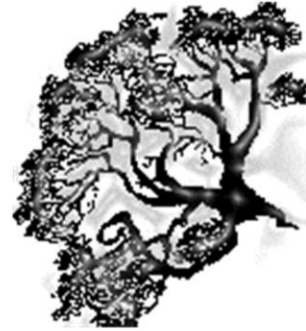
Niemiec et al. (1995). [Hardwoods of the Pacific Northwest](#).

Seattle Urban Nature (2008). [The State of Seattle's Madrone Forests](#).

Silvics of Forest Trees of the United States
http://www.na.fs.fed.us/spfo/pubs/silvics_manual/volume_2/arbutus/menziesii.htm

Trudell, S.A. et. al. (1999). [Possible Role of Mycorrhizas in Resistance to Decline in *Arbutus menziesii*](#). In: Adams, A. B.; Hamilton, C.W., eds. The Decline of Pacific Madrone....

USFS Plants Database - Fire effects reference
<http://www.fs.fed.us/database/feis/plants/tree/arbmen/all.html>



Resources

Adams, A. B.; Hamilton, C.W., eds. [The Decline of Pacific Madrone \(*Arbutus menziesii* Pursh\): Current Theory and Research Directions....](#)

Gurung, Janita; Adams, A. B.; Raphael, Martin G. 1999. A review of the use of Pacific madrone by nesting, pollinating and frugivorous birds, and

Maleike, R. & Hummel, R.L. (1999). The propagation of *Arbutus menziesii* from seed.

Garry Oak Ecosystem Recovery Team (2018). [Propagation guidelines for *Arbutus menziesii*.](#)

Harrington, C. A., Lodding, C. C., & Kraft, J. M. (1998). [Extraction and germination of Pacific madrone seed.](#) In Proceedings of the symposium on native plants, propagating and planting (pp. 9-10).

