

Management options for declining madrones in urban areas of the Puget Sound

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<http://students.washington.edu/melliott/arbutus/ManagementOptions.htm>

There is a large population of overmature madrones in the Puget Sound area due to lack of disturbance by fire to destroy and regenerate the aerial stems, and also due to urbanization and the retention of these trees in parks and as street trees. Trees growing in the urban environment are expected to have shorter lifespans than those of the same species growing in their natural habitat (Manion 1991). The type of management for Pacific madrone decline depends on the objective. If large diameter single stem trees are desired, one must keep in mind that this type of madrone is overmature and more susceptible to decline than smaller trees. Large, overmature trees are less buffered to the effects of environmental stress than small trees. This is especially true of a species which is characterized as being adapted to frequent disturbances, especially fire (USDA 2001).

However, there exist trees of this type that are healthy. The large madrone in the parking lot behind the Burke Museum at the U.W. in Seattle and the giant madrone tree in Port Angeles at 8th and Cherry Streets are two examples. Both have full, spreading crowns and very little canker and branch dieback. They may be genetically superior and disease resistant, or the microclimate may be important in their survival.

Microclimate

These two trees have in common the low humidity provided by heat reflection off the impervious surfaces of asphalt parking lot or city street, and they are both relatively protected from exposure to wind. The low humidity environment prevents heavy infestation by foliar pathogens resulting in defoliation in the late spring/early summer, then sunscald injury to the exposed branches. Colonization by canker fungi later in the summer causes water stress and branch dieback. This is the beginning of the decline cycle that is difficult for a mature tree to break out of unless it has a large amount of stored starch that can be used in defense, either as inducible chemical defenses or as callus growth. Madrones are well-suited for this type of environment because they are drought-tolerant and can be deeply rooted (Field et al. 1983, Zweinecki and Newton 1996). However, madrones cannot tolerate extreme drought and do best in climates with high light intensity and abundant water (Morrow and Mooney 1974, Hunter 1997).

The declining madrones at Magnolia Bluffs Park in Seattle are subject to high winds. Trees growing in a windy area are often stunted because wind damages the vegetative buds and growth slows (Thomas 2000). Wind can cause stress on trees growing in the open by increasing transpiration from the leaves and causing desiccation of the bark (Bernatzky 1978, Larcher 1995). The original forest at Magnolia Bluffs was more dense and Pacific madrone was mixed with other hardwoods and conifers. This provided protection from the wind to individual madrone trees. Older madrones that

were part of the forest had tall trunks and leaned out into the open at the edge of the bluffs, because madrone is relatively shade-intolerant. In pure stands of madrone, such as the ones on Vashon Island and Arroyos, the trees are healthy because they are growing in a group and not isolated as the Magnolia trees are. Many of these trees also have multiple stems, indicating past disturbances. These stands are located on bluffs similar to Magnolia, although there may be some differences in soils and other factors.

There was a dense coniferous forest at the top of Magnolia Bluffs in a photograph taken by the Olmsted brothers in 1903 (Snoey, 1998). Gradually the area was cleared until only the madrones remained from the previously surrounding forest. Any trees left from that period would be more than 100 years old and overmature. Healthy madrones are in conflict with preserving views in the bluff environment because their natural state in such environments is to be surrounded by other trees, which help to dampen the effects of the wind. When growing in isolation under windy conditions, madrones may tend to adopt a bushy growth form, especially if nutrients and water are limiting.

Soil conditions

Trees with a full crown need to have a healthy root system, because the amount of foliage determines the demand for water. Trees with less foliage require less water and so can tolerate some root losses. Good growing conditions for roots are in well-aerated soils which are not waterlogged or compacted. Roots can grow for a long distance under impervious materials to areas with better growing conditions.

Poor soil conditions result in fewer fine roots, water stress on the whole tree, and then decline. Mulching lowers bulk density of the surface soil and increases the amount of organic matter and fine root growth. Soil replacement in selected areas of the root zone of mature trees has had some good results (Watson et al. 1996). Best results (increased fine root density) were obtained by replacing the soil with compost and were attributed to increased N availability. Decline symptoms were reversed in some cases. A layer of organic mulch applied to the soil surface within the dripline of the tree should be tried before something as drastic as soil replacement.

Soil chemistry is also important in maintaining tree health. Soils low in available N will encourage mycorrhizal fungi to colonize tree roots, and these fungi will disappear in lawn or other environments which are regularly fertilized with inorganic N. Madrones have a high nitrogen-use-efficiency (photosynthetic rate related to leaf N content) relative to other sclerophyllous plants and may not do well under conditions of excess N (Field et al. 1983). Tree age and forest successional stage also influence the amount of nutrient uptake by trees. Nutrients are most heavily used during the exponential growth phase of the tree, and uptake slows after canopy closure (Hunter 1993).

Management Recommendations

Summary of management recommendations for madrone in the urban environment:

1. Avoid predisposing factors - In general, predisposing factors should be avoided, although it is not always possible. It should be recognized that overmature trees will not recover from a stress or inciting factor at all or as rapidly as young trees.

Plans should be made for their removal and replacement by younger, healthier trees. It is possible that the madrone decline was first noticed in the Puget Sound area in the 1970s because of severe droughts in the 1965, 1967, and 1970 (Russell 1995). The trees first affected and most noticeable were the large, overmature madrones at Magnolia Bluffs which were growing in an especially stressful environment. Later droughts in 1987-1995 made the condition more apparent. These trees are showing signs of decline after the stress was removed. They cannot afford to lose much foliage because their leaf area is fixed or declining and their respiratory area is increasing. Older and larger trees have a higher demand for water and die back to reduce their photosynthetic surface area and water needs. This causes a decrease in diameter growth which is needed for creating more xylem transport between the crown and roots. The older trees respond more slowly and may instead direct their energy into reproduction, rather than repair and maintenance (Manion 1991).

2. Protect trees from excessive wind exposure -- Protection from wind increases thickness of the leaf boundary layer and reduces transpiration rate and water stress. Wind stress would be lessened in a clumped arrangement of trees rather than single, isolated trees.
3. Prevent severe water stress -- It may be a good idea to surround madrones in parking lots and streets with some areas of pervious material for better availability of water to the roots by using the occasional drain, grating, or perforated block. During periods of drought, irrigate trees on gravelly or sandy soils if there is no rain for more than 2 weeks. Applying mulch to these soils in early summer will help to retain water. The mulch should be 6-8 inches thick. (Russell 1995).
4. Open growing conditions – allows madrones to develop a full crown and avoids tall thin trunks because the species is relatively shade-intolerant. Seedlings establish better in open canopies on exposed mineral soil. Humidity and the resulting damage from foliage diseases is reduced. Keep conditions similar to sites with high fire frequency that madrones are adapted to. They are an early successional species, and do best in situations with open canopies, low humidity, low nutrient soils, and little competition from other plants (USDA 2001). Trees with multiple stems and a high ratio of crown foliage to stem mass have fewer cankers and less branch dieback. Multiple stems are a result of resprouting after fire. Make changes to the environment around trees slowly because madrones do not respond well to sudden changes. Remove surrounding trees or prune gradually to reduce the amount of sunscald injury.
5. Do not disturb soil by compaction or changing the water table, which would cause either drought or waterlogging. The madrones are prone to *Phytophthora* under these conditions, or are damaged and become infected by canker fungi and butt rot. Adding fertilizer is not a good idea unless it is to improve shoot growth after defoliation or dieback due to a stress in young trees on nutrient-poor soils. Plant native shrubs or mulch around madrones and avoid planting lawns. Lawn requires more N and water than madrones, and the soil gets compacted from use. Remove lawns around existing madrones, and mulch around trees to improve permeability and retain water. Some trees may need the soil replacement treatment for compacted soil (Watson et al. 1996). Trees growing in moist areas such as low-

lying areas and lawns may have *Phytophthora* root rot. Changing the soil conditions by replacing the lawn with shrubs or improving drainage may be necessary.

6. Avoid defoliation stress, either by canker-induced branch dieback, radical pruning, or foliage diseases. Defoliated trees are low in vigor and cannot compartmentalize wounds effectively due to lower radial growth (Wargo 1977), especially in the case of older trees. They should be cut down and allowed to resprout after they have lost more than 50% of their crowns to dieback. The actual amount of dieback that would be tolerated can be determined on an individual tree basis.
7. Exotic plants to avoid are ivy and Scotch broom. Scotch broom (*Cytisus scoparius*) is a leguminous shrub that fixes N and may discourage colonization of madrone roots by mycorrhizal fungi if present in large quantities. English ivy (*Hedera helix*) covers the ground and prevents seedling establishment, and weighs down branches causing breakage. Ivy roots do not hold soil on slopes, so slope stability is compromised. Ivy and other vines (honeysuckle (*Lonicera ciliosa*), clematis (*Clematis vitalba*)) can encircle the trunk and cause girdling. These should not be permitted to climb on the trees.
8. Remove dead madrones or leave standing for wildlife habitat only if they have been dead for more than a few years, because recently dead trees can be a source of fungal inoculum. Standing dead trees can also be a food base for *Armillaria* root rot. This is especially true if the dead tree is near other trees. It may be advisable to keep dead trees of other species for wildlife habitat if *Armillaria* is not present, and remove the dead madrones.

Management for new plantings – Include madrones in a planting area with other native shrubs such as salal (*Gaultheria shallon*), ocean spray (*Holodiscus discolor*), and Oregon grape (*Mahonia aquifolium*). The soil surface should be covered with mulch or bark, never lawn. Avoid excessive watering leading to waterlogging of the soil. Water only during a drought period. The trees will do well in an area that is protected from wind and gets some reflected heat from buildings or asphalt. If decline symptoms such as cankers and dieback are seen, prune and destroy the branches, then fertilize and water if needed to encourage callus growth on young trees. This should be done in the late winter or early spring. Old trees should be cut down and allowed to resprout if they have lost more than 50 to 70% of their foliage to branch dieback.

[References](#) (available on website)