

The State of Seattle's Madrone Forests

Seattle Urban Nature
2008



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Citywide Habitat Assessment (CHA)

In 2005, Seattle Urban Nature (SUN) launched a citywide forest monitoring program known as the Citywide Habitat Assessment (CHA) to monitor improvements or declines in the state of Seattle's urban forests. This assessment builds on data collected during SUN's 1999-2000 Seattle Public Lands Habitat Survey, which provided vegetation information about 8,000 acres of public lands throughout Seattle (see <http://www.seattleurbannature.org/Survey/background.html> for more information). The aim of the CHA is to implement a long-term monitoring program using a repeatable, accurate methodology that measures specific indicators of forest function and health.

The first step in this process is to establish and sample baseline assessment plots in each of the eight forest types identified in the 1999-2000 survey (see Table 1). A previous report, released in 2006 focused on conifer/deciduous mixed forests in Seattle (available at: <http://www.seattleurbannature.org/Projects/citywide.html>). In this report, baseline information from three of the eight forest types identified in Seattle during the 1999-2000 survey will be highlighted: madrone forests, conifer/madrone forests, and deciduous/madrone forests. Information about the state of pure conifer forests in Seattle will be made available in 2009.

Once data for all eight forest types are collected, a "report card" will be released that summarizes and compares the health, existing conditions, and potential threats to all forested habitat types found on Seattle's public lands. Ultimately, SUN envisions that these plots will be revisited and future data will provide trend information on the health of Seattle's forests.

This report provides a comprehensive analysis of the existing condition of Pacific madrone (*Arbutus menziesii*) forested habitat in Seattle's parks and open spaces, and was made possible by a generous grant from the Bullitt Foundation. While less disturbed madrone habitat has been categorized in Western Washington (Chappell, 2004), little information presently exists describing urban madrone forests. We hope that this information will help us, as a community, to better understand our urban forests and will help guide a proactive movement for the restoration and preservation of these rare habitats.



(Top) Peeling madrone bark reveals a smooth surface underneath; (bottom) madrone leaves and orange berries.



Introduction to Seattle's Madrone Forests

Pacific madrone trees are broad-leaved evergreen trees that are native to the pacific coast of North America, ranging from southwestern British Columbia to southern California (Reeves, 2007). Madrone trees provide a number of important ecosystem and wildlife functions. Due to their propensity for growing on steep bluffs, madrones are key to stabilizing these erosion-prone areas. They also serve as important wildlife habitat year-round due to their evergreen leaves, natural cavities and abundant berries that last into winter (DOE, 2008). Trees greater than 12 inches in diameter are an important habitat component for primary cavity-nesting species such as the red-breasted sapsucker and hairy woodpecker. Secondary cavity nesters such as the downy woodpecker, house wren, and western bluebird also use Pacific madrone (FEIS, 2008). Madrones harbor many insect eating birds including the orange-crowned warbler, the chestnut-backed chickadee, and the Hutton's vireo. Berries provide a source of food for band-tailed pigeons, varied thrush, American robins, fox sparrows, dark-eyed juncos, cedar waxwings, spotted towhees and raccoons (DOE, 2008).

Pacific madrone forests were once far more common in the Seattle area, thriving on the well-drained slopes and bluffs overlooking Puget Sound and Lake Washington. Since European settlement, much of the original madrone habitat has been converted to residential development (Chappell & Giglio, 1999). In addition to loss of habitat, Pacific madrones are also susceptible to diseases caused by fungal pathogens that can be exacerbated by the effects of urban development and habitat fragmentation (Adams *et al*, 1999). A further limiting factor potentially affecting the current state of madrone forests in the Pacific Northwest is fire suppression. The absence of moderately frequent fire occurrences may be limiting regeneration and increasing susceptibility to disease (Chappell & Giglio, 1999).

The Seattle Public Land’s Habitat Survey completed by SUN in 1999-2000 shows the limited distribution of Pacific Madrone forests on public lands in Seattle. Pure and mixed madrone forests consist of approximately 128 acres, accounting for less than 5% of Seattle’s roughly 2,800 acres of forested habitat (Table 1). Pure madrone forests total only 25.3 acres (less than 1% of forested habitat) of existing public land and are mostly confined to the bluffs above Puget Sound in southwest Seattle. Because of their limited distribution on public lands and high ecological value, it is important to preserve and protect these areas as well as look for opportunities to acquire and protect remaining intact madrone forests.

Forest Type	Acres	Percent
Conifer/Madrone Mixed Forest	51.97	1.90%
Conifer/Deciduous Mixed Forest	361.5	13.20%
Conifer Forest	293.6	10.72%
Deciduous/Madrone Mixed Forest	50.88	1.86%
Deciduous Forest	1865.5	68.10%
Madrone Forest	25.27	0.92%
Palustrine Forested Wetland	69.3	2.53%
Riparian Forest	21.3	0.78%
Total	2739.32	

Table 1. Forest types, cumulative acreage, and percent of each type present in Seattle’s public urban forests (from SUN’s 1999-2000 survey). Forest types presented in this report are highlighted in red.

In order to ensure that the beauty and ecological diversity of Seattle’s Pacific madrone forests remain for future generations, it is important to understand their current condition and monitor the health of these habitats over time. In an effort towards these goals, SUN established and sampled permanent assessment plots throughout madrone and mixed madrone forest types from 2005-2007. Because of their limited size and distribution, a total of five plots were sampled in each of the existing madrone habitats for a total sample of 15 plots (Map 1). This translates to approximately a 1% sampling intensity for the conifer/madrone and deciduous/madrone mixed forests, and 2% in the pure madrone forests. Forested areas were randomly chosen for plot locations in each habitat type across the city.

The sampling unit for this survey consisted of a 164.04 foot (50 meter) x 26.25 foot (8 meter) plot. Plots were marked with a wooden stake and GPS coordinates were recorded. Data recorded at each plot included the species, height and diameter of all live and dead (snags) trees present. All coarse woody debris (CWD) (downed wood) greater than five inches in diameter were also recorded. Shrub, herbaceous, and vining plant species were identified within each plot and percent cover was recorded for each species.

Further information about the methods used in this survey is available in our report: “Methodology to Assess Habitat Conditions on Public Land in Seattle” (SUN, 2006).

Madrone Habitat Overview

Seattle's madrone forests vary considerably in both structure and composition across the city. Most madrone habitat on public land occurs in mixed forests with madrone trees occupying a co-dominant position among either a conifer or deciduous dominated canopy (Map 1). Pure madrone forests, on the other hand, have been limited to a narrow distribution where they occupy a more distinct niche. These areas tend to be rocky exposed sites with well drained soils, common to the bluffs and outcroppings overlooking Puget Sound and Lake Washington. Some of the best and most intact pure madrone habitat in Seattle occurs in the far south-western corner of the city in the Arroyos Natural Area and Seola Park vicinities and in Westcrest Park in West Seattle. Other notable forests can be found in the West Duwamish Greenbelt and in Lincoln and Seward Parks. Smaller madrone forest remnants can be found throughout the city, with notable stands occurring in Madrona Greenspace, Camp Long, Magnolia Boulevard Park, and Colman Park.



During the 1999-2000 survey, a total of 72 distinct areas of madrone associated forests were mapped throughout Seattle: 21 pure madrone forests, 19 conifer/madrone mixed forests, and 32 deciduous/madrone mixed forests (Map 1). These forests are located in a total of 30 parks and open spaces found across the city. Pure madrone forests are found in only 10 of Seattle's parks and open spaces.

A total of 81 plant species were recorded during the CHA inventory: 49 native, 30 non-native, and two that were undetermined. The deciduous/madrone mixed forest has the highest individual species richness with a total of 32 native species. In our study plots, the most common trees associated with madrones are Douglas fir (*Pseudotsuga menziesii*) in the conifer/madrone mixed forest and big-leaf maple (*Acer macrophyllum*) in the deciduous/madrone mixed forest. Pacific madrone densities and proportions are the lowest in the conifer/madrone mixed forests, which include relatively high densities of both red alder (*Alnus rubra*) and western red cedar (*Thuja plicata*) (Table 2). In forests categorized as pure madrone, madrone trees make up nearly 90% of the overstory canopy and have the highest densities at 186 trees per acre (Table 2).

On average, the well-developed shrub layer of these forests is dominated by beaked hazelnut (*Corylus cornuta*) and salal (*Gaultheria shallon*). Other common species include snowberry (*Symphoricarpos albus*), trailing blackberry (*Rubus ursinis*), ocean spray (*Holodiscus discolor*), and low Oregon grape (*Mahonia nervosa*) (Figure 2). The somewhat sparse herbaceous layer is generally dominated by sword fern (*Polystichum munitum*) with high cover of honeysuckle (*Lonicera ciliosa* and *Lonicera hispidula*) present in the pure madrone forests (Figure 3).



(Top) A pure madrone forest found on the bluffs of the Arroyos Natural Area in West Seattle; (middle) needles of a Douglas fir tree; (bottom) sword fern frond with sori.

Invasive Species Threatening Madrone Forests

In most habitats in Seattle, invasive non-native plant species occupy niches that have historically been filled by native flora. Introduced species do not necessarily provide the same habitat functions (food, water, shelter) in supporting native fish and wildlife species. Many invasive species become dominant to the exclusion of all other species on a site, thereby reducing overall biodiversity and ecosystem function in these urban forests and making them more susceptible to greater loss or damage resulting from disease, pests, and other disturbances. Ecosystems with impaired functions contribute less value to the social, biological, and economic goals of the City of Seattle. Knowing the extent and type of invasive species present can be an important step towards managing and tracking their impacts.



Seattle's madrone forests are invaded by a suite of non-native species. Invasive species of particular concern include English ivy (*Hedera helix*), Himalayan blackberry (*Rubus armeniacus*) and invasive trees such as English holly (*Ilex aquifolium*), one-seed hawthorn (*Crataegus monogyna*), cherry laurel (*Prunus laurocerasus*) and sweet cherry (*Prunus avium*). English ivy is a climbing vine, capable of creating dense mats on the forest floor, smothering native species, climbing and toppling trees and restricting natural tree and shrub regeneration. Himalayan blackberry is a shrub commonly found in open and disturbed areas. It is capable of rapidly forming dense thickets and excluding all other species over a large area. Invasive trees pose a particularly important challenge to the health of urban forests. Not only are these species capable of forming dense thickets in the forest understory and suppressing native trees, but they represent the future composition of our forests. Most of Seattle's forests were logged during the past century and are now dominated by deciduous trees which are nearing the end of their life cycle. The majority of regenerating trees are non-native invasive



species which will dominate our forests in the next 50 years unless proactive action is taken now. All of these species are dispersed by birds that eat berries from horticultural plantings and drop seeds into natural areas.

During our survey, 30 different non-native plant species were recorded across all plots and habitat types. English holly is a serious threat in the deciduous/madrone mixed forest with an alarming average density of 332 stems per acre and accounting for nearly 40% of all tree regeneration in this forest type (Table 2). Sweet cherry, on the other hand, has invaded the pure madrone forests with an average of 184 stems per acre or nearly 60% of all tree regeneration (Table 2). English ivy was found in 80% of all sampled plots (including every conifer/madrone and deciduous/madrone plot) at an average cover where present of 21% (Figure 3). Without active management, these and other invasive species have the potential to drastically alter the future makeup of the forest, substantially impacting the ecological integrity of madrone habitat on Seattle's public lands.



(Top) One-seed hawthorn leaves and berries; (middle) English ivy; (bottom) cherry laurel leaves.

Pure Madrone Forests

Forests categorized as pure madrone have the least overall species richness with 41 species (27 native, 12 non-native, and two undetermined) recorded across five sample plots (Map 1). These forests, like their name implies, are dominated by Pacific madrone trees in their overstory with a smaller Douglas fir component (Table 2). Madrone regeneration was recorded at the moderate density of 32 stems per acre, accounting for approximately 10% of all tree regeneration and 73% of native tree regeneration (Figure 1). As mentioned above, very high densities of regenerating sweet cherry were recorded in this forest type. Other invasive tree species of concern include English holly which averages 85 stems per acre, one-seed hawthorn (four stems per acre) and European mountain ash (*Sorbus aucuparia*) (two stems per acre) (Table 2).

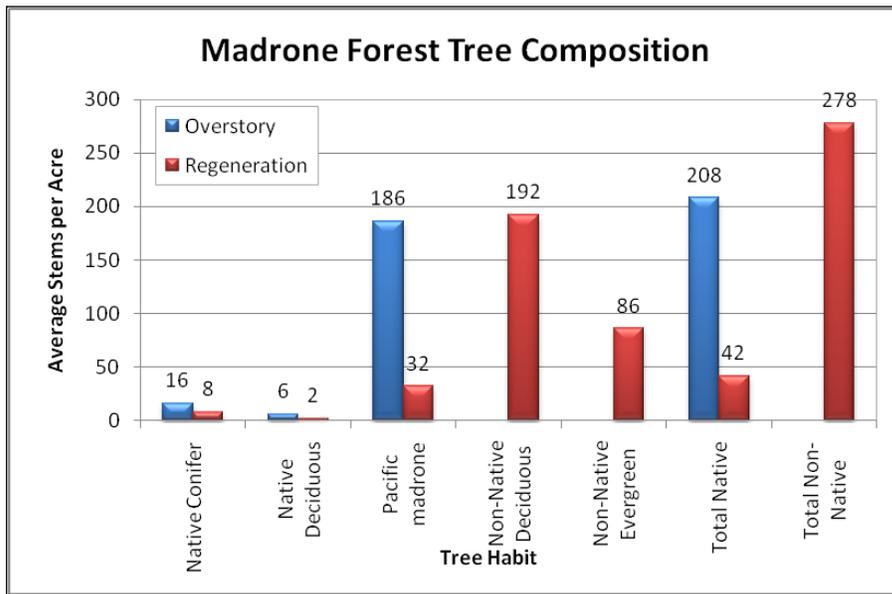


Figure 1. Overstory and regenerating average tree densities for native and non-native conifer, deciduous, and broadleaf evergreen tree species found in pure madrone habitat plots in 2006 and 2007 (N=5).

The pure madrone forest type has a well developed shrub layer with a relatively high combined average cover of 142%. Average covers greater than 100% are possible when multiple species overlap throughout the forest floor. The shrub layer of these forests are dominated by salal (55%), beaked hazelnut (38%), snowberry (19%), and oceanspray (16%) (Figure 2). Himalayan blackberry was found in two of the five plots at the lowest recorded average cover of all three forest types at 2%. In contrast, Scotch broom was found at an average cover of 3%, the highest of all forest types.

The herb and vine layers of the pure madrone forests are dominated most notably by both orange and hairy honey suckle, although these species may have been mistaken in the field for one another where both species were present in the vegetative state (Figure 3). Other notable species found at low cover in this habitat type are riverbank lupine (*Lupinus rivularis*) found in the Arroyos Natural Area and giant vetch (*Vicia nigricans* ssp. *gigantea*) found in both the Arroyos and Seola Park.

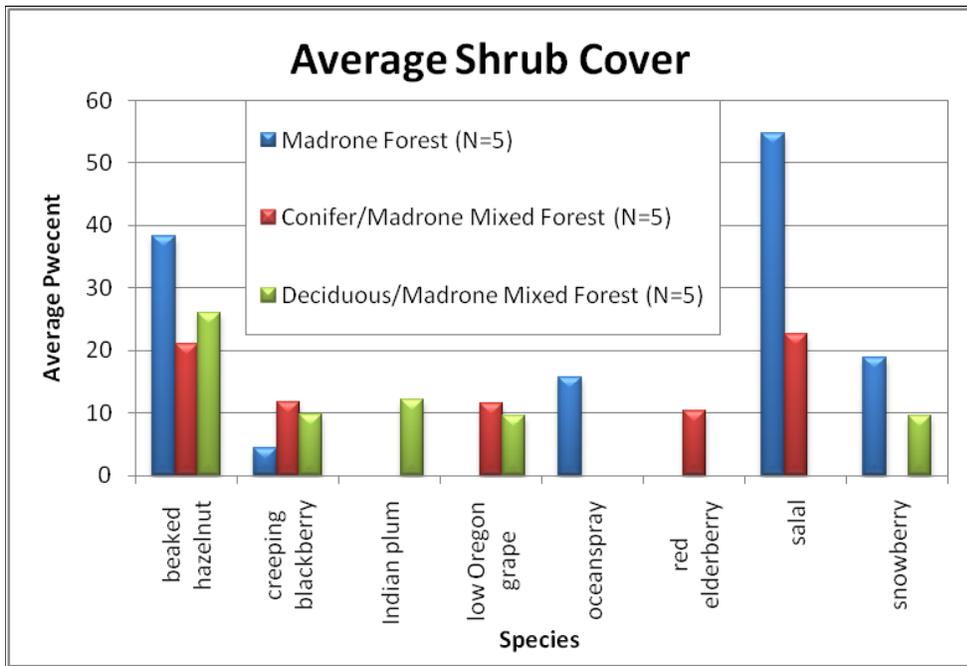


Figure 2. Average cover for the five most prevalent shrub species found in each of three habitat types sampled in Seattle from 2005-2007.

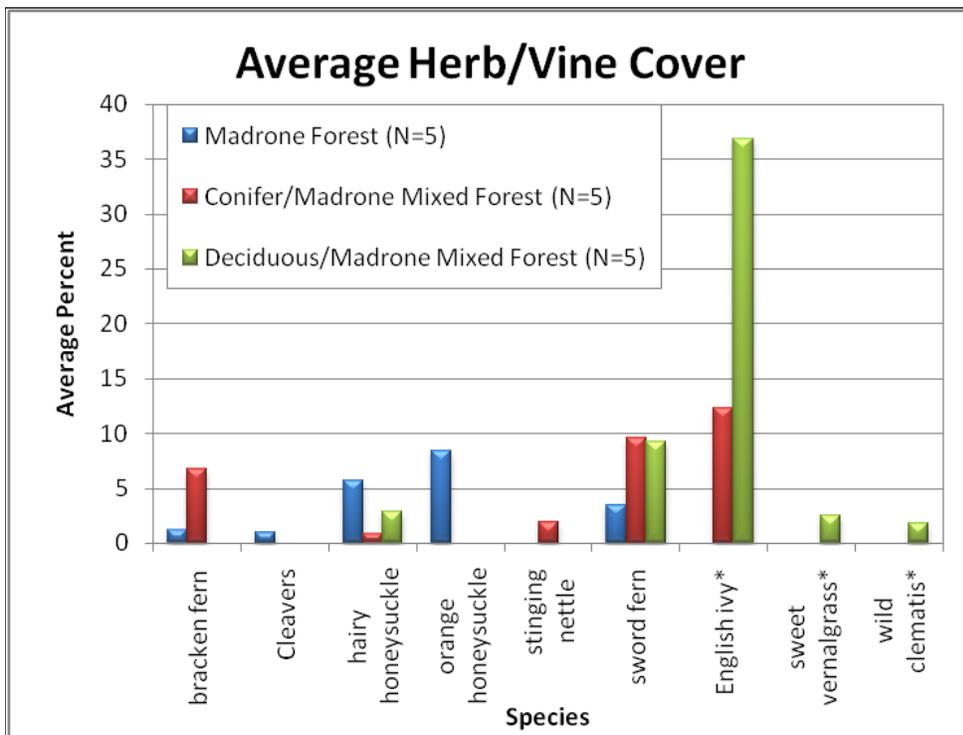


Figure 3. Average herb and vine cover for the five most prevalent species found in each of three habitat types sampled in Seattle from 2005-2007. Species with a * indicate non-native species.

Table 2. Overstory (greater than 5 inches dbh) and regenerating (5 inches dbh or less) tree species found in each of the sampled habitat types from 2005-2007 on Seattle public lands. Values represent density (stems/acre) and proportion (in parentheses) of each species averaged across all plots (N) in each habitat type.

Species¹		Madrone		Conifer/Madrone		Deciduous/Madrone	
Scientific Name	Common Name	Overstory	Regeneration	Overstory	Regeneration	Overstory	Regeneration
Acer macrophyllum	big-leaf maple			20 (15%)	8 (2%)	60 (35%)	314 (35%)
Acer platanoides**	Norway maple						2 (T%)
Acer sp.	maple			2(1%)			
Alnus rubra	red alder			16 (12%)	2 (1%)		
Arbutus menziesii	Pacific madrone	186 (89%)	32 (10%)	32 (24%)	10 (3%)	102 (59%)	68 (8%)
Castanea sp.	chestnut			2 (1%)			
Cornus nuttallii	Pacific dogwood			2 (1%)	6 (2%)	6 (3%)	
Crataegus monogyna**	one-seed hawthorn		4 (1%)		8 (2%)		64 (7%)
Frangula purshiana	casacara		2 (1%)		72 (19%)		
Fraxinus latifolia	Oregon ash						6 (1%)
Ilex aquifolium*	English holly		84 (26%)		84 (22%)		332 (37%)
Pinus monticola	western white pine			2 (1%)			
Prunus avium**	sweet cherry		184 (58%)				42 (5%)
Prunus emarginata	bitter cherry			2 (1%)	2 (1%)		6 (1%)
Prunus laurocerasus*	cherry laurel		2 (1%)		14 (4%)		34 (4%)
Prunus lusitanica**	Portugal laurel			2 (1%)	10 (3%)		2 (T%)
Prunus serotina**	black cherry			2 (1%)	144 (38%)		
Prunus sp.	horticultural cherry species				4 (1%)		2 (T%)
Pseudotsuga menziesii	Douglas fir	14 (7%)	4 (1%)	36 (27%)	6 (2%)	2 (1%)	
Salix scouleriana	Scouler's willow	6 (3%)					
Salix sp.	willow		2 (1%)				
Sorbus aucuparia**	European mountain ash		2 (1%)			2 (1%)	4 (T%)
Thuja plicata	western red cedar	2 (1%)	4 (1%)	16 (12%)	8 (2%)		8 (1%)
Tsuga heterophylla	western hemlock			2 (1%)	4 (1%)		2 (T%)

¹ Species in bold are non-native species. Species denoted by * are species which have been given a legal designation by the King County Noxious Weed Program (King County 2008). Species denoted by ** are non-native invasive species which do not have a legal designation at this time.
²T=Trace presence of species (less than 1%).

Conifer/Madrone Mixed Forests

Conifer/madrone mixed forests total approximately 52 acres of Seattle’s public urban forests (Table 1). Many of these forests (12.7 acres) are located on the Bailey Peninsula in Seward Park. These forests have similar densities of both Douglas fir (36 stems per acre) and Pacific madrone (32 stems per acre) dominating the overstory, together accounting for 51% of the canopy (Table 2). The rest of the overstory is made up mostly of big-leaf maple (15%), western red cedar (12%), and red alder (*Alnus rubra*) (12%) (Table 2). Other trees found only in the overstory of this forest type include western white pine (*Pinus monticola*) and bitter cherry (*Prunus emarginata*).



The conifer/madrone mixed forest type has the lowest recorded density of regenerating madrone trees at only 10 stems per acre, as well as very low densities of regenerating conifer trees (18 stems/acre). Averaged across all five plots, the regenerating tree layer is dominated by black cherry (*Prunus serotina*) with 144 stems per acre (Table 2 & Figure 4). This species was found in only one plot in Ravenna Park at the alarming density of 720 stems per acre and should be monitored for further invasive potential. Other invasive tree species include relatively high densities of regenerating English holly trees (84 stems per acre), as well as cherry laurel (14 stems per acre) and Portugal laurel (*Prunus lusitanica*) (10 stems per acre), all of which are non-native evergreen trees (Figure 4).

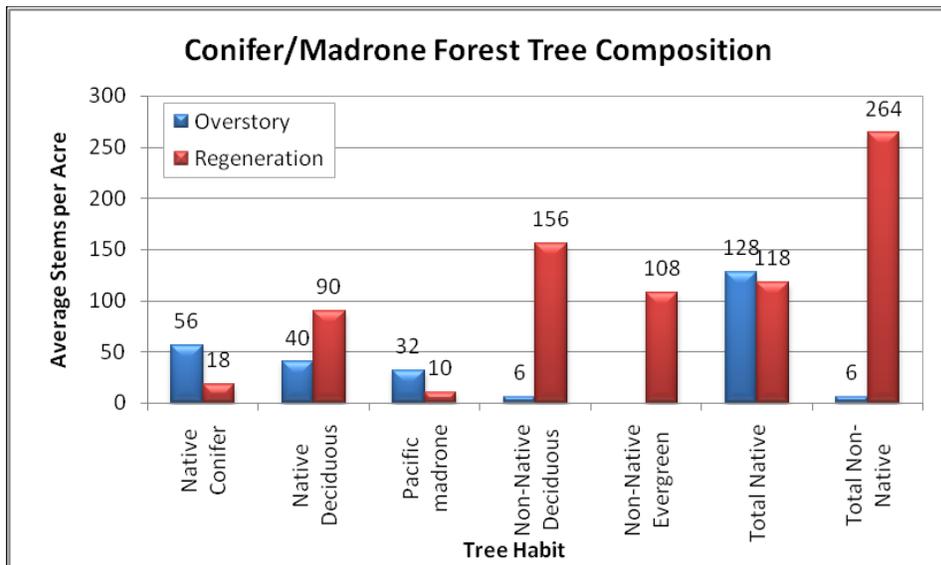


Figure 4. Overstory and regenerating average tree densities for native and non-native conifer, deciduous, and broadleaf evergreen tree species found in conifer/madrone mixed habitat plots in 2005 (N=5).

The shrub layer of the conifer/madrone mixed forest is generally dominated by salal, hazelnut, low Oregon grape, and creeping blackberry (Figure 2). Unique to this forest type, native red elderberry (*Sambucus racemosa*) was found at the relatively high average cover of 10%. Invasive shrubs include Himalayan blackberry (6% average cover), Scotch broom (<1%) and spurge laurel (*Daphne laureola*) (<1%).

The herb and vine layer is dominated by non-native English ivy at an average cover of 12% (Figure 3). Dominant native species include sword fern (10%) and bracken fern (7%) with smaller amounts of stinging nettle (*Urtica dioica*) (2%) and hairy honeysuckle (1%).

Deciduous/Madrone Mixed Forests

The deciduous/madrone mixed forests account for approximately 51 acres of Seattle’s public open space (Table 1). Of all madrone habitats, these mixed forests have the greatest distribution across the city. Larger tracts of these forests can be found in Westcrest, Frink, Coleman, and Magnuson Parks, as well as in the Magnolia Boulevard green space and the West Duwamish Greenbelt. Because of their wide geographic distribution, they also exhibit the highest species richness with 57 species recorded, 32 of which are native to the Puget Sound region. The overstory of these forests is dominated by Pacific madrone trees averaging 102 stems per acre (59%), with a strong big-leaf maple component (60 stems per acre or 35%) (Table 2). Pacific dogwood (*Cornus nuttallii*) is present at lower densities (six stems per acre), along with small amounts of Douglas fir and non-native European mountain ash. Regenerating madrone trees have the highest densities (68 stems per acre) in this forest type, while big-leaf maple seedlings dominate the understory with 314 stems per acre (Table 2). Non-native evergreen tree species are present at alarming rates in the regenerating layer of this forest type, with English holly accounting for the vast majority at an average of 332 stems per acre (Table 2 & Figure 5). Non-native deciduous trees are also present at relatively high densities and are dominated by one-seed hawthorn (64 average stems per acre) and sweet cherry (42 stems per acre) (Table 2).

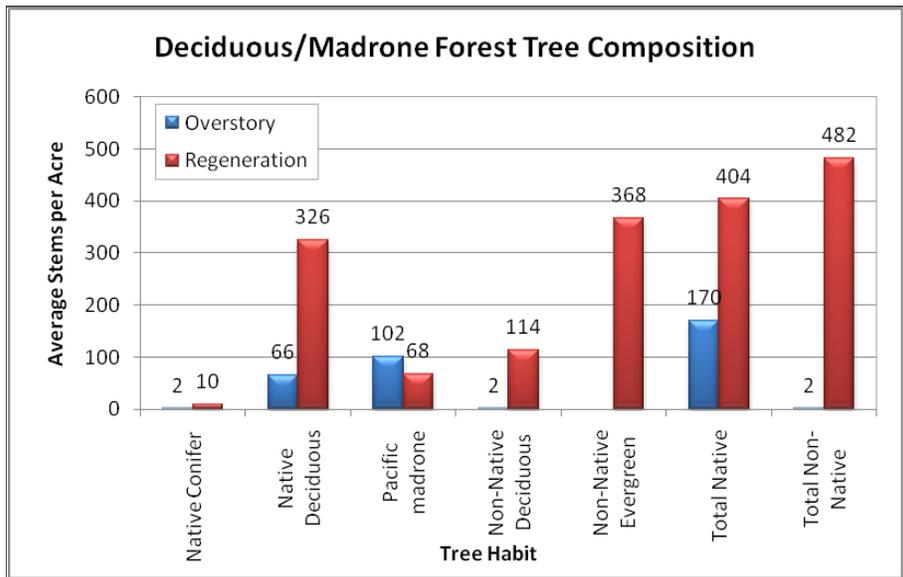


Figure 5. Overstory and regenerating average tree densities for native and non-native conifer, deciduous, and broadleaf evergreen tree species found in deciduous/madrone mixed habitat plots in 2006 and 2007 (N=5).

The shrub layer of the deciduous/madrone

mixed forest is dominated by beaked hazelnut, Indian plum (*Oemlaria cerasiformis*), creeping blackberry, low Oregon grape, and snowberry (Figure 2). Other notable shrubs found here include serviceberry (*Amilanchier alnifolia*) (3% average cover), vine maple (*Acer circinatum*) (3%), and baldhip rose (*Rosa gymnocarpa*) (1%). Himalayan blackberry is present at similar average cover as in the conifer/madrone forest type at 6%.

A total of 23 herb and vine species were recorded in the deciduous madrone forest type, 12 of which are native. By far the most dominant species is invasive English ivy, found in all five plots in this forest type at an average cover of 37% (Figure 3). Another invasive woody vine present in this forest type is wild clematis (*Clematis vitalba*) at an average cover of 2%. Like ivy, clematis can climb and smother native trees. Dominant native species include sword fern (9%) and hairy honeysuckle (3%).

Summary/Conclusions

Madrone forests are a beautiful and beloved resource in the Puget Sound region. These sculpted trees with peeling bark are associated with scenic views of steep bluffs and rocky shores. But they provide much more than that – madrone trees stabilize steep erosion-prone areas, provide shade and cover to near-shore shallow waters and serve as important wildlife habitat year-round due to their evergreen leaves, natural cavities and abundant berries that last into winter. With only 128 acres of madrone forests remaining within the City of Seattle, these forests urgently need our care and protection. Invasive species are seriously compromising the health of all madrone forests throughout the city. Madrone trees are not regenerating in sufficient numbers to perpetuate healthy madrone forests. Instead, these forests are becoming dominated by English holly, sweet cherry, English ivy and other species that are suppressing the growth of native plants. Unless we begin to actively manage these forests to reduce the impact of habitat loss, invasive species and other urban pressures, we stand to lose an incredibly valuable cultural and ecological resource. Seattle’s remaining madrone forests are in decline, and it’s up to us as a community to reverse these trends.

"Foliage, bark, flower, and fruit of madrone consummate one of Nature's most ornamental works of art."

*-Arthur Kruckeberg, *The Natural History of Puget Sound Country**



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(Left) Western trumpet honeysuckle flowers; (middle) dark-eyed Junco (*Junco hyemalis*); (right) riverbank lupine (*Lupinus rivularis*) flowers.



Map 1. Locations of plots sampled in the conifer/madrone (2005), madrone (2006 & 2007), and deciduous/madrone (2006 & 2007) forest