8

Habitat Physical Structure and *Arbutus menziesii* Status in Seattle, Washington

A.B. Adams, F.J. Harvey, W.T. Crooks and P. Williston
V. Cholvin and R.F. Wilson, Coordinators with Friends of Discovery Park

Abstract: To test the hypothesis that urban decline of Pacific madrone (*Arbutus menziesii*) correlates with disruptions of plant community physical structure, 126 madrones with diameters at breast height (DBH) >15 cm were sampled in Seattle, Washington from April to July 1994. Thirty-two attributes for each tree are joined with surveyed locations in a Geographic Information System (GIS). Attribute categories are classified as ecological, standard tree descriptions, pathological characteristics, root and soil condition, and physical damage. A paired t-test reveals that tree status is better in August than in April. Tree status and soil conditions of urban sites in Magnolia are compared with less disturbed stands. In Magnolia, many trees have stem cankers, dieback of branch tips, a dark wine-colored discoloration of the bark, and heartwood and butt rot diseases. Less disturbed areas and sheltered sites have healthier trees. Bark damage, pruning wounds, stand thinning and soil compaction are associated with urban decline of madrone. Healthier, natural stands located on well drained soils occur in other parts of the Puget Sound. We believe the effect of fungal pathogens on madrones is density independent; thus, we propose a model for the urban decline of madrone stands in which the impetus for disease comes from development and management practices.

Hummel, *et al*. 1991 and Hunt, *et al*. 1992 propose that habitats derived from development and management practices affect the overall health of madrone trees in urban habitats. Their hypothesis is based on observations that disease is prevalent on wild madrones that are exposed as a result of urban development. To test this hypothesis, we classified habitats by physical structure (Washington State Gap Analysis Project and the Interagency Committee for Outdoor Recreation 1993 and Miller 1994) and sampled madrone trees within these habitats. We report here on 32 attributes of 126 individual madrones sampled in urban habitats. Our purpose is to determine if there is a correlation between plant community physical structure and disease.

For our work we use literature characterizations of visual manifestations of madrone diseases to evaluate the pathological status of trees within habitats. Foliar diseases are caused by a great variety of fungal species. Heart rot due to *Phellinus ignarius*, *Fomitopsis cajanderi* and *Poria subacida* creates cavities and hollow trunks in older madrones. Butt rot causes fungal infections spreading from the stem down to the ground or up from the roots. Stem cankers are the result of the fungus *Nattrassia mangiferae*. This infection is initially characterized by a purplish to black discoloration of bark followed by development of elongated sunken cankers in the discolored areas. Eventually, the infected bark will slough off leaving a cankered area surrounded by callused margins. *Fusicoccum aesculi* causes the dieback of branch tips and a dark wine-red discoloration of the bark. The branch turns black after death. Branches appear fire-damaged. The continued advance of this infection leads to a wedge-shaped canker that eventually encircles and kills the branch. The fungus spreads from branches to the heartwood of the tree (Davison 1972, Hepting 1971, Horst 1990, McDonald and Tappeiner 1991 and Sinclair, *et al.* 1987).

METHODS

Five sites are compared within the Magnolia neighborhood of Seattle (Figure 8-1). These sites represent a variety of madrone forest types including pure madrone stands, madrones on grass lawns, madrones in mixed conifer/deciduous forests and madrones in shrublands (Appendix 8-1).

During the spring and summer of 1994, 126 individual trees were sampled (Table 8-1). At the same time, we developed a database for the Magnolia area using the Seattle Engineering Department's Geographic information system (GIS) digital data. Our procedure for georegistering the madrone trees is as follows: Measurements are made to the trees, or to some other point decipherable with 1992 orthophotos. In some cases, distance from the monuments or the intersection of madrone tree trunks with ground shadows on digital orthophotos are used to determine coordinates. Distances are measured to other trees, and triangulation and trigonometric functions are used to solve for point locations. We use State Plane Coordinate (SPC) projections with North American 83–91 survey datum (NAD83–91) for all maps.

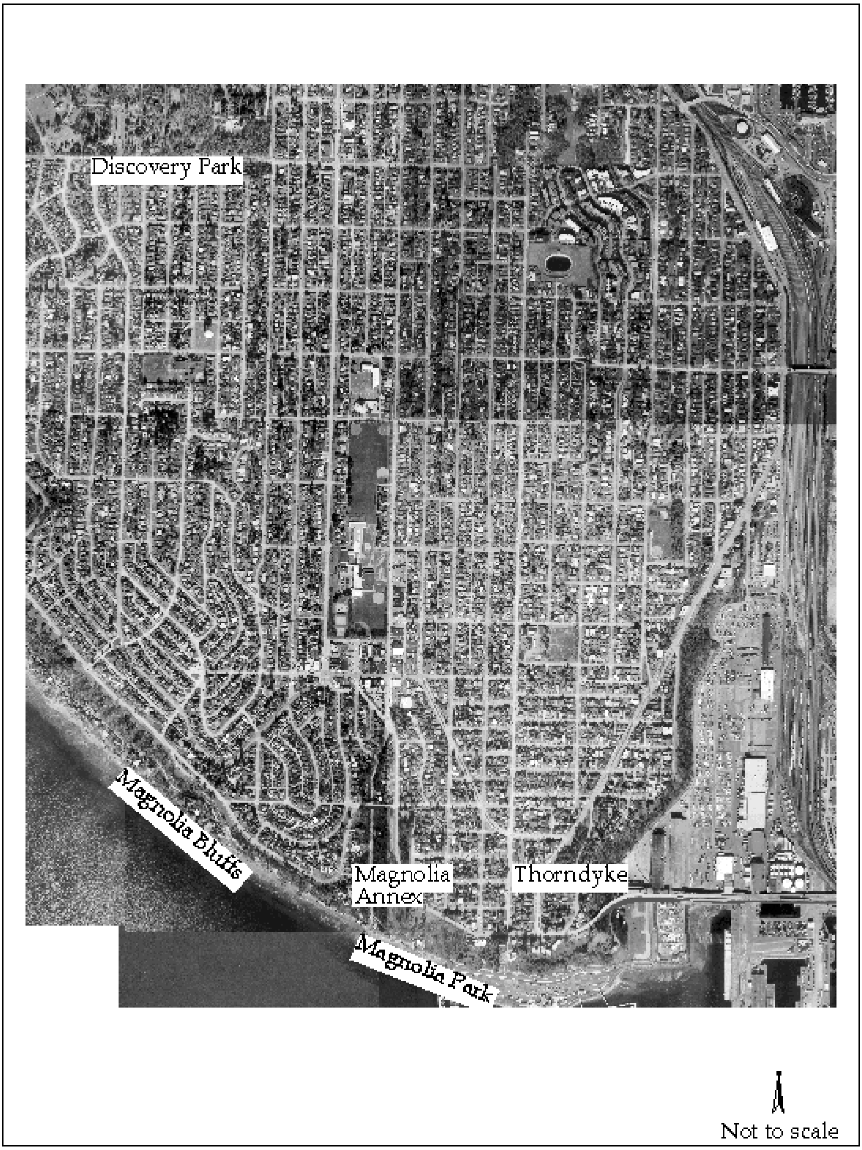

Figure 8-1. Orthophoto of southwest Magnolia neighborhood in Seattle. Note the urban nature of the study sites. The image is one of the 25 coverages built into our Magnolia GIS library. The digital data for the library was obtained from the Seattle Engineering Department. Photo taken in 1992.

Table 8-1. Number of madrone trees by location and structural habitats. The bold number in each row is the largest number of trees occurring in any habitat type for each site. See Appendix 8-1 habitat key. LG = Landscaped Grassland, LS = Landscaped Shrubland, SL = Shrubland, SS = Shrub Savannah, LF = Landscaped Forest, IDF = Immature Deciduous Forest, MDF = Mature Deciduous Forest and BEF = Broadleaf Evergreen Forest. Data for 1994.

Site	LG	LS	SL	SS	LF	IDF	MDF	BEF	TOTAL
Magnolia Bluff	**27**	1	18	2	-	-	-	-	**48**
Magnolia Park	**16**	1	-	-	-	-	-	-	17
Magnolia Annex	-	-	-	-	**9**	-	-	-	9
Thorndyke	-	-	-	-	5	-	16	**18**	39
Discovery Park	-	-	-	-	-	**13**	-	-	13
Total	**43**	2	18	2	14	13	16	18	126

City records provide “as built” improvement maps for each site. These maps are used to identify existing points on the ground (base points) from which to begin mapping. For example, at the Magnolia Bluff site, the curb line along Magnolia Boulevard starting at a curb sidewalk intersection is identifiable with both the city maps and the digital orthophoto. From this point, 30.5 m stations are laid off along the curb (with additional intermediate stations when needed) and marked with flagging. As such baselines are set up, measurements are made to manholes and catchbasins. By checking the scaled distances on the city maps, an accuracy checking mechanism for field measurements is maintained.

With the baseline in place, a survey method called “two-chaining” is used to locate individual trees. Essentially, 2-chaining involves measuring known points on city quarter-section maps. Through trigonometric calculations of offsets to the SPC values of these points, the SPC location of every tree is established. The tree locations and attributes are then connected to multiple data layers from our GIS library.

Thirty-two attributes are measured for each tree. The attributes are: A) ecological measurements (habitat type, aspect, associated tree growth forms and presence of seedlings and/or saplings); B) standard descriptions (tree ID, presence of suckers, number of trunks, DBH, height, phenology and reproductive status); C) pathological characteristics (branch status, percent leaf clusters diseased, percent branches dead, area of butt rot, relative length of heart rot to height of tree, number of trunk cankers, mean size of trunk cankers, area of largest trunk canker, presence of branch cankers, burnt appearance); D) root condition (flaring, girdling, soil cracking and exposed roots); E) soil condition; and, F) physical damage (cambial ringing, initial carvings, lawn mower damage, number of branches cut and number of branches broken naturally).

Tree locations are generated as topological coverages into ARC/INFO GIS and then joined to the attribute items. The sites are summarized collectively by combining the map extents of each site onto a single page in which spatial relations and direction are consistent within each site, but only north/south and east/west orientations are consistent between sites. This allows us to view tree relationships within and between habitats simultaneously.

RESULTS

Comparison of structural habitats within site locations (Table 8-1) reveals that Landscape Grassland is the most common habitat (34%). Shrubland and Broadleaf Evergreen Forest second (14%). At 3 sites a variety of structural habitats, but only one habitat is dominant at each site. For instance, the majority of trees at Magnolia Bluff (56%) and Magnolia Park (94%) are in Landscape Grassland, whereas Thorndyke had 46% of its trees in Broadleaf Evergreen Forest habitat. Magnolia Annex is 100% Landscape Forest, Discovery Park 100% Immature Deciduous Forest.

Seedlings are absent at all sites (Table 8-2). Saplings occur near many trees on Magnolia Bluff, sometimes are present in Magnolia Annex and Magnolia Park and are absent at 2 sites. The percent of trees with suckers present at the Magnolia sites are 0.19, 0.33 and 0.18. Suckers are infrequent at Thorndyke and Discovery Park. The largest trees are at Magnolia Annex (mean height = 19.1 m and DBH = 68.4 cm) and the smallest at Discovery Park (13.6 m and 38.9 cm). The trees sampled in Discovery Park are smaller and more spindly than trees at other sites.

Percent leaf clusters diseased show a seasonal trend (Figure 8-2). Because of this observation, we developed an *a priori* hypothesis that percent leaf clusters diseased show no difference in spring versus late summer. To test this hypothesis, 42 trees at the Magnolia Bluff site were sampled again in August. A paired t-test reveals a 17.5% mean improvement in appearance of trees in August compared to April

Table 8-2. Descriptive statistics of madrone trees by site. Data collected during spring and summer of 1994.

Site	Percent trees with seedlings 0.07 ha	Percent trees with saplings 0.07 ha	Percent trees with suckers	Mean trunk number	Height (meters)	Diameter at breast height (cm)
Magnolia Bluff						
mean	0	85	19	1.10	15.9	55.3
std error				0.10	0.5	4.1
median				1	15.9	49.3
Magnolia Park						
mean	0	18	18	1	18.6	76.2
std error				0	1.4	6.9
median				1	21.0	74.4
Magnolia Annex						
mean	0	44	33	1.22	19.1	68.4
std error				0.15	1.1	5.4
median				1	19.4	66.8
Thorndyke						
mean	0	0	5	1.29	16.9	57.8
std error				0.10	0.5	3.4
median				1	16.8	56.3
Discovery Park						
mean	0	0	0	1	13.6	38.9
std error				0	0.7	5.6
median				1	13.0	37.1

($p < 0.001$). Similarly, the percentage of dead branches shows little variation between sites (Figure 8-2). In some instances, crowded dense stands have trees with a larger proportion of dead branches than diseased trees in open habitats. Over 30% of the branches are dead at all sites in Magnolia. Trees in the natural stands (Arroyos and Maury Island) show few signs of infection but have many dead branches on their lower trunks probably due to canopy closure.

In contrast area of butt rot, percent of heart rot to tree height, number of trunk cankers and the proportion of trees with branch cankers and/or a burnt appearance varies with site. Trees have more of these symptoms in open areas that have more compact and poorly drained soil, than in less disturbed forested habitats (Figures 8-3–8-6).

Mean butt rot area (Figure 8-3) is greatest at Magnolia Park and Magnolia Bluff (mean/tree = 0.43 and 0.20 m^2, respectively) while trees at the other 3 sites have means/tree < 0.03 m^2. Mean heart rot (Figure 8-4) is greatest in Magnolia Park (mean/tree = 15.9%), whereas the other 4 sites range from 4.8 to 7.5%. Mean number of trunk

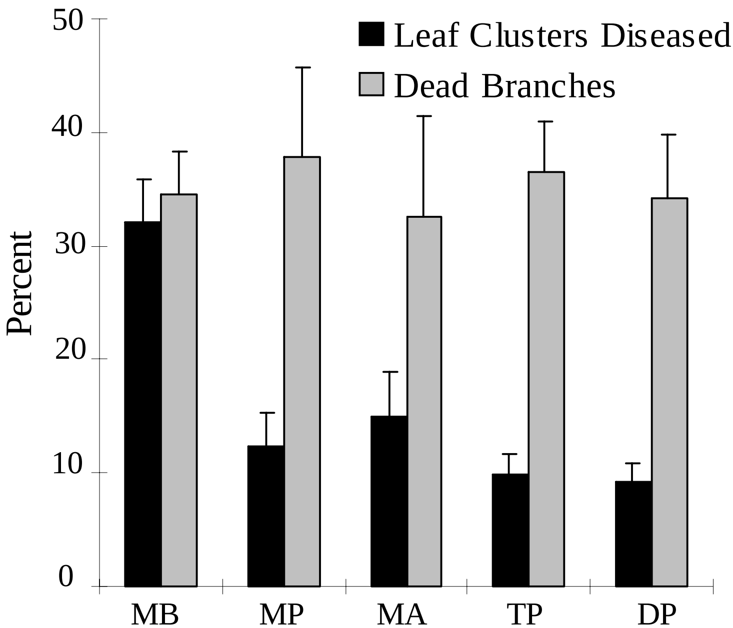

Figure 8-2. Mean percent leaf clusters diseased and mean percent dead branches by site in 1994. Leaf data collected May 15 for Magnolia Bluffs (MB), May 24 for Magnolia Park (MP), June 10 for Magnolia Annex (MA), July 5 for Thorndyke Park (TP), and July 11 for Discovery Park (DP). There is a seasonal sampling gradient (spring to late summer) from left to right (note negative trend with percent leaf clusters diseased).

cankers (Figure 8-5) is highest for Magnolia Bluff (32.1 cankers/ tree) and relatively intermediate for Magnolia and Discovery Parks (mean/tree = 13.9 and 20.9, respectively). The variance is highest for Discovery Park. Inspection of the raw data shows that here, a few trees have numerous trunk cankers, while the majority of madrones at the site have few to none. Magnolia Annex and Thorndyke have the lowest mean number of trunk cankers/tree (1.4 and 4.3, respectively). The proportion of trees having both branch cankers and a burnt appearance (Figure 8-6) is highest for Magnolia Bluff (0.77 and 0.71, respectively) and Magnolia Park (0.53 and 0.35), intermediate for Magnolia Annex (0.33 and 0.22) and Thorndyke (0.41 and 0.10). Discovery Park is unique in that <half (46%) of the trees have branch cankers, but no trees appear burnt (Figure 8-7).

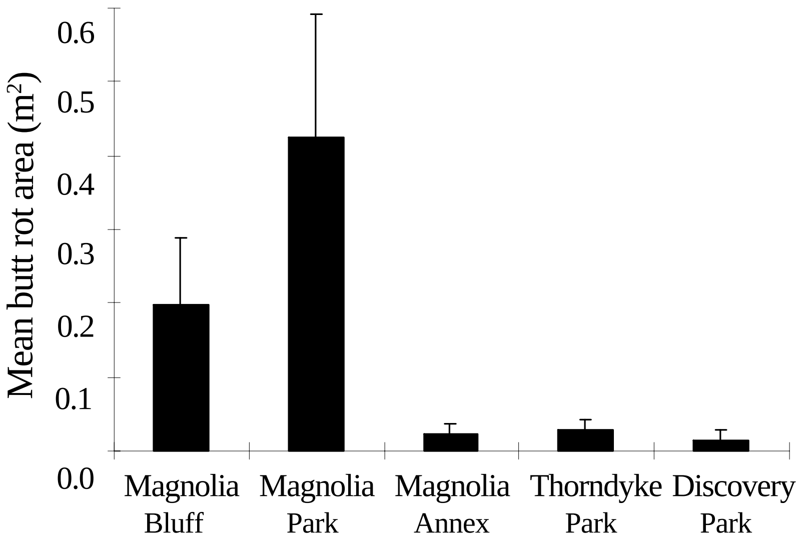

Figure 8-3. Mean butt rot area by site. Data for spring and summer of 1994.

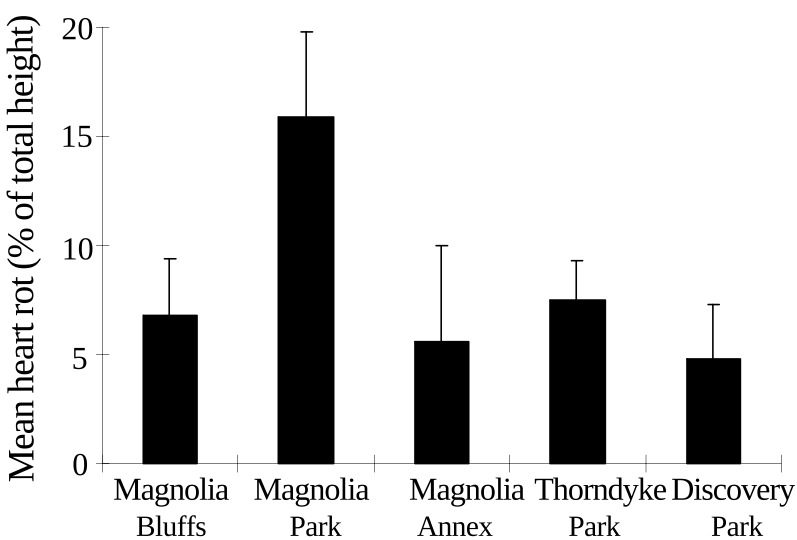

Figure 8-4. Mean heart rot (measured as percent of total height of tree) by site. Data for spring and summer of 1994.

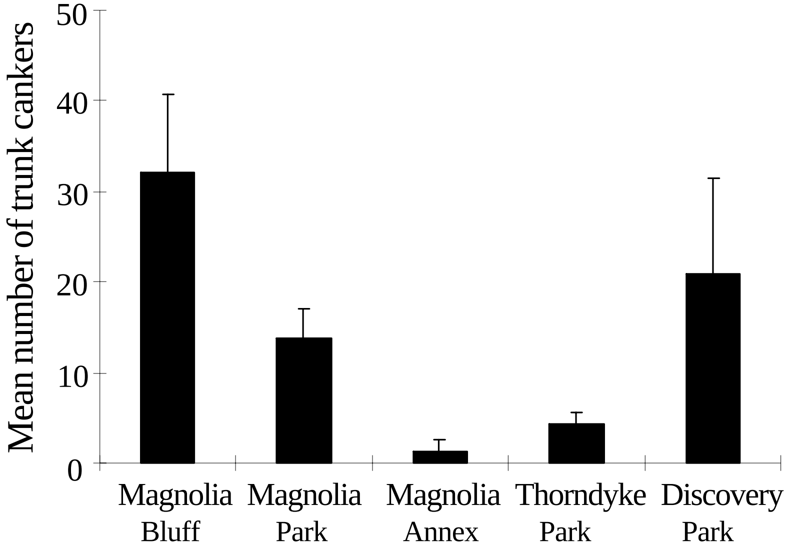

Figure 8-5. Mean number of trunk cankers by site. Data for spring and summer of 1994.

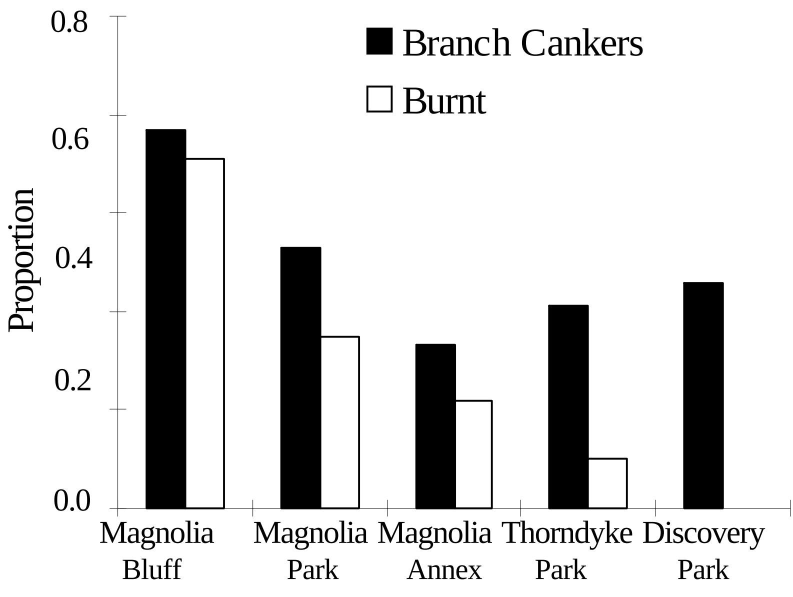

Figure 8-6. Proportion of branch cankers to the appearance of being burnt by site. Data for spring and summer of 1994.

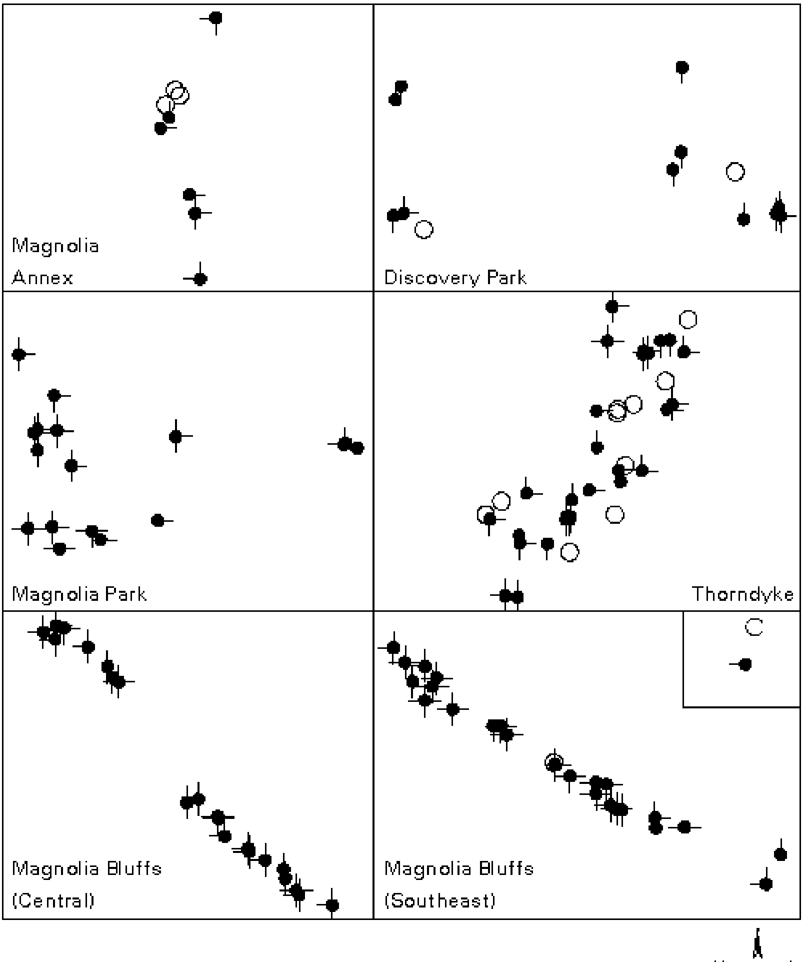

Figure 8-7. Site maps with disease symptoms for individual trees. Data for spring and summer of 1994. Explanation—if stick: points up = branch cankers; points down = trunk cankers; points left = burnt; points right = butt rot. Unfilled circles = trees in which no disease symptoms noted.

An unmanaged stand of madrones growing in the Arroyos area of southwest Seattle is classified as a Broadleaf Evergreen Forest. Three sieved soil samples from a 5 cm depth from this site contain a <2 mm fraction that is 98% sand. The mean of the 3 replicates had 46% of the soil particles > 0.6 mm (coarse sand), 33% range from

0.59–0.29 mm (medium to coarse sand) and 19% is between 0.28–0.15 mm (fine sand). This particle size distribution is characteristic of esperent sand (Mullineaux, *et al*. 1965). A similar stand located on the southern bluffs of Maury Island has similar soil texture. There is a large sand quarry next to both sites indicating large, sandy proglacial outwash deposits such as esperent sand.

DISCUSSION AND CONCLUSIONS

Some tree attributes we measure are reliable indicators of tree status, others are not. Percent leaf clusters diseased and percent dead branches are not reliable indicators. Hunt, *et al*. (1992) and Byther (this volume) came to similar conclusions with opportunistic leaf infections (fungi attack at the time of leaf abscission. The paired t-test shows that percent diseased leaf clusters is lower in August than in April; therefore, madrones we evaluate with poor vigor in spring, may then appear healthy in late summer (when soil water potential is lowest). The percentage of dead branches is a function of successional status or density of trunks (crowded stands have a higher percent of dead branches than open ones) as well as diseases (Figure 8-2).

Heart rot, butt rot, cankers and branch discoloration are more direct measures of tree status. Magnolia Bluff and Magnolia Park are exposed Landscaped Grassland habitat with heavy foot traffic and physical abuse (including girdling). These 2 sites have high rates of disease. The other less disturbed and/or sheltered habitats (Broadleaf Evergreen Forest at Thorndyke and Landscaped Forest at Magnolia Annex) have trees with fewer disease symptoms and even trees with no symptoms at all. Our results support the hypothesis that development, and management practices and habitats derived from development, facilitate disease transmission and tree demise. These results, however, do not imply anything with respect to the future status of trees should management practices change. Interestingly, Magnolia Annex has the largest trees even though it is in a more competitive environment and is, presumably, the same age as the trees atop Magnolia Bluff and at Magnolia Park. The Discovery Park stand partially fits into this pattern; however, the differences in sample size, habitat (Immature Deciduous Forest), age and disturbance history create some problems in interpreting results at this site.

Results of the 5 urban sites in Magnolia are interesting when put in context with the preliminary observations at the Arroyos and Maury Island pure Broadleaf Evergreen stands. Management has

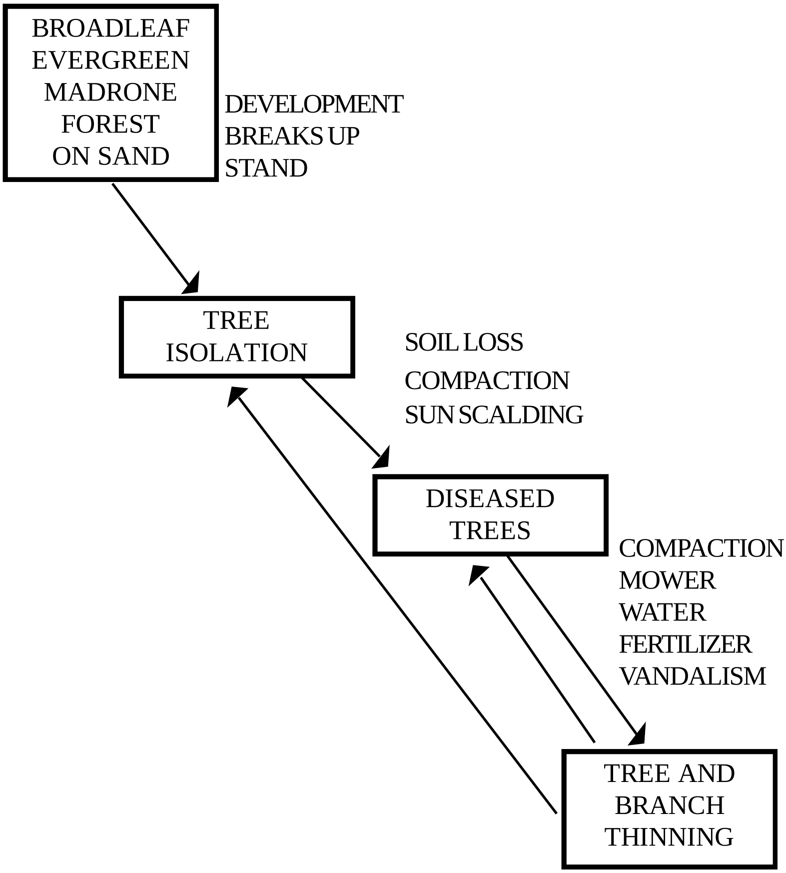

Figure 8-8. Density independent model of stand dynamics with development.

treated problems with madrone trees as a classic response to density-dependent selection. In density-dependent selection, parasites kill some host individuals and affect an increasing proportion of the host population as host density increases such that the transfer of the parasite between host individuals becomes more frequent. Two well-known North American tree species and their fungal parasites [American chestnut (*Castanea dentata*) and its parasitic *Endothia parasitica* and the American elm (*Ulmus americana*) with the parasite *Ceratocystis ulmi*] fit into the category of density-dependent selection (Whittaker 1975 and Webster 1970). Management practices of madrone in Seattle are based on density-dependent selection (that is, cut and prune diseased trees quickly) (Figure 8-8). Results from our study

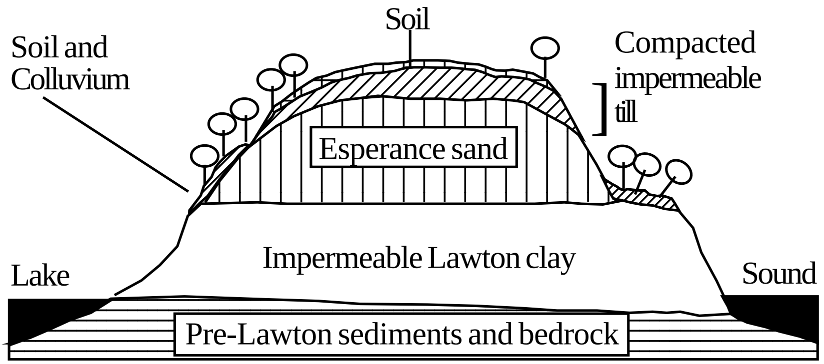

Figure 8-9. Cross section of a typical central Puget Sound hill. The circles with sticks represent individual madrone trees. Generally, madrone stands occur on southerly facing slopes above bodies of water (*e.g.*, Lake Washington and Puget Sound). Here, the trees are portrayed growing on soil and colluvium (debris made up of fragments of rock detached from heights above and carried down the slope mostly by gravity) and atop bluffs in soil over compacted till (see also Adams this volume). Pure madrone stands are on coarse-loamy soil and colluvium over sand. The steepest slopes of esperance sand (right top) are too unstable to grow trees. Modified from Tubbs (1974) and Gerstel, *et a*l. (1997). Stratigraphy is vertically exaggerated.

suggest that madrone population regulation is density-independent (dense stands are less infected). If this is true, pruning and thinning stands will increase the spread of disease, not limit it.

Our model predicts an increase of the proportion of seriously diseased trees when forest stands are broken up. The overall result is a positive feedback system in which the response increases the stimulus. This model implies nothing about the effect of such management on seedling establishment and survival; however, it is obvious that sites of heavy management and use (*e.g.*, regular mowing and pruning) are not suitable for recruitment of madrone seedlings nor sapling survival. Landscaped Grassland habitats encourage the spread of disease and are not suitable for madrone maintenance or establishment. Much more research with larger sample sizes over broader areas is necessary to confirm this model.

Pure Broadleaf Evergreen Forest habitat occurs in the central Puget Sound region (Figure 8-9. This habitat is dominated by madrone and is successionally seral, not climatic (Chappell and Giglio this volume). The best example found in Seattle is the Arroyos Research Area at the south-eastern city limits of Seattle. Perhaps, prior to settlement, below the Magnolia Park and Magnolia Bluff sites were madrone forests dominant or codominant with Douglas-fir. Management of the sites in Magnolia resulted in the premature breakup of the stands, such that the environmental conditions favored the spread of disease (Adams this volume). The trees prefer soil with sandy loam texture which is well-aerated and well-drained. Esperent sand found on cliffs overlooking the Sound provide ideal habitats for these stands. Glacially derived soils from the Vashon stade (Mullineaux, *et al*. 1965) provide habitats favorable for the successional development of madrone stands in the northern limits of its range.

LITERATURE CITED

Davison, A.D. 1972. Leaf spot of madrone. Washington State University Cooperative Extension. E.M. 2951.

Dunne, T. and L.B. Leopold. 1978. Water in Environmental Planning. W.H. Freeman & Company, New York, New York.

Gerstel, W.J., M.J. Brunengo, W.S. Lingley, Jr., R.L. Logan, H. Shipman and T.J. Walsh. 1997. Puget Sound Bluffs: The Where, Why, and When of Landslides Following the Holiday 1996/97 Storms. Washington Geology (25)1:17–31.

Hepting, G.H. 1971. Diseases of forest and shade trees of the United States. USDA Forest Service Handbook #386:77–78.

Horst, K.B. (editor). 1990. Host Plants and their Diseases. 55th edition. Westcott's Plant Disease Handbook.

Hunt, R.S., B. Callan and A. Funk. 1992. Common pests of *Arbutus* in British Columbia. Forestry Canada, Forest Insect and Disease Survey, Pacific Forestry Centre. Forest Pest Leaflet Fo 29-6/63-1992#.

InterAgency Committee on Outdoor Recreation (IAC). 1993. Terrestrial and Aquatic Habitat Diversity Classification Scheme. Olympia, Washington.

Kelley (Bressette), D.S., R.I. Hummel and R.S. Byther. 1993. The magnificent Pacific madrone. The Arboretum Bulletin 56(3):2–5.

McDonald, P.M., and J.C. Tappeiner, II. 1991. *Arbutus menziesii* Pursh Pacific madrone. USDA Forest Service. Handbook #567:124–132.

Miller, G. 1994. Urban Wildlife and Habitat Management Plan. Seattle Department of Parks and Recreation.

Mullineaux, D.R., H.H. Waldron and M. Rubin. 1965. Stratigraphy and Chronology of Late Interglacial and Early Vashon Glacial Time in the Seattle Area, Washington. US Government Printing Office. Geological Survey Bulletin 1194-0.

Sinclair, W.A., H.H. Lyon and W.T. Johnson. 1987. Diseases of Trees and Shrubs. Comstock Publishers and Associates, Ithaca, New York.

Tubbs, D.W. 1974. Landslides in Seattle. Division of Geology and Earth Resources, Olympia, Washington. Information Circular #52.

Webster, J. 1970. Introduction to Fungi. Cambridge University Press, Cambridge, England.

Whittaker, R.H. 1975. Communities and Ecosystems. 2nd edition. McMillan Publishing Company, Inc., New York, New York.

APPENDIX 8-1. URBAN PLANT COMMUNITY STRUCTURAL HABITAT KEY

1a Vegetation community and land cover types occurring on land 2
1b Saline marine or estuaries or freshwater habitats
2a Vegetation cover < 10%, but not developed with building and pavement
    3a Exposed bedrock or talus slope .... Rock and Talus
    3b Vertical or near vertical surface on which no soil has built up
    Perhaps an isolated tree or shrub present .... Cliff
    3c Cave, beach and dunes
        4a Naturally occurring underground chamber .... Cave
        4b Area along shore, above mean high water mark with < 10% plant
        cover. Composed of sand, gravel or large rocks ..... Beach and Dune
2b Vegetation cover >10%, or developed with buildings and pavement
    5a Intensively managed field dominated by plants producing food for
    humans or domestic animals or fiber for human use; not forests used for
    wood fiber or unmaintained rangeland (agriculturally managed areas)
        6a .... Developed Pasture
        6b .... Herbaceous Row Crop
        6c .... Orchard or Vineyard
    5b Non-agricultural 7
7a Plant cover > 10% and tree canopy cover < 25%; not agricultural or developed land
    8a Plant cover >10% and <40% under natural conditions (60-90% bare ground
    not from agriculture or development) .... Sparsely Vegetated Habitat
    8b Vegetation cover > 40%
        9a Grass and forb dominance with <10% tree or shrub
        .... Grassland Forb
        9b Combination of tree and shrub cover > 10%
            10a Ten to 25% shrub cover and <10% tree cover
            .... Shrub Savannah
            10b Shrub cover >25% and <10% tree cover
            .... Shrubland
            10c Eleven to 25% tree cover; habitat may have dense or
            sparse shrub layer .... Tree Savanna
7b Tree cover >25%; or developed, or landscaped and manicured vegetation
    11a Tree cover >25% with > 70% tree canopy evergreen.
    Deciduous trees <30% of canopy (Evergreen Forest)
        12a Tree canopy >70% broadleaf evergreen
        .... Broadleaf Evergreen Forest
    12b Tree canopy > 70% coniferous
        13a Conifer canopy <30 ft tall and <5 in DBH
        .... Sapling Conifer Forest
        13b Canopy dominated by conifers >30 ft tall
        14a Conifers 5-15 in DBH .... Pole Conifer Forest
        14b Conifers 15-20 in DBH .... Immature Conifer Forest
        14c Dominant conifers 20-30 in DBH.......... Mature Conifer Forest
        14d Two or more canopy layers with dominant conifers >30 in DBH
        .... Old Growth Conifer Forest
11b Greater than 25% tree cover and <70% of tree canopy coniferous or riparian
forest (lead 21a), or developed or landscaped areas (lead 21b) 15

15a Greater than 70% of tree canopy deciduous (Deciduous Forests)
16a Canopy dominated by trees <30 ft tall and <5 in DBH
....Sapling Deciduous Forest
16b Canopy dominated by deciduous trees >30 ft tall
17a Deciduous trees 5-15 in DBH
.... Pole Deciduous Forest
17b Deciduous trees generally 15-20 in DBH
.... Immature Deciduous Forest
17c Dominant deciduous trees generally 20-30 in DBH
...................................Mature Deciduous Forest
17d Two or more canopy layers with dominant deciduous
trees >30 in DBH .... Old Growth Deciduous Forest
15b Tree canopy containing < 70% of either deciduous or conifer species,
or riparian or developed areas 18
18a 30-70% hardwood tree species in forest canopy ... (Conifer Hardwood Mixed Forest)
19a Canopy dominated by deciduous trees <30 ft tall and <5 in DBH
.... Sapling Conifer Hardwood Mixed Forest
19b Canopy dominated by deciduous trees >30 ft tall
20a Trees 5-15 in DBH .... Pole Conifer Hardwood Mixed Forest
20b Trees 15-20 in DBH
.... Immature Conifer Hardwood Mixed Forest
20c 20-30 in DBH trees ... Mature Conifer Hardwood Mixed Forest
20d Two or more canopy layers with trees >30 in DBH
.... Old Growth Conifer Hardwood Mixed Forest
18b Forests associated with rivers and streams; or in non-forested developed areas 21
21a Forests associated with stream or river, containing cottonwoods, willows,
alders, other hardwoods and conifers (Riparian Forest)
22a Canopy dominated by trees <30 ft tall and <5 in DBH
....Sapling Riparian Forest
22b Canopy dominated by trees >30 ft tall
23a Trees with 5-15 in DBH .... Pole Riparian Forest
23b Conifers 15-20 in DBH ....Immature Riparian Forest
23c Dominant trees 20-30 in DBH .... Mature Riparian Forest
23d Two or more canopy layers with dominant trees >30 in DBH
....Old Growth Riparian Forest
21b Area either dominated by buildings, structures, and pavement; or landscaped and
manicured vegetation (Developed Areas)
24a Developed area dominated by buildings, structures or pavement
25a 10-30% of land surface covered by buildings, structures orpavement
.... Light Development
25b 30-60% of land surface covered by buildings, structures or pavement
.... Medium Development
25c Greater than 60% of land surface covered by buildings, structures or
pavement .... Heavy Development
24b Developed area dominated by vegetation (Landscaped Forests)
26a Dominated by grass and forbs. Contains <25% shrub and tree
canopy. Landscaped and manicured .... Landscaped Grassland
26b Contains > 25% shrub canopy and <25% tree canopy,and shrub and
herbaceous layers are landscaped and manicured .... Landscaped Shruband
26c Contains >25% tree canopy and tree, shrub and herbaceous layers are
landscaped and manicured .... Landscaped Forest