Pioneer Park Forest Management Plan

Adopted
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Mercer Island Open Space Conservancy Trust
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1. Introduction

Pioneer Park is a 113-acre park consisting of three 38-acre blocks of second-growth western-hemlock forest situated on the south-central spine of Mercer Island. The park represents the largest relatively unfragmented forest habitat remaining on the island, providing a range of ecosystem services and benefits including recreation, water retention and slowing storm water runoff, improving air quality, temperature buffering, wildlife and aquatic habitat. Pioneer Park provides nesting or foraging habitat for at least 74 avian species, including bald eagles and pileated woodpeckers. The park is home to over a dozen mammalian species, including little brown bats, the uncommon Douglas squirrel, mountain beavers, shrews, voles, and raccoons. The park provides a range of dry and wet habitats supporting an unknown number of invertebrate species. The park's forest soils nurture at least 38 species of mushrooms.

Riparian areas provide habitat for a greater number of wildlife species than any other habitat type. These areas serve as travel connectors between habitat types and provide food cover, microclimates and edge effects at adjacent forest margins. In Pioneer Park, the wetlands and ravine in the Northeast Quadrant are noteworthy for their diverse microhabitats, which attract a wide variety of wildlife species, including invertebrates, amphibians, reptiles, mammals and birds.

The matrix of trees, shrubs, soil, water, and wildlife in Pioneer Park comprise an unparalleled resource for the residents of Mercer Island. In the park, an island resident can find quiet, solitude and a world far different from urban existence. Here, too, once common plants and animals find an ideal place to live near a major urban center.

However, if left unmanaged, the forest in Pioneer Park will likely deteriorate. Laminated root rot is killing Douglas fir trees, while age is claiming many alders and maples. As these trees die, they leave “gaps” in the tree canopy of the park. In a wilderness setting, new trees would grow up in these gaps and restore “closed” canopy. However, invasive, non-native plants, notably ivy, holly and blackberry, are widespread in Pioneer Park and often take over wherever trees are dying. They prevent the regrowth or “regeneration” of canopy trees.

Left unmanaged, the forest canopy would become increasingly fragmented, and the ground would become a patchwork of invasive brambles and vine-choked trees. This fate can be seen in other public open spaces (the Queen Anne and Duwamish greenbelts in Seattle are examples). Not only would this affect the public’s enjoyment of the park, but it would also impact wildlife that relies on forest cover. The loss of canopy would increase the amount and rate of surface water flowing into Lake Washington.

The forest must also be managed if the park is to benefit the public. Park users and adjacent properties must be protected from undue risk of tree failure. Moreover, an uncontrolled fire could devastate the forest and neighboring homes. More commonly, however, it is humans that injure the forest by trampling vegetation, piling yard waste

around trees or harvesting greenery. Rarely are these activities malicious, nor is any one incident significant, but taken together they noticeably impact the health of the park.

This plan is intended to provide sensitive and efficient direction for management and intervention within Pioneer Park that will maintain the native forest ecosystem, protect public safety and enhance positive uses of the park over the long-term.

2. Plan Goals

The Open Space Conservancy Trust (the Trust) was established by an ordinance of the City of Mercer Island (the City) in 1992. The purpose of the Trust, according to the ordinance, is: to receive and hold open space properties in perpetuity, to protect, maintain and preserve these properties, and to insure that the development and use of the properties are consistent and compatible with the purposes of the Trust. The ordinance defines an open space property as a property with potential natural or scenic resources that has been reserved by Mercer Island City Council (Council) for passive and low impact forms of use, such as walking, jogging and picnicking. In 2003, the Trust adopted the following mission statement:

> *The Mercer Island Open Space Conservancy Trust is a board of citizen volunteers appointed by the City Council to oversee open space properties placed in the Trust as passive, low-impact recreational open space. The Trust manages these properties to protect, maintain and preserve them as natural, scenic and recreational resources, maintaining all their ecological, scenic, aesthetic, scientific, and educational attributes for the current and future residents of Mercer Island.*

In 1994, Council approved the document called ***Policies for Protecting, Maintaining and Preserving Mercer Island Open Space Conservancy Trust Properties***. That document provided direction for managing the park, including an extensive section called *Pioneer Park Site Management Plan*. It has been the guiding document for forest management in Pioneer Park. This new plan retains, restates and expands upon the goals and objectives outlined in that document.

The Trust board has expanded on the goals for forest management in Pioneer Park. The Board reviewed the assumptions that would underlie any plan (See Appendix A). It looked at alternative management scenarios for the park (see Section 7 and Appendix B). It considered how criteria for a sustainable urban forest should be applied to this park (see Appendix C). The goals below summarize the results that this plan will have on the long-term condition of the forest.

1. Pioneer Park will remain a healthy, sustainable native forest.
2. The soils of the park are the foundation for all life in the park. Therefore, they will be preserved, along with the living organisms and soil-building processes found there.

3. The forest will consist of plant species native to the Puget Sound basin. Plants native to the coastal northwest, but not endemic to the Puget Sound basin may be used, limited to sites where locally native species cannot perform a landscape function necessary for forest management.
4. Natural regeneration will be the primary mechanism for managing the forest vegetation, since this achieves ecological restoration with lower levels of input and disturbance. Plantings will be used where native regeneration is not sufficient to achieve plan goals.
5. Diversity of structure and composition will be managed. Too much or too little diversity impacts habitat, aesthetics, pest control, and management efficacy. Activities that increase diversity should not introduce excessive randomness to the forest composition.
6. Habitat will be preserved and enhanced to maintain the park's populations of native animals, including, but not limited to mammals, birds, reptiles and invertebrates.
7. The riparian environments within the park will be managed as in Goal 6 and also avoid adverse impact to aquatic habitat downstream from the park.
8. Invasive non-native plants will be controlled to achieve plan goals.
9. Park vegetation will not pose an unreasonable hazard to park users, adjacent streets or neighboring properties.
10. The vegetation in the park will be managed to enhance park users' passive enjoyment of a native forest setting.
11. Members of the Mercer Island community find ways to actively participate in restoration projects under the leadership of the Open Space Conservancy Trust.
12. The City of Mercer Island will manage the forest under the leadership of the Open Space Conservancy Trust.

See Appendix C for a more detailed exploration of these goals.

3. Location

Pioneer Park is located at the south end of Mercer Island in King County, Washington. It is comprised of the northeast quarter, northwest quarter and the southeast quarter of Section 30, Township 24 North, Range 5 East. The three quadrants meet at the intersection of Island Crest Way and SE 68th Street. Parking is available south of this intersection on the east side of the Island Crest Way, to the east of this intersection on the north side of SE 68th Street, and on the east side of 84th Avenue SE.

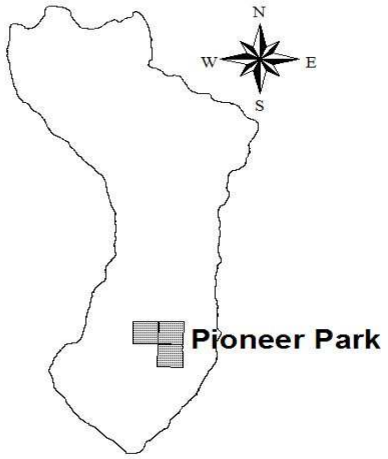


Figure 3.1: Location of Pioneer Park

4. Background

A comprehensive history of Pioneer Park can be found in the ***Pioneer Park Master Plan***, adopted in 2001. The definitive natural history of the park is contained in ***Pioneer Park: a natural history***, first published in 1972 and revised in 1990 (See Appendix I). This section will not duplicate those works, but will instead outline other information relevant to forest management in the park.

The Mercer Island City Council chartered the OSCT to protect, maintain and preserve Pioneer Park in a manner that will "maintain or enhance the present or potential conservation of natural or scenic resources of Mercer Island with the intent that any future use of the property be limited to passive and low impact forms of use such as walking, jogging or picnicking." All improvements to and uses of Pioneer Park "shall not change its character or impair any of its ecological, scenic, aesthetic or natural attributes." According to its bylaws, the Open Space Conservancy Trust's objectives and purposes include:

- To maintain, protect, and preserve properties placed by the City Council in the Mercer Island Open Space Conservancy Trust.

- To develop, evaluate, and promote policies to further the preservation and protection of these open space properties for the public use and enjoyment and for their environmental, aesthetic, scientific, and educational use.

In 1994, the Mercer Island City Council approved ***Policies for Protecting, Maintaining and Preserving Mercer Island Open Space Conservancy Trust Properties***. Subsequently, the Trust commissioned two studies of the park, one concerning invasive plants (Appendix D) and another concerning root rot in Douglas fir (Appendix E). In 2002, a survey of the park boundary was conducted to identify boundary trees and encroachments. Also in 2002, Sheldon and Associates completed a biological assessment of the riparian habitat in the ravine (Appendix F).

The Trust and the City have undertaken several restoration projects in the park. In 1997, a portion of the ravine overlook area was revegetated. Also in 1997, previously topped trees under the utility lines along SE 68th Street were removed and replaced by lower growing trees and shrubs. Starting in 1998, selected areas of root rot in the northeast and southeast quadrants were replanted. Large areas of invasive, non-native plants were removed and additional plantings were installed in 1999, 2000 and 2001. These plantings were maintained through the fall of 2002 by controlling the regrowth of the invasive plants competing with the plantings. Summaries of these projects can be found in Appendix G.

5. Inventory

5.1. Soils

Soils are the foundation of the park. Understanding soils and soil fertility is preliminary to all other plan items. The soils of Mercer Island are derived from material deposited by the Vashon glacier approximately 10,000 to 12,000 years ago. They are relatively young soils, coarse in texture and low in native fertility. According to the ***Soil Survey of King County***, there are three types of soils in Pioneer Park predominantly formed from glacial sand and gravel. In some areas, there is compacted glacial till near the surface that impedes drainage and causes local seasonal wetness. However, the most significant characteristic of the park's soils for forest management is their dryness during the growing season.

In the ravine, soil development is influenced by erosion and landslides. Upper ravine soils are thinner, while lower ravine soils have developed from accumulated colluvium that has worked its way down the slope. Local hydrology brings water to the surface in some areas, creating wetland soils along the stream corridor. In some sections, the stream channel contacts a compacted silt stratum commonly called "blue clay". This is a layer that is impermeable to groundwater flow and is sometimes implicated in landslide activity. Further discussion of soils in Pioneer Park can be found in ***Pioneer Park: a natural history***. See Appendix I for this comprehensive description of the natural resources of the park.

Colluvium: *soil that has collected on a slope by natural erosion and weathering.*

5.2. Overstory

Overstory of the park (vegetation at least 15' tall) was surveyed using a combination of digital aerial imagery, Light Distancing and Ranging (LIDAR) data and ground observation. Based on this analysis, the park contains 32 acres of conifer forest, 45 acres of broadleaf forest, and 40 acres of mixed broadleaf-conifer forest. Predominant species are alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), Douglas fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*).

LIDAR analysis shows that only about two thirds of the park is under closed canopy. The other third is split evenly between areas

How does LIDAR work?
An airplane flies over an area, directing a laser at the ground. The light bounces off layers of vegetation and returns to the plane. An instrument in the plane measures the time it takes for the light to return. From this, a computer calculates the distance from the plane to the object. The difference between the first "return" and the last "return" measures the height of the vegetation canopy.

with no canopy ("canopy gaps") and areas with fragmented tree canopy. The quadrant with the least canopy is the Northwest quadrant, and the quadrant with the most canopy is the Southeast quadrant. Table 5.1 gives a summary of these conditions. See Appendix H for more details of this analysis.

The structure of the forest (height of the canopy, canopy layering, canopy openings, grouping and dispersion of plant populations) indicates the integrity and habitat function of a forest. A forest typically becomes more complex in structure as it matures. Early successional forests typically have lower canopy, fewer canopy layers, and large patches of single species of plants. Over time, the trees grow taller and are more varied in height. As trees die, more sunlight reaches the forest floor, encouraging the growth of sapling trees. The dead standing trees ("snags") become habitat to over 100 vertebrate species. The canopy gaps that result also provide "edge" habitat. Eventually, stands of trees become more mixed in species composition and ground layer vegetation becomes more diverse as well.

	Northwest	**Northeast**	**Southeast**
Canopy Gap	20%	16%	13%
Fragmented Canopy	14.5%	18%	16%
Closed Canopy	65.5%	66%	71%

Table 5.1: Percentage of each quadrant containing tree canopy condition

Pioneer Park is developing structural diversity as it matures. The tree canopy is becoming more layered as tree age becomes more staggered. Many areas of the park have sapling trees regenerating in the understory. Openings in the tree canopy accelerate their growth. Gaps and fragmented canopy provide additional opportunities for new vegetation to establish. They are a natural part of forest succession. However, they need to be managed, given the presence of invasive, non-native species (see below).

5.3. Edges and "edge effects"

Most of the park is considered "edge" forest. This refers to the microclimatic difference between the conditions found at the edge of the forest and those found in the interior. Edges of forests have higher light levels, lower humidity, higher wind speeds, greater temperature fluctuations, and greater movement of wildlife. Edges are inherently less stable, more dynamic parts of the forest. This, combined with the surrounding urban environment, has made this forest susceptible to loss of "interior" forest conditions, the kind of conditions that we see in "old-growth" forests.

Scientists at the University of Washington have found that "edge effects" extend from the edge of the forest inward for a distance equal to three times the height of the canopy. Assuming an average canopy height of 100 feet, seventy percent of the area of Pioneer Park is "edge" forest.

Management activities can only partially mitigate "edge effects". Denser plantings along edges are one such mitigation. Periodic removal of sun-loving plants to favor shade-loving natives is another. However, these are only partial solutions. Therefore, a goal to develop "old-growth" forest character in most of Pioneer Park is probably not realistic. Nevertheless, increasing the complexity of forest structure and composition is a reasonable goal and "interior" forest character can be achieved in the middle of the park quadrants.

5.4. Tree Diseases

In 1999, Robert Edmonds, Ph.D. was commissioned to prepare the ***Management Plan for Tree Diseases in Pioneer Park*** (Appendix E). A number of tree diseases were identified on the site, the most significant of these being laminated root rot which affects Douglas fir trees. This is an endemic disease that travels from tree to tree by root grafts. The study includes an aerial map of areas most affected by laminated root rot, indicating that there are pockets of diseased firs in each quadrant of the park. The aerial survey conducted in Dr. Edmonds' study did detect affected trees, confirmed by ground survey. However, it did not identify all affected trees in the park, nor did it claim to. The Park Arborist has observed other trees infected with laminated root rot that were not detected by the aerial survey. It is reasonable to expect that every Douglas fir tree in Pioneer Park is vulnerable to laminated root rot because of its widespread presence. Hemlock and grand fir trees are also susceptible to this disease. Cedar is known to be resistant to the disease.

5.5. Understory

The understory vegetation (shrubs less than 15 feet tall) in Pioneer Park greatly influences both the character (for humans) and the habitat (for wildlife) of the park. The greatest threat to both comes from the introduction of invasive, non-native plant species. These species can be observed in every area of the park. The most widespread is English ivy (*Hedera helix*). It smothers ground layer vegetation and ultimately carpets the entire forest floor. It has been listed as a Class C noxious weed by the Washington State Noxious Weed Control Board. Along with ivy, holly (*Ilex aquifolium*) and laurel (*Prunus laurocerasus*) are becoming established in the understory of Pioneer Park. Meanwhile, blackberry (*Rubus discolor*) is becoming dominant along edges of the quadrants, in gaps, and wherever light levels are higher than in the forest interior.

Native understory vegetation is alive and well, however. In the upland of Pioneer Park, it is remarkably homogeneous. Common species such as sword fern, elderberry, hazel, Indian plum, trailing blackberry, salal and Oregon grape are dominant wherever invasive, non-native species are not established. The ravine contains stands of salmonberry, elderberry, and devil's club in wet soils, with sword fern carpeting drier slopes. Notably, occasional patches of vanilla leaf (*Achlys triphylla*) trillium (*Trillium ovatum*) and wild ginger (*Asarum caudatum*) are found sporadically throughout the park. These species have become rare in urban forests, but can still be found where taller shrubs or ivy have not crowded them out.

In 1996, Sarah Reichard, Ph.D. prepared the ***Pioneer Park Invasive Plant Report and Recommendations*** (Appendix D) in which she identified four non-native species of concern in the park: English ivy, herb Robert, Himalayan blackberry and English holly. In other parts of Mercer Island and around the Seattle area, additional species such as laurel (*Prunus laurocerasus*), wild clematis (*Clematis vitalba*), garlic mustard (*Alliaria petiolata*), periwinkle (*Vinca minor*), Norway maple (*Acer platanoides*), and Japanese knotweed (*Polygonum cuspidatum*) have become prevalent and may become a problem for Pioneer Park in the future.

The 2008 Forest Health Survey (Appendix R) of Pioneer Park showed that native understory is well established. However, the survey found several startling conditions that had been previously undocumented. First, tree regeneration was lacking in the park. Native conifer regeneration was found to average 24 stems per acre across the park. This was not sufficient to replace the canopy losses anticipated from attrition and laminated root rot. Furthermore, the Trustees consulted with Mike Nystrom from Washington State Department of Natural Resources. He stated that the dense shrub stands that develop in canopy gaps may take 100-200 years to produce new overstory trees absent management intervention.

Second, the excessive presence of regenerating holly trees was considered a great threat to native regeneration. Holly was found to average around 900 stems per acre across the park. Left unchecked, large areas of the park would become holly forests over time. Third, ivy was found to be growing up 20% of the overstory trees, potentially compromising the existing overstory's integrity.

5.6. Riparian Resources

The ravine area in the northeast corner of Pioneer Park includes seeps, upland swales and the headwaters of a perennial creek that drains to Lake Washington. This riparian area is unique within the park, offering a mosaic of diverse microhabitats characterized by hillside slope wetlands, dense forested canopy cover, and open canopy areas. A fuller assessment of Pioneer Park's Ravine Habitat is included in Appendix F.

The ravine's wetland and stream habitat in Pioneer Park attracts and supports a wide variety of wildlife species, including invertebrates, amphibians, reptiles, mammals and birds. Maintenance of riparian vegetation has been identified as a forest management policy because of its overall importance to the forest ecosystem. Riparian vegetation contributes twigs, leaves and other fine litter that are a critical component of the aquatic food base. Riparian vegetation moderates stream temperatures and root systems stabilize channel banks.

The vegetation of Pioneer Park's riparian plant community embraces a variety of species including red alder, bigleaf maple, western red cedar and others. Understory plants include native and non-native species. Giant conifer stumps indicate that a mature forest occupied this site in the past. This is a dynamic landscape; a combination of wet soils overlaying a compacted silt strata facilitates soil slippage and the deposition of sediments into the creek.

Good water quality is essential for growth, survival, reproduction and migration of individuals within the park's aquatic community. Degradation of watercourses or watercourse condition and water quality occurs because of removal of riparian vegetation, urban influences, and accelerated sediment input associated with management activities.

A healthy stream has a large variety of organisms. Indicators of healthy aquatic biological quality include fish, amphibians, macroinvertebrates, such as insects and crustaceans, and certain rooted aquatic vegetation and algae.

Three factors are critical in maintaining the aquatic habitat in Pioneer Park's wetlands and ravine.

1. The first factor is retention of the forest canopy bordering the stream and wetlands that directly provide the vegetative matter that is the base of the aquatic food chain. The streamside canopy also shades the watercourse and thus prevents increases in water temperature. High water temperatures (with less dissolved oxygen) tend to increase the metabolic rate of cold-water organisms causing increased stress.

2. The second factor is to maintain complex structure in the streams and wetlands through the contribution of large woody debris. As streamside trees die, they often fall into or adjacent to the channel, creating complex stream and riparian pool habitats.

3. The third factor is limiting the input of sediment to stream channels. Excess fine sediment can impact salmonids through degradation of spawning gravel and reduction of aquatic food production.

5.7. Wildlife Resources

Avian resources have been well documented in Pioneer Park (see Appendix I: ***Pioneer Park: a natural history***). A summary inventory of mammalian species in Pioneer Park was undertaken in the past, but this analysis is incomplete (*ibid.*). Little is known about the extent, health or population trend-lines for reptiles, amphibians, invertebrates and aquatic species utilizing Pioneer Park. Further inventory and analysis of these wildlife resources would prove valuable to maintaining and protecting biodiversity values in Pioneer Park.

5.8. Management Resources

Management resources are the people, funds and "tools" that are dedicated to the park on an ongoing basis. The "tools" are not so much hardware as the plans, standards, policies, technologies and protocols used in the management of the natural resources. It is important to establish whether these "tools" meet industry standards (commonly referred

to as "Best Management Practices") and whether they are based on "Best Available Science."

Management resources for Pioneer Park are detailed in Appendix J. They include the lead involvement of Mercer Island Parks and Recreation in the daily management of the park. The City's Maintenance Department and Development Services Group also have involvement with the park. Puget Sound Energy also has interest where power line clearance zones overlap park boundaries. State urban forestry programs, State "land grant" colleges, the International Society of Arboriculture and the Society for Ecological Restoration have been sources for publications and technologies that make up many of the "Best Management Practices" that pertain to forest management. These are listed in the Appendix.

5.9. Community Resources

Community resources are the people, funds, expertise and political support that are volunteered in support of the park. Unlike management resources, they are not necessarily dedicated to or fit for a particular service. However, these resources have proven to be indispensable for the long-term sustainability of urban forests.

The Open Space Conservancy Trust is the main community resource dedicated to the park. This non-profit volunteer board represents the community that is served by the park. Other community resources include: Ivy Brigade, Committee to Save the Earth, youth and school programs, businesses, religious congregations, service clubs and concerned citizens. Descriptions of these resources can be found in Appendix K.

6. Analysis

Pioneer Park is an unusually large area of native forest set within a suburban landscape. Pioneer Park can remain a viable native forest with management by the City and involvement of the community.

In summary, its strengths are:

- Large overall size of the park
- Overall abundance and diversity of native vegetation
- Natural regeneration of both trees and shrubs
- Connectivity with forest landscapes on nearby properties
- Ongoing funding of forest management projects
- Conservation of the park property in trust
- Community sense of "ownership" of the park

Challenges are:

- Droughty soils and unpredictable summer rain

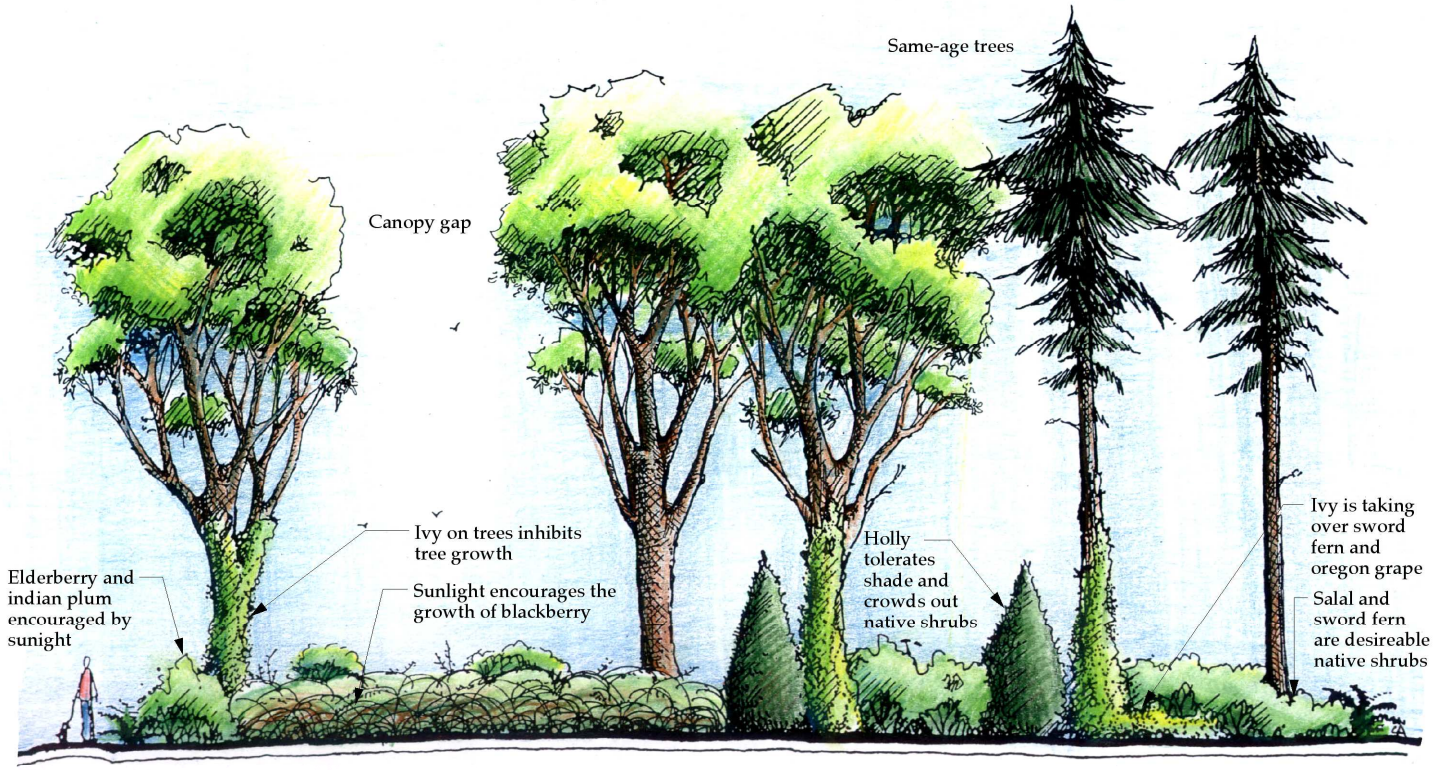
- Fragmentation of the habitat, i.e. the roads separating the quadrants
- Exposed edges of the park causing higher light and wind levels in the park interior – "Edge effects"
- Managing hazard trees, especially from laminated root rot
- Managing fire potential
- Numerous and widespread canopy gaps
- Invasive plant patches
- Laminated root rot pockets
- Instability in the ravine
- Boundary encroachments
- Damage to vegetation from trampling
- Organizing volunteers
- Funding limitations
- Lack of canopy regeneration
- Excessive non-native holly regeneration
- Ivy growing in canopy trees

7. Overall Strategy

The Trust board considered several scenarios for managing Pioneer Park that would achieve different long-term results (see Appendix B). The "Deep Forest" strategy would drive forest succession towards a conifer-dominated forest with dense canopy. The "Purely Native" strategy, like Deep Forest, would aggressively control invasive, non-native plants, but instead utilize "natural regeneration" relying on self-seeded plants to restock the forest rather than actively planting nursery stock. The "Basic Canopy" offered a more casual approach to invasive plant control. It would focus on controlling plants only as they impacted tree canopy or affected the park user's experience. This third approach would manage canopy regeneration by plantings or natural regeneration.

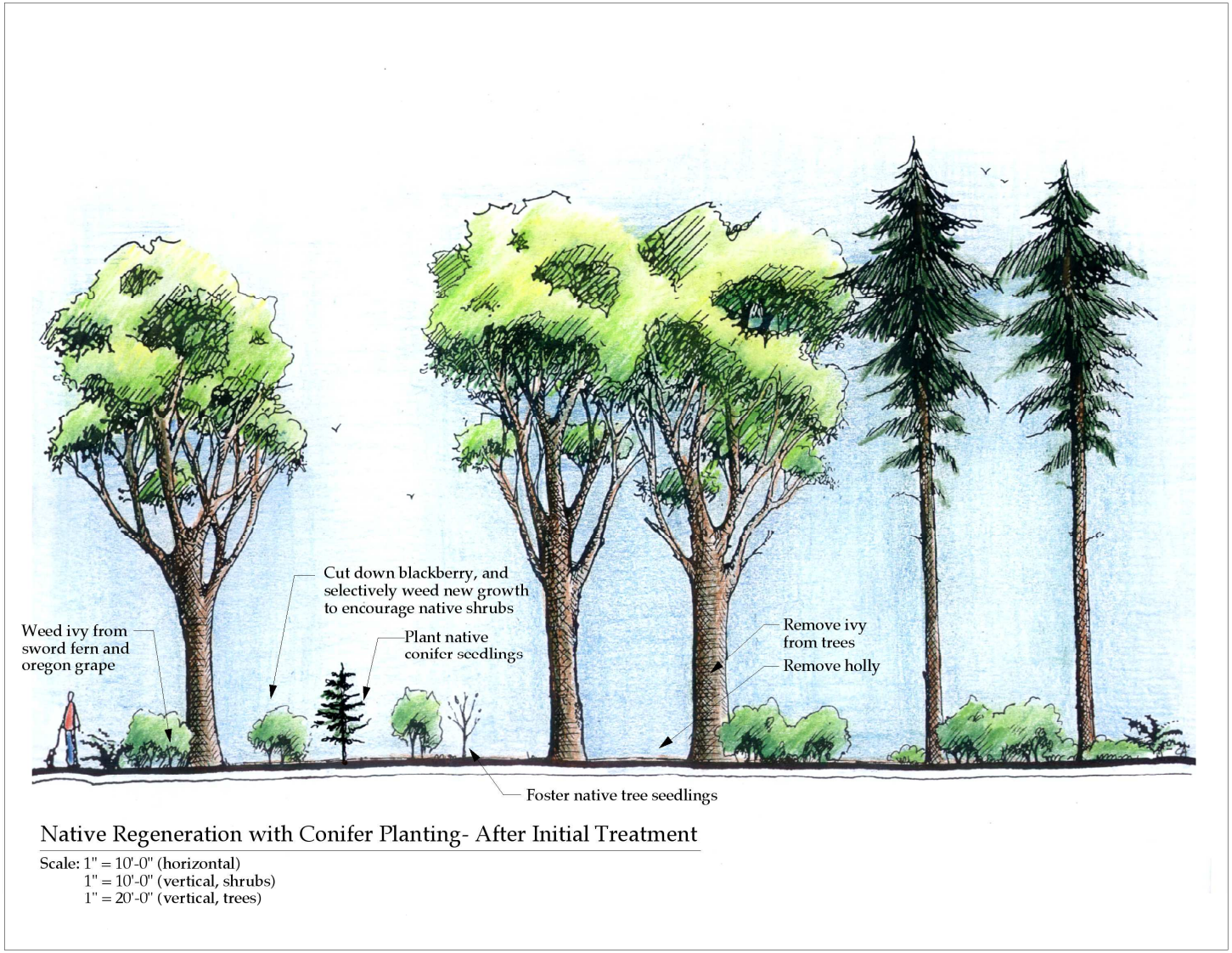
The Trust board and City staff eventually developed a strategy that relies predominantly on native regeneration, as in the "Purely Native" strategy, but also incorporates some conifer planting to direct succession toward a more evergreen forest. In 2008, the Trust authorized a thorough analysis of Pioneer Park's forest to determine whether this original strategy would be sufficient to protect the health of Pioneer Park. The 2008 Forest Health Survey (Appendix R) concluded that canopy regeneration in Pioneer Park is not sufficient to maintain tree canopy in the park. The survey indicated the need for more conifer regeneration in the forest. Therefore, the Open Space Trust decided to support a change in strategy that focused on planting new conifer tree canopy throughout the park. The new strategy also called for targeting specific invasive plant species that compete with native tree regeneration. This represented a significant change in strategy from the 2003 version of this plan.

The following illustrations depict the types of management activities that would influence the forest.



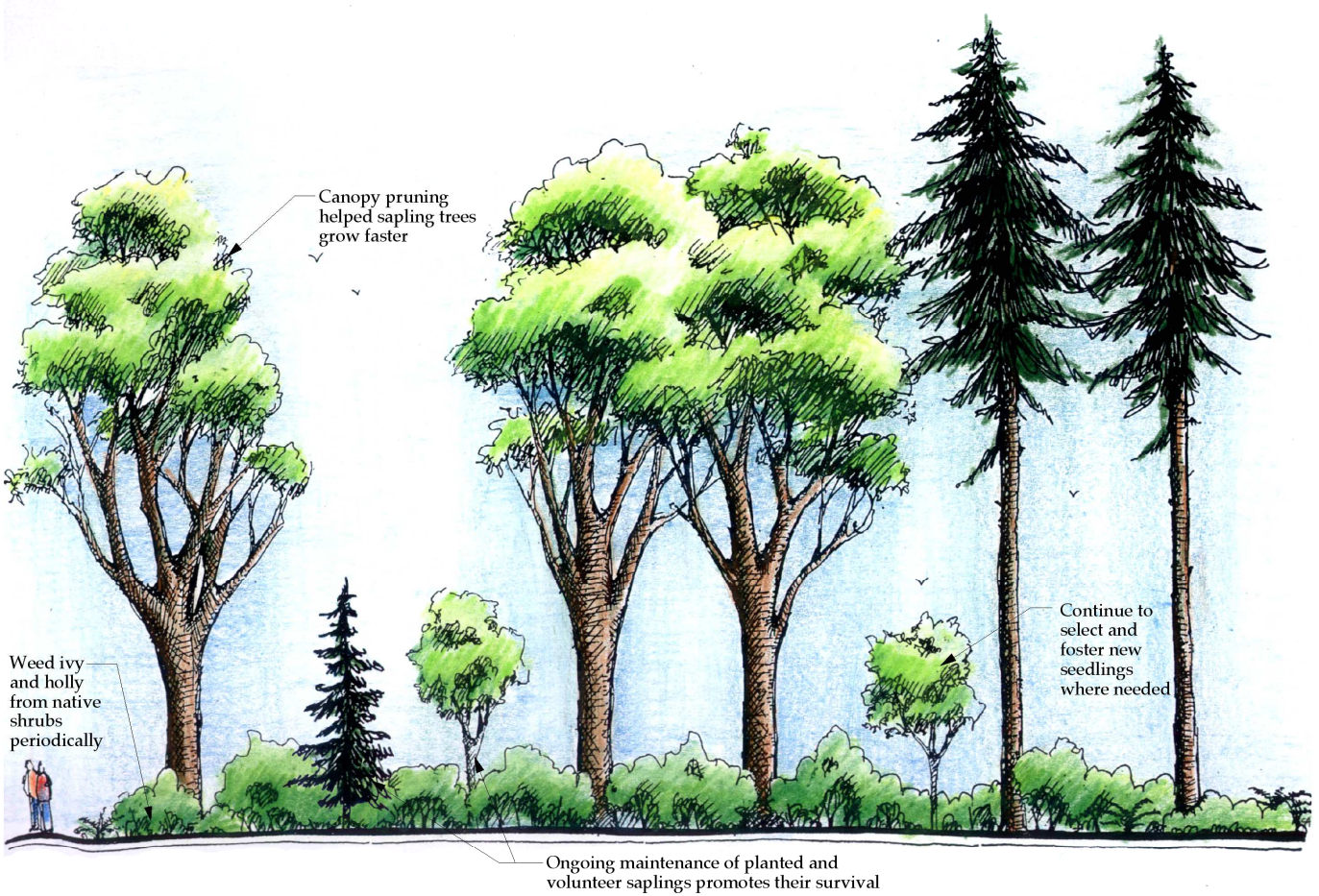
Existing Conditions and Issues

Scale: 1" = 10'-0" (horizontal)
1" = 10'-0" (vertical, shrubs)
1" = 20'-0" (vertical, trees)



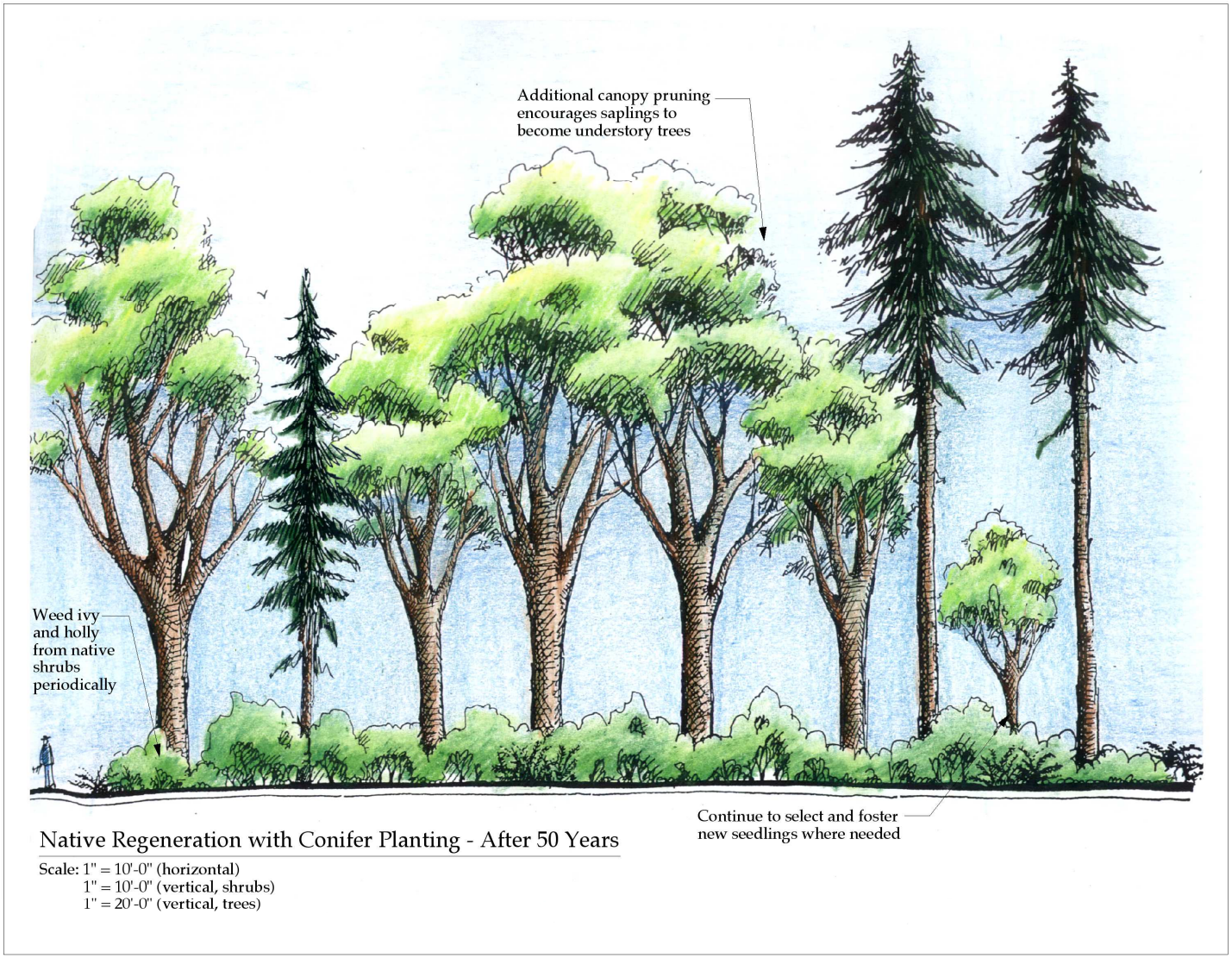
Native Regeneration with Conifer Planting- After Initial Treatment

Scale: 1" = 10'-0" (horizontal)
1" = 10'-0" (vertical, shrubs)
1" = 20'-0" (vertical, trees)



Native Regeneration with Conifer Planting- After 20 Years

Scale: 1" = 10'-0" (horizontal)
1" = 10'-0" (vertical, shrubs)
1" = 20'-0" (vertical, trees)



Native Regeneration with Conifer Planting - After 50 Years

Scale: 1" = 10'-0" (horizontal)
1" = 10'-0" (vertical, shrubs)
1" = 20'-0" (vertical, trees)

The Trust board's vision for Pioneer Park is to achieve the complexity and character that can be found in native forests uninfluenced by urbanization. Therefore, conifer trees and evergreen understory will be favored in the overall strategy of using the natural regeneration of native plants to achieve an overstory and understory full of native species. Since natural regeneration is not sufficient, the main management tool will be planting new conifer trees and controlling vegetation that competes with desired tree regeneration.

Canopy gaps are a natural part of forest ecology. However, the introduction of non-native invasive plants to the Pacific Northwest has drastically changed forest succession. Himalayan blackberry, English ivy and other non-native species are well established in the forest of Pioneer Park. These species are so competitive that they can inhibit regeneration of native canopy trees. Their presence is correlated with higher light levels, such as are found in canopy gaps and in areas where the tree canopy is fragmented. Therefore, a primary strategy of maintaining forest cover in Pioneer Park is to manage gaps and fragmented canopy so that non-native, invasive plants do not prevent new trees from growing. Some invasive species will spread regardless of tree cover. English ivy, holly and laurel tolerate shade and propagate under dense canopy. Therefore, an equally important strategy of this plan is controlling these species on a parkwide basis.

Another cornerstone of the strategy for Pioneer Park involves a system of experimentation and decision-making to develop techniques that work best for the conditions in the park and the goals we are trying to achieve. Until now, techniques for planting, watering, or invasive plant control have been tried in various areas of the park with varying results. However, there is no systematic way of tracking and evaluating these results to learn from them. A system of "adaptive management" will allow the Open Space Conservancy Trust and the City of Mercer Island to evaluate results of management strategies and create new strategies for future projects.

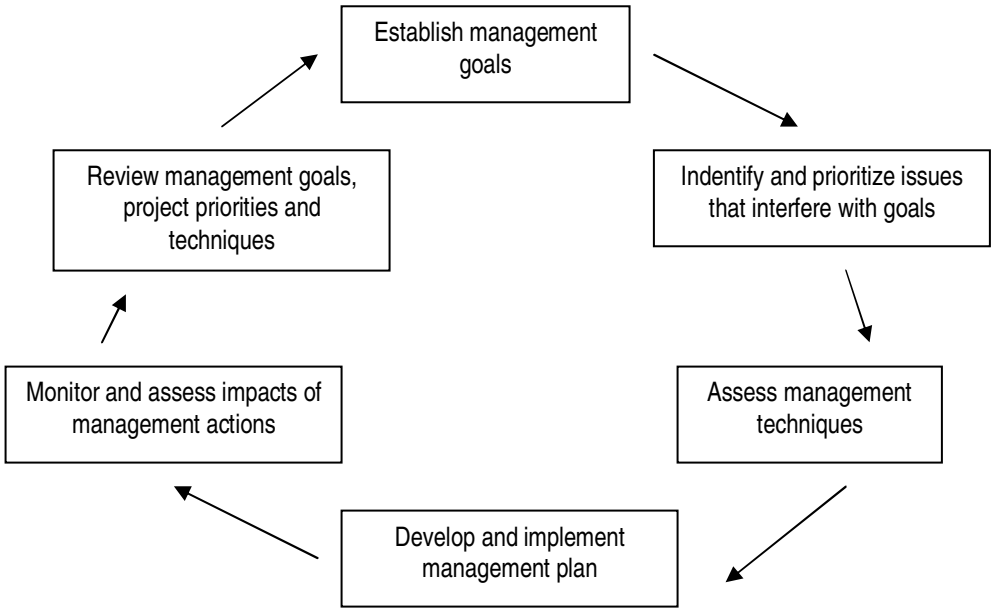


Figure 7.1: Adaptive Management Flowchart (adapted from Schwartz and Randall (1995) in Luken and Thieret (1997)).

The process of adaptive management has begun with this plan. It begins with defining management goals in Section 2. The management issues that impact these goals are summarized in Sections 5 and 6. Sections 7, 8 and 9 detail the strategy and techniques needed to achieve the management goals. Taken together, these comprise the core of the Pioneer Park Forest Management Plan and complete the first half of the adaptive management system.

Management projects will begin after adoption of this plan by the Open Space Conservancy Trust. The Parks and Recreation Department will plan and implement projects under their leadership. The Park Arborist will be responsible for monitoring and evaluating the results of the projects. Discussions of these results with the Open Space Conservancy Trust may lead to reevaluation of the goals, priorities and techniques contained in this plan after several projects are completed.

The 2008 Forest Health Survey (Appendix R) provided the first chance to evaluate the effectiveness of management strategies. As a result, a new work plan (Appendix S) is being adopted to replace the original work plan contained in Section 9 below.

8. General Management Prescriptions

Management prescriptions will fall into two categories: ones that will be applied on a park-wide basis, and ones that pertain to specific areas within the park. Park-wide prescriptions may include techniques for the management of the following:

8.1. Project Planning

All project proposals, whether initiated by the City, the Trust or another community entity should provide the City and the Trust basic information on the project in a standard format. The form in Appendix L is proposed for this purpose. This form should be reviewed by City staff and Trust board members before the project is executed. This will help incorporate the goals of this plan into every project and provide a basis on which to conduct an evaluation of the project at its completion. The essential data on the form should be entered into a database.

8.2. Hazard Trees

Hazard trees are a result of a tree failing, hitting a “target” and causing damage or injury. A target could be either property (car, house, another tree) or a person. The chance of this happening depends on the likelihood of the tree failure, the size of the failure and the likelihood of hitting a “target”.

The likelihood of failure can be evaluated if a “defect” (i.e. rot, dead branch, lean) can be seen or measured. This must be done by an experienced arborist who can assess the severity of the defect in comparison to other trees of the same species. It is important to note that virtually <u>all</u> trees have defects. The task is to rate those that have a high probability for failure.

The next step is to estimate the size of the part that will fail. A cavity at the base of the tree could cause the entire tree to fail. This type of failure can cause significant damage. On the other hand, a severe cavity on a small branch would be less significant, even if the likelihood of failure was greater.

Not all targets have the same value. Obviously, damage to a house is likely to be more costly than damage to a fence. People are found more often along the edges of the park (on foot, in cars or in houses) than in the middle of the park. If a tree is leaning away from a target, it is less likely to be affected by the tree's failure. The three factors of relative risk – likelihood of failure, size of failure and value of the target – must be considered together to properly manage hazard trees.

This general philosophy of tree hazard management has been developed over the past twenty years, and is most recently summarized in ***Evaluating Trees for Defect*** (2002). This evaluates trees based on six characteristics that are most common indicators of defect: lean, roots, cracks, branch attachments, cankers & decay, and dead wood. In addition, the information provided in Dr. Edmonds' report (Appendix E) on laminated root rot can be used to assess conifers. Where a tree's condition is in dispute, the protocol described in ***A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas 2nd Edition*** (1994) should be used by both parties to resolve the dispute. This provides an extensive evaluation of the tree in question.

Since hazard rating is proportional to the likelihood of hitting something, it is prudent to inspect areas that have more vulnerable targets. The boundaries of the park are where the most risk factors are found. Cars in the road, houses next to the park, power lines, and pedestrians are most likely to be found at the boundaries. Therefore, more frequent and in-depth inspections should occur there. Conversely, the likelihood of a tree hitting something on an interior trail varies with the use of the trail. Higher traffic trails should be inspected more frequently than lower traffic trails. Therefore, the priority for hazard tree survey should be as follows:

Boundaries	once per year, or after a severe storm
Perimeter trails	once per year, or after a severe storm
Primary interior trails	once every two years, or after a severe storm
Secondary trails	once every two years, or after a severe storm

Hazard survey may be conducted by the Park Arborist, or by Parks and Recreation staff trained in hazard tree identification. Citizens also are encouraged to call about trees that look suspicious.

8.3. Fire Management

Pioneer Park is susceptible to fire primarily from human behavior. Historical incidents of encampment (with fire) and fire works used in the park are particular concerns. The forest is prone to drought because the soils are well drained. Woody debris has built up in the park, increasing fuel loading. Houses back up to the park with minimal distances

between structures and stands of dense vegetation. The interior of the park is not accessible to fire vehicles because the trails are too narrow for them.

However, the size of the park and the cooler, moister climate of Western Washington reduce risk in comparison to Eastern Washington forest landscapes where fire protection standards have been developed. The quadrants are surrounded by a network of fire hydrants that can supply water to the park perimeter and significant portions of the interior. Fire Station 92 is located across the street from the park. The staff of Mercer Island Fire Department is highly trained in incident response. Furthermore, mutual aid agreements with other cities would enable the City to sustain a response and provide specialized capabilities as conditions warrant.

Limitations in response include the difficulty of conveying water to the center of a quadrant. For certain hydrants, vegetation poses a barrier to trail access. City firefighters have not received training specific to the situation in Pioneer Park. These limitations are certainly addressable.

The goals of this plan are directed toward maintaining a diverse native forest with dense vegetation buffering the edges of the park and abundant deadwood for wildlife habitat. The generally accepted principles of fire management along wildland interfaces run counter to these goals. Prescriptions for reducing risk to adjacent properties usually include extensive pruning of trees and shrubs to reduce ladder fuels and clearing the ground layer of woody debris to reduce fuel loads.

These two goals can be reconciled to achieve dense vegetation along park edges while achieving some reduction of ladder fuels and fuel loads along residential border of the park perimeter. Neighbor partnerships would be sought to “adopt” areas of the park. These neighbors, under the direction of City staff, would restore and maintain the portion of the park behind their houses within a certain distance of the residence depending on the terrain and the vegetation found there. For example, neighbor partners would foster dense, low-growing evergreen shrubs in the understory and periodically thin tall shrubs and dead branches to inhibit a ground fire from climbing into the canopy. Neighbors also would work to eliminate firewood and debris piles along property boundaries. City staff would support these activities with debris pickup, tool lending and technical assistance. The City would also remove the wood from trees that they cut down in these areas, instead of leaving them to decompose.

See Appendix M for the full plan.

8.4. Tree Pruning and Removal

Trees in Pioneer Park will be pruned or removed when it is necessary to mitigate risk to park users, right-of-way or adjacent properties. Otherwise, tree work will be restricted to instances where it directly achieves a project objective. Such instances might include:

- A mature tree may be pruned or removed to encourage nearby sapling trees to grow. Wherever possible, the preferred technique for reducing competition will

be pruning. If a tree is removed, it should be converted to a "snag", essentially a branchless trunk. This reduces costs and increases habitat features in the park.

- A group of sapling trees may be "thinned" by cutting down weaker, damaged or poorly located trees until there is enough space between the remaining trees for them to remain at a mature size. Some planned projects may plant trees closely together to be thinned in the future for this same reason.
- Low branches on trees along a trail may be pruned to provide overhead and side clearance according to the ***Pioneer Park Master Plan***.
- Trees and shrubs along Island Crest Way may be pruned to provide roadway clearance or allow motorists and pedestrians on the street to have views into the forest.

Trees in Pioneer Park will not be pruned or removed for other reasons. Pruning and removals that are not safety-related must be reviewed by Mercer Island staff and the Open Space Conservancy Trust through a Project Planning Form (see Appendix L). All trees that fall within the forest due to a natural course of events will be left in the forest. If a tree needs to be removed along the park perimeter for forest management or maintenance, the Open Space Conservancy Trust will determine how the wood will be disposed. Removals on steep slopes, in slide-prone areas, in wetlands, watercourses or buffer areas are subject to Section 19 of the Mercer Island City Code "The Tree Ordinance".

8.5. Tree Roots and Tree Protection

Tree roots are mostly invisible to us, and most of the injury that occurs to trees is to their roots. Trees are vulnerable to compaction by traffic from trucks and heavy equipment. Trees may take up to ten years to show visible signs of construction damage to roots, and there is little remedy once the damage is done. Preventing damage is most important.

The two most critical elements of tree protection are:

- A site evaluation by a qualified arborist when planning maintenance or construction activities to identify tree protection issues.
- An on-site meeting of maintenance or construction staff with a qualified arborist to insure that protection measures are understood by everyone involved.

For routine maintenance activities, it is most critical that staff understand where tree roots are likely to be found and when compaction is most likely to be a problem. The sandy soils found near Pioneer Park are resistant to compaction when soils are relatively dry. Wet soils are most vulnerable to compaction.

For construction activities, it is critical that a qualified arborist work with designers to establish tree protection zones on plan drawings and that the contractor understand his or her responsibility inside and outside these zones. Protection zones are designed to protect where trees are most vulnerable. They are usually fenced off and all construction activity is prohibited within them. However, contractors may also be required to report whenever they dig up any root greater than 2" diameter. This would allow the project arborist to

track impacts to trees as they occur and recommend changes to construction, if trees are being more heavily impacted than anticipated.

8.6. Trails and Roots

On dirt or gravel trails, exposed tree roots may be covered with dirt or gravel sufficient to reduce the trip hazard. On paved asphalt trails, bridging with asphalt or root pruning may be required according to the specific situation. Rerouting the trail will be considered if no other corrective measure is feasible. Future conflicts between tree roots and paved surfaces should be prevented by proper design, including compacted subgrade and use of root barriers along pavement edges.

8.7. Exotic Invasive Control

Recommendations for control are found in the 1996 ***Pioneer Park Invasive Plant Report and Recommendations***. (See Appendix D) These and additional recommendations are given here. These recommendations will be a starting point to tailor control practices specific to the situations found in Pioneer Park. Through evaluation of control projects, project managers will refine control strategies to achieve more efficient and environmentally sensitive weed control.

Blackberry

Projects in Pioneer Park to date have relied exclusively on digging out plants. This has been a successful first step. However, the area treated has been limited, and repeated visits have been necessary. WSU Cooperative Extension recommends both manual and chemical controls for blackberry. They recommend a combination of cutting, digging and applying glyphosate herbicide (Roundup®.) Another experimental technique involves cutting the stem off about a foot from the ground and painting undiluted glyphosate in the freshly-cut, still damp stem.

Initial control of blackberry will be accomplished by non-chemical means. If necessary, chemical use will be limited to glyphosate products because of their relative safety, low toxicity, immobility in the soil and rapid breakdown. The decision to use glyphosate will be made depending on the extent of the area to be managed, the level of infestation, the ability to limit application only to the target plants, and the availability of trained personnel to carry out the work.

In the 2008 Forest Health Survey, active removal of blackberry is recommended only in preparing areas for tree planting. This control consists of blackberry ‘knockdown’ or brushcutting, which reduces the height of blackberry canes to one foot, allowing new trees access to light and water. By planting trees densely throughout Pioneer Park, Himalayan blackberry, which thrives in high-light areas, will be greatly reduced through the creation of shade.

Ivy

The first stage of ivy control is cutting vines growing up trees to prevent fruiting. Every vine is severed around the base of the tree and the vines are left to die. The second stage of control is cutting ivy away from the tree for a distance of four feet, creating a "lifesaver" around the tree. The third stage of ivy control is pulling ivy from the ground where it is mixed in with native vegetation. The fourth stage is smothering or cutting blankets of ivy that carpet the forest floor. These are all excellent activities for volunteers.

Applying Herbicide

The decision to apply herbicide will be made by the Trust board on a case-by-case basis through project planning (see 8.1). Herbicides applied at Pioneer Park will be used sparingly and in conjunction with other control methods. . Applications may be made several ways. A sponge applicator would spread the chemical directly on the leaves or cut stems of the target plant. A drill or knife would expose the inner bark and the chemical would be dispensed into the cut from a pump bottle. In any case, the application would be restricted to the target plant.

Researchers at the University of Washington have tested herbicide, heat, steam and mechanical means of control, but they have not provided any clear answers about these techniques yet. The Thornton Creek Alliance has had success with controlling blankets of ivy with horticultural weed block fabric, applied over the leaves for two growing seasons. This excludes all sunlight and slowly starves the ivy. The herbicide technique used on laurel and holly below should also be tried on large ivy vines to see if it can be effective there as well.

In 2008, a demonstration project authorized by the trust consisted of spraying 5% Roundup with dye marker on a carpet of ivy in the northeast quadrant. Spraying took place on a sunny, warm day in late winter, as recommended by Nature Conservancy web resources. The control method was found to be successful at targeting ivy but preserving herbaceous native perennials. Nevertheless, the Trust expressed concern about the impact of Roundup® on salamanders, frogs and other native terrestrial vertebrates. Recent research shows that certain formulations of glyphosate herbicide, such as AquaMaster®, which contain no surfactant, have little to no effect on amphibian health (Mann and Bidwell, 1999; Howe et al, 2004). Further investigation of ivy control should be pursued under the direction of the Trust.

Laurel and Holly

Small plants (less than 1" diameter) can be pulled with a weed wrench or dug out with a shovel. Workers must be careful not to confuse holly with the native Oregon grape. Larger plants have been cut down with saws and removed from the park. Removing larger plants has resulted in large areas of ground disturbance and compaction from foot trampling back and forth between the plant and the waste collection area.

In an effort to find an alternative, glyphosate herbicide was tested on a limited basis in Pioneer Park. The concentrate was applied by drilling trunks of larger trees with a ¼ inch drill bit and injecting 1cc of Roundup Pro® concentrate into each hole. Stems were drilled every two to three inches around their circumference. Dying plants have been left

standing to minimize site disturbance. These experiments should be expanded to develop more accurate dosages for control. The City and the Trust can then evaluate the value of this technique in comparison to physical removal.

Herb Robert, Bindweed, Other Herbaceous Perennials

Herb Robert is easily pulled by hand. However, the established seed bank may result in new crops emerging for several years. Bindweed is very difficult to control by hand. Its fleshy roots break easily and resprout rampantly. It responds well to foliar application of glyphosate (Roundup®) herbicide applied to the leaves at the dilution recommended on the label. In most instances, the vine is tangled with desirable vegetation. In these situations, the herbicide should be applied by sponge applicator to limit application to the target plant.

8.8. Rare or Unusual Plant Species

A signature plant of the park, Trillium (*Trillium ovatum*) is locally rare and difficult to propagate. This species, as well as vanilla leaf (*Achlys triphylla*) and wild ginger (*Asarum caudatum*) may be losing ground in competition with invasives and other natives. Areas where these are found should be protected from this encroachment. Other rare or unusual plant species may be found as project work progresses and should be added to this section. Rare or unusual plants should be propagated and replanted in restoration project areas where they are suitable choices.

8.9. Off-trail Use

Off-trail use in the park has impacted park vegetation. Both humans and dogs have trampled desirable vegetation. Unfortunately, native vegetation gets preferentially trampled because it is low growing and easy to step on, whereas blackberry and holly are prickly and are generally avoided. New trails develop by repeated use of the same route. Educating park users is the most obvious first step to address this issue. Where off-trail use has damaged park resources such as steep slopes, unstable soils or locations with sensitive plant species, further off-trail use will be discouraged. Woody debris, signage and/or barriers may be placed along trails to discourage off-trail traffic where vegetation has been impacted.

8.10. Habitat Management

Wildlife habitat will be managed to promote species diversity and to ensure that populations of indigenous species are maintained. This can be best achieved through the maintenance and enhancement of habitat values. Habitat values that lead to species diversity include the following elements: breeding, foraging, watering, rearing, hiding and thermal cover.

Wildlife management within Pioneer Park is focused primarily on the protection and enhancement of key habitat and structural components that are utilized by a diversity of species. Snags and down logs will be maintained through the retention and recruitment of snags over time. Snags are used to some degree by all major groups of wildlife species

found in Pioneer Park. Their primary value is as a nesting and roosting site, or foraging for insects. Species excavate their own cavity, utilize previously excavated cavities or utilize natural cavities and crevices. Other species use the tops of larger snags as nest and roost sites. Species in Pioneer Park that use cavities in snags include hairy woodpecker, chestnut backed chickadee, red-breasted nuthatch, screech owl, violet-green swallow, brown creeper, Douglas squirrel and two bat species. Species that nest or roost at the top of snags include red-tailed hawk, raven, and osprey. Retention of dead and down materials are particularly critical in riparian areas.

Snags can be created from trees that are scheduled for removal. Logs from removed trees can be left lying on the ground and allowed to decompose. These features are most effective in their woodland context. It is less effective to create a snag along a busy street, or leave a log in the middle of a lawn, for example. Typically, snags should be at least 10 inches in diameter, and are most effective in the 22 to 46 inch diameter range.

9. Site-Specific Prescriptions

See Appendix S for the 2008 Forest Health Work Plan

9.1. Work Plan

To guide the first phase of plan implementation, a set of priority projects have been outlined with initial cost estimates. These costs have been planned to spread out over 10 years. Specific timing and locations of these projects can be found also in Appendix N.

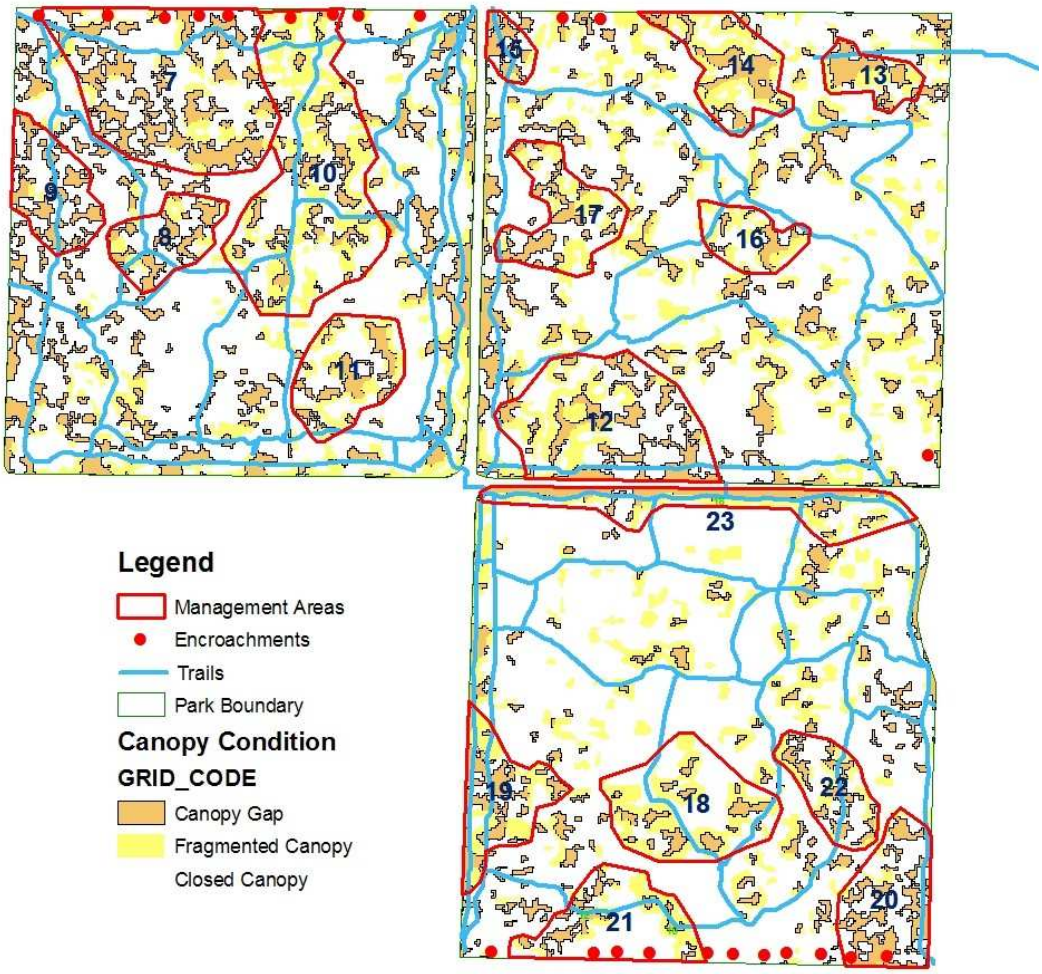


Figure 9.1: Canopy Condition and Management Areas

Project	Project Type	Acres	Quadrant	Priority	Goal	Total Cost
1	controlling ivy in trees, laurel and holly	113	all	1	control invasive plants in non-project areas	$50,000
2	public education	113	all	1	raise public awareness about park environment	$20,000
3	neighbor partnerships	3	all	1	recruit park stewards from adjoining neighbors	$10,000
4	wildlife habitat assessment	113	all	2	inventory wildlife habitat and determine needs	$3,000
5	tree risk management	113	all	1	prune or remove hazard trees	$20,000
6	forest management plan	113	all	1	revise plan with experience and data from projects	$18,000
7	NW regeneration mgmt w/conifer planting	5.36	NW	1	foster native regeneration, plant conifers, control invasives	$59,326
8	NW regeneration mgmt w/conifer planting	1.28	NW	1	foster native regeneration, plant conifers, control invasives	$14,882
9	NW regeneration mgmt w/conifer planting	1.52	NW	1	foster native regeneration, plant conifers, control invasives	$17,524
10	NW regeneration mgmt w/conifer planting	5.54	NW	2	foster native regeneration, plant conifers, control invasives	$61,232
11	NW regeneration mgmt w/conifer planting	1.82	NW	1	foster native regeneration, plant conifers, control invasives	$20,762
12	NE deciduous regeneration mgmt	3.86	NE	1	encourage deciduous regeneration, control invasives	$43,046
13	NE ravine mgmt w/planting	0.77	NE	2	install erosion control, replant canopy trees	$9,407
14	NE ravine mgmt w/planting	1.69	NE	1	install erosion control, replant canopy trees	$19,429

Project	Project Type	Acres	Quadrant	Priority	Goal	Total Cost
15	NE regeneration mgmt w/conifer planting	0.46	NE	2	foster native regeneration, plant conifers, control invasives	$5,991
16	NE deciduous regeneration mgmt	0.96	NE	2	encourage deciduous regeneration, control invasives	$11,449
17	NE regeneration mgmt w/conifer planting	2.35	NE	1	foster native regeneration, plant conifers, control invasives	$26,520
18	SE deciduous regeneration mgmt	2.76	SE	2	encourage deciduous regeneration, control invasives	$30,984
19	SE deciduous regeneration mgmt	1.68	SE	1	encourage deciduous regeneration, control invasives	$19,229
20	SE regeneration mgmt w/conifer planting	2.02	SE	2	foster native regeneration, plant conifers, control invasives	$23,003
21	SE deciduous regeneration mgmt	2.11	SE	1	encourage deciduous regeneration, control invasives	$23,909
22	SE deciduous regeneration mgmt	1.27	SE	2	encourage deciduous regeneration, control invasives	$14,859
23	Utility canopy conversion	2.07	SE	1	remove hazard trees, plant trees that won't grow into powerlines	$23,562

Figure 9.2: Forest Management Project Summary Grouped by Quadrant

See Appendix N for an expanded version of this list. The topics covered below govern how the site-specific project should be planned and implemented.

9.2. Trees

Species Selection

This plan identifies tree species to be planted in Pioneer Park. The presence of laminated root rot makes plant selection for reforestation projects challenging. Douglas fir is the native tree most adapted to the general condition of the park. However, it is most vulnerable to laminated root rot. Moreover, most native conifers are at least somewhat susceptible to *Phellinus weirii*, the organism that causes the disease. Native pines and western red cedar are tolerant of the disease. Additionally, several non-native choices were made in the year 2000 project to avoid susceptible species. Specifically, ponderosa pine and coast redwood were selected as resistant species. However, these selections conflict with the goal to maintain a native forest. Alder and maple regenerate in canopy gaps and are resistant to laminated root rot. This regeneration will be encouraged and the planting of exotic conifers will be discouraged, except where conifers are required and no native species are adequate selections. The table below lists tree selections that are considered native.

Species	Height in ft.	Habitat
Western hemlock (*Tsuga heterophylla*)*	150	Flats and slopes
Western red cedar (*Thuja plicata*)*	150	Moist flats and lower slopes
Douglas fir (*Pseudotsuga menziesii*)*	200	Flats, slopes, ridges
Western white pine (*Pinus monticola*)	125	Flats, slopes on sandy soil
Shore pine (*Pinus contorta* var *contorta*)	30	Swamps, prairies
Yellow pine (*Pinus ponderosa*)	150	Gravelly prairies
Grand fir (*Abies grandis*)	125	Flats
Sitka spruce (*Picea sitchensis*)	150	Moist bottoms
Western yew (*Taxus brevifolia*)	30	Moist flats and slopes
Madrona (*Arbutus menziesii*)*	30-80	Drier slopes
Chinquapin (*Chrysolepis chrysophylla*)	50	Dry forests
Bigleaf maple (*Acer macrophyllum*)*	100	Bottoms and slopes
Red alder (*Alnus rubrum*)*	60	Flats, slopes, near water
Black cottonwood (*Populus trichocarpa*)*	100	Valley bottoms
Western dogwood (*Cornus nutallii*)*	50	Flats, slopes with Douglas fir
Scouler's willow (*Salix scouleriana*)*	50	Openings and edges
Birch (*Betula papyrifera*)	50	Flats
Rocky Mountain maple (*Acer glabrum*)	40	Forested slopes
Quaking aspen (*Poplulus tremuloides*)	30	Wet areas
Bitter cherry (*Prunus emarginata*)*	40	Openings in forest
Garry oak (*Quercus garryana*)	40	Gravelly prairies and parkland
Ash (*Fraxinus latifolia*)	50	Low-lying wet areas, rivers

Crabapple (*Malus fusca*)	30	Wet brushy thickets
Hawthorn (*Crataegus douglasii*)	30	Wet brushy thickets
Pacific willow (*Salix lasiandra*)	50	Low-lying wet areas
Cascara (*Rhamnus purshiana*)*	40	Second growth & forest openings
Vine maple (*Acer circinatum*)*	40	Moist soils, adaptable

*previously existing in Pioneer Park

Figure 9.3: Trees of the Western Hemlock Zone (after Kruckeberg 1991)

Tree Replacement/Stand Regeneration

This plan is intended to insure that there are new trees to replace those that die. In closed canopy conditions, mature native trees would occur within a range of 10-30 feet apart. Therefore, this plan will adopt a guideline to recruit a viable tree sapling anywhere there is a space of greater than 30 feet between trees. This guideline may be adjusted for local site conditions.

Tree seedlings will be encouraged in several ways. The ground in the area can be scarified to receive seeds falling from neighboring trees. A sapling can be transplanted from another area. Existing saplings in a good location can be encouraged by clearing competing vegetation away from them. Nursery stock can be purchased where none of the above options are viable. Conifer species will be the preferred tree for planting where laminated root rot is not likely to affect them.

Root Rot Pockets

Laminated root rot is the biggest challenge to the goal of increasing conifer composition in the park's tree canopy. Most native conifers are at least somewhat susceptible. Dr. Robert Edmonds in his 1999 report to the Open Space Conservancy Trust (Appendix E) offered options for controlling the disease that involved highly invasive techniques, including logging and digging out stumps. At that time, the Trust decided not to pursue these techniques. Instead, a milder strategy of replanting with less susceptible species was pursued.

In his report, Dr. Edmonds outlined the symptoms of laminated root rot and the trees that are most susceptible to laminated root rot. This information is reproduced here, as follows:

Typical symptoms and signs of laminated root disease

Symptoms (tree responses)

- Reduced height growth
- Formation of root disease centers
- Wind thrown trees with distinctive root balls lying in many directions
- Standing dead trees
- Excessive cone crop
- Thinning and yellowing foliage
- Wood in roots and butt of tree delaminating at annual rings
- Incipient decay stain in butt of tree
- Hollow internal tree butts

Signs

- Buff colored ectotrophic hyphae growing on the outside of the roots
- Red setal hyphae growing in the wood
- Annual fruiting bodies on upturned roots with brown pore surface (very rare)

Highly susceptible	Douglas fir Grand fir Mountain hemlock Pacific silver fir White fir
Intermediately susceptible	Western hemlock Giant sequoia Noble fir California red fir Pacific yew Sitka spruce Subalpine fir Western larch
Tolerant	Lodgepole pine Western white pine Ponderosa pine
Resistant	Western red cedar Yellow cedar Incense cedar Redwood
Immune	Bigleaf maple Red alder Vine maple

*Figure 9.4: Susceptibility of tree species to Phellinus weirii in lowland Puget Sound (additional species from **Common Tree Diseases of British Columbia**)*

This information will be used to manage laminated root rot in Pioneer Park. Nevertheless, it is an endemic disease, difficult to detect and impossible to eradicate. The aerial survey conducted in Dr. Edmonds' study did detect affected trees. However, it did not identify all affected trees in the park, nor did it claim to. The Park Arborist has observed other trees infected with laminated root rot that were not detected by the aerial survey. Furthermore, many trees that have failed from laminated root rot have exhibited few if any of the symptoms or signs listed above.

In order to manage root rot, additional detection techniques will be needed. Internal investigation of tree root crowns through increment coring or Resistograph drilling may be necessary in high-risk situations. Conservative management in these situations may require removing trees that appear normal and healthy.

Immune trees will be preferred for stand regeneration in and adjacent to root rot pockets. If a conifer species is essential in these situations, red cedar should be considered first. If the area is unsuitable for red cedar, certain species that are native to the Pacific Northwest but not indigenous to this area should be considered for planting. These include: western white pine, incense cedar, coast redwood, and Modoc cypress.

9.3. Understory Vegetation

Natural Regeneration

Natural regeneration occurs when seeds or roots in the soil sprout. This is usually triggered by removing competing vegetation and tilling of the soil surface. Once this triggering has occurred, the regeneration success depends on controlling competing vegetation and preventing further disturbance. Furthermore, rampant new growth should be thinned to allow less vigorous species to establish. For example, elderberry is a successful regeneration species, but thinning of elderberry early on could allow other species – Oregon grape, salal, etc.- to grow also.

Plant Selection

Natural regeneration is the preferred method for reestablishing native understory plants in Pioneer Park. Planting shrubs may become necessary where the forest floor has been so radically altered that the native seed bank is no longer viable. In those cases, nursery-grown plants can be planted to reestablish native understory. Appendix O provides a list of plants suitable for planting in Pioneer Park and the conditions required for each plant. All plants on the list are native to the Puget Sound basin. This list is intended to be used as a first step in designing a planting. A mixture of species should be selected for the conditions at the site where they will be planted.

Planting Design

The layout of plants should be designed to promote optimal growing conditions for the plants. Trees should be surrounded by native groundcovers. Shrubs should be located between trees. The diagram below is an example of a planting layout. It shows salal and sword fern planted in the shade of the cedar trees, providing the proper microclimate for

these plants. Plant species are not mixed together randomly, but placed in groups, as they might be found in the field.

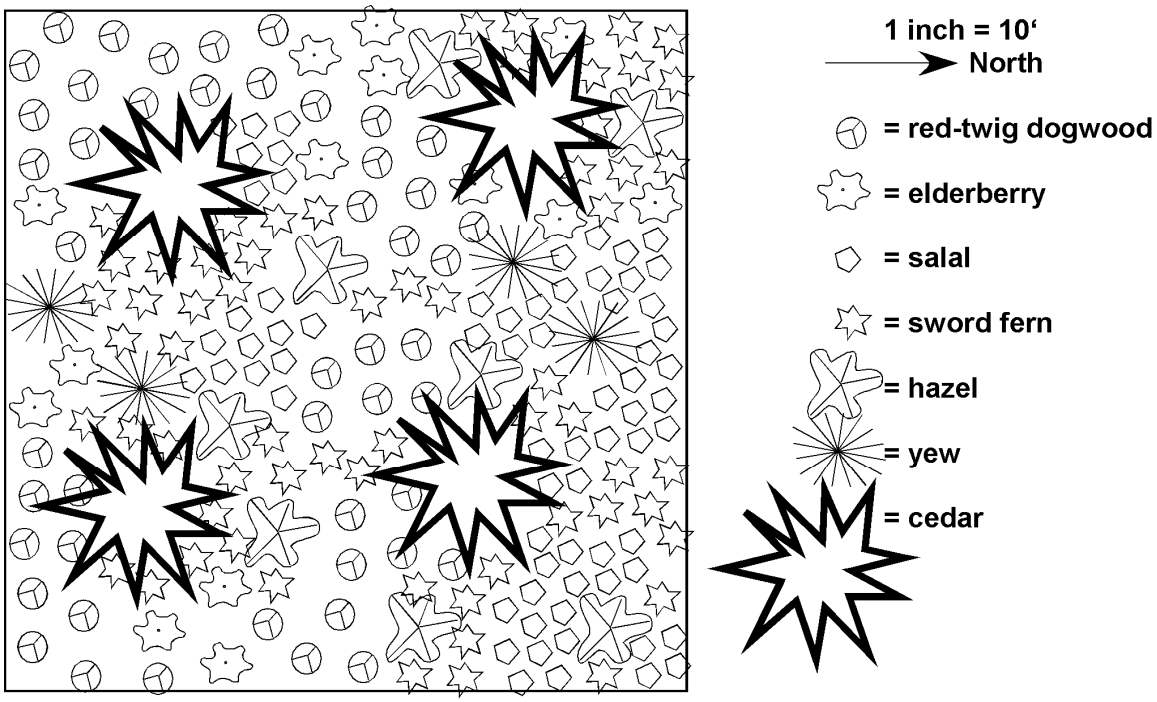


Figure 9.5: Sample Planting Template for Restoration Plantings

Spacing on this list is purposefully tight. In the initial plantings at Pioneer Park, plants were spaced very widely (4-5’ or more) and dispersed over a large area. This made it difficult to maintain them. Tighter spacing gives full coverage faster, even if it means thinning (i.e. removal of trees) must be done later to maintain forest health. In general, the benefit of the shrub plantings must be carefully weighed against the high cost of this restoration option. Wherever possible, native regeneration should be used where revegetation is needed.

Plant Sources

Plants may be purchased through wholesale nurseries or obtained through the local Natural Resources Conservation District. Plants may also be grown by volunteers if they have sufficient skills and commitment to produce viable plants. All plants should meet minimum standards for nursery stock, otherwise efforts to plant and maintain them will be wasted.

Planting Technique

Nursery grown plants should be planted in October, November or February to have the best chance of survival. Plants should be handled by their containers or root balls, never lifted by their tops. Container plants should be unpotted by turning the pot upside down and shaking the plant free while holding onto it. Burlapped plants should be planted with the fabric removed or cut away as much as possible. Planting holes should be dug only to the depth of the root mass. It should be dug at least twice as wide as the root mass to

allow friable soil for new roots to grow into. Planters should check container plants for circling roots and cut them where they exist. Planters should check burlapped plants for excessive soil around the stem and raise the root flair to the surrounding grade when adjusting it in the planting hole. Backfill should be unamended native soil. All plants should be watered thoroughly within 15 minutes of planting to displace any air pockets around the roots. New plantings should receive 2-3" of composted wood chip mulch spread around the base of the plant, but kept from contact with the stem of the plant.

The above activities should be organized to minimize the number of times the soil must be walked on. Soils in planted areas become compacted by repeated visits to clear, plant and maintain. New plantings may take longer to establish with compacted soil surrounding them. Advanced planning can reduce compaction and increase the success of the restoration project. For example, boards can be laid down along the most heavily traveled routes to create pathways and prevent compaction.

9.4. Signs

All projects are recommended to have temporary signs that explain the goals of the project and contact information. These should be placed at strategic locations where they are visible to park users at least one week prior to the beginning of visible project work.

9.5. Maintenance

No restoration project can succeed without maintenance. Therefore, all projects must have a maintenance plan. These plans must show activities, schedules, assignment of responsibilities and costs for these activities. Project planners are strongly suggested to budget 50% of their available resources for the maintenance of any project where plants are being established.

Maintenance of a project should include watering, weeding, fertilization, plant replacement and monitoring. The scope and frequency of these activities will depend heavily on the type of project, its goals and the site conditions. A trained horticulturist should consult with the project leader to determine what level of maintenance will be necessary to insure project success.

A particular concern should be the need for watering plantings where dry soil conditions are anticipated. Mortality on recent plantings has been particularly high from extremely dry summer weather conditions. Hand watering is expensive because most water must be carried to the plants (usually with difficult access) by hand. Managers must be strategic about where to apply watering services to maximize plant survival because it would be impossible to water all new plants in the park.

Watering should begin in late May as soon as rainfall falls below one inch per week. Early watering is critical because plants go dormant after repeated drought stress and do not start regrowing until the next growing season. Gel watering supplements may help mitigate these conditions. These are packages of water held by a binder that are installed when the plant is planted. They slowly release the water to the plant over three months.

They can be replenished during the growing season. Polymer crystals may also help plantings retain moisture. These products should be trialed in future planting projects.

9.6. Monitoring

Projects should be visited and inspected throughout the year to insure consistency with the plan. This typically does not require significant time, but it is important to have this continuity to circumvent problems that may arise. Recommended monitoring intervals are monthly from April-October, and in December and February.

9.7. Record Keeping and Evaluation

Mercer Island Parks and Recreation will be the location for records of site projects for Pioneer Park. Each project will have a separate file. Evaluating a project helps all future efforts by sharing information on what worked and what did not work. The first evaluation would typically occur the third year after plantings have been completed to properly evaluate survival. A second evaluation may be useful another three or four years later. The project should be evaluated by someone who is not directly leading the project for best results. The evaluator should work closely with the project leader to inspect the project. The evaluator should write a brief description of the observed results, compare it to the objectives stated on the Project Planning Form, and make recommendations for future projects of this type.

9.8. Edges

The edges of Pioneer Park require the highest level of management. They are the most heavily maintained parts of the park and are also most vulnerable to risk. Therefore, separate issues have been identified here for the forest edges.

Power Lines

In general, the vegetation under and around power lines should be converted to plant species that do not grow taller than 20' to avoid conflicts with electrical transmission (see Appendix Q). Because of the expense of this objective, it will be achieved primarily through attrition of existing trees and control of tree regeneration in these corridors. The exception to this is a project identified in Section 9.1 above to continue the work begun in 1997 along the SE 68th Street power line corridor. Additional trees along this corridor will be removed and replaced to reduce risk from previously topped trees that may fail and damage transmission lines. This work will be planned and executed in partnership with Puget Sound Energy according to the schedule in Appendix N.

Utility Boxes

Utility boxes are located in the right-of-way along Island Crest Way and SE 68th Street. Members of the community have raised concerns about the appearance of them against the natural setting of Pioneer Park. The ***Pioneer Park Master Plan*** calls for screening these boxes with native shrubs to mitigate the aesthetic impact of these boxes. This plan adopts that objective as well.

Encroachments

The boundary survey conducted in 2002 and subsequent inspections identified 24 areas along residential boundaries where non-park uses of park property are occurring. Many of these are piles of yard waste or stacks of firewood. Some are substantial homeowner improvements, including lawn, play equipment, fences or sheds. Appendix P is a list of these areas identified by the adjacent property address. An objective of this plan is to restore all of these areas to appropriate native vegetation indistinguishable from the rest of the park landscape.

Encroachments will be dealt with in the following manner: The City of Mercer Island, on behalf of the Open Space Conservancy Trust, will contact neighbors of the park who have encroachments in the park. Each situation will be considered on an individual basis. The main objective will be for the neighboring property owner to remove the encroachment and restore the park vegetation to the standards and with the methods described in this plan. The Park Arborist will work with neighbors to design and maintain the restoration. Hopefully, constructive engagement with neighbors will remedy most, if not all the identified issues. This approach recognizes that the park benefits from good relationships with its neighbors. Unresolved encroachments will be referred to the City Attorney.

Residential Edge Landscaping

The conditions of the edges of Pioneer Park are important to the integrity of the park. Additional buffering of the park edges would reduce the incursion of invasive, non-native plants into the park and increase the habitat value of the park. One objective of this plan will seek to educate neighbors about the benefits of landscaping with native plants along their boundary with the park. The Washington State Department of Fish and Wildlife and Seattle Audubon Society have developed educational materials to encourage landscaping with native plants for wildlife, and the Open Space Conservancy Trust will offer such materials to interested neighbors.

Turf

Turf margins of the park are maintained along the entire length of Island Crest Way and on the north side of SE 68th Street. Islands of trees and native vegetation are interspersed within these turf areas. These turf areas create a foreground for the forest edges that frames these streets. These turf areas will be maintained at their current size. Tree islands may be relocated over time as trees die.

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11. Appendix A: Assumptions for Forest Management

Resource Management

- The City will continue to support the vision of Pioneer Park as a sustainable native forest.
- The funding of maintenance in the park will not change substantially from 2001-2002 levels. Existing maintenance resources have occasionally been devoted to managing vegetation, but only in conjunction with trail maintenance or boundary issues.
- In addition, City Council will likely continue to allocate $50,000 annually for forest management for Pioneer Park through 2008. City Council approves Capital Improvement Project funding with each biennial budget.
- The Park Arborist will be responsible for implementation of this plan.
- The plan that results from this process will provide sufficient direction and detail so that the Park Arborist can implement projects without further planning with the Open Space Conservancy Trust or the general public. The OSCT will receive a quarterly report on proposed and accomplished projects and will give feedback to the Park Arborist at that time. Adjacent residents that are affected by specific projects will be contacted about Parks and Recreation activities in advance.
- The Parks and Recreation Department will be the lead agency for implementation of this plan and will be responsible for contacting other agencies with jurisdictions that overlap in the park.
- From preliminary conversations with Mercer Island Fire Department staff, fire risk is a consideration in Pioneer Park. Parks and Recreation will consult with Fire staff and Washington State Dept. of Natural Resources to assess fire risk and develop fire management protocols in the event of a fire.
- Parks maintenance staff will be involved in the implementation of this plan, but their existing maintenance responsibilities prevent them from being extensively involved on an ongoing basis without additional resources. Plan implementation will be accomplished by contractors or seasonal labor.
- Maintenance of plantings is essential for successful forest management. This means that approximately 50% of the cost of restoration planting projects will be spent in the preparation and installation phase, and 50% will be spent in the maintenance phase (over several years) to insure plant establishment and control of competition.
- Baseline data will be collected as part of the planning process to provide long-term monitoring capabilities. This data will be stored in a geographic information system where this is feasible.
- Arboricultural industry standards, such as ANSI A300, ANSI Z133 and ISA Pruning Guidelines will be followed where applicable.
- Tree hazards will be managed through periodic inspections by trained staff to detect defects that might cause structural failure. Inspections will follow industry-accepted protocols. Areas with higher risk potential will be inspected more frequently.

Community Framework

- The community will continue to support the vision of Pioneer Park as a healthy, sustainable native forest.
- The Open Space Conservancy Trust will continue to advocate for the best possible management of the park and educate the greater community about the value of the park.
- Volunteer and service learning activities will contribute to stewardship of the park at roughly double historical levels (historically there has been one volunteer project and one service learning project (i.e. school group) in the park each year).
- Parks and Recreation staff will seek cooperation of residents along the park boundary to help us manage the edges of the park adjacent to their property according to the plan.

Vegetation Resource

- The existing forest in Pioneer Park is the result of historical events of both human and non-human origin.
- The forest condition within each quadrant varies from place to place, but these variations can be typified by observable criteria, namely the composition, age and condition of the tree canopy. Groups of trees of similar composition, size and condition (stands) will be the primary unit of analysis for this study.
- Management of the forest should achieve a distribution of tree ages within a tree stand whereby enough younger trees are available to replace older trees that are lost through natural attrition or planned thinning.
- Management of the forest should retain the multi-layered canopy structure typical of a coastal Pacific Northwest forest. This includes ground layer, understory and overstory vegetation.
- Managing diversity is an important part of forest management. Too much or too little diversity impacts habitat, aesthetics, pest control, and management efficacy. Activities that increase diversity should not introduce excessive randomness to the forest composition.
- The forest canopy bordering the stream and wetlands directly provides the vegetative matter that is the base of the aquatic food chain. The streamside canopy also shades the watercourse and thus prevents increases in water temperature. High water temperatures (with less dissolved oxygen) tend to increase the metabolic rate of cold-water organisms causing increased stress.
- Additions of large, woody debris maintain the complex structure in the streams and wetlands . As streamside trees die they often fall into or adjacent to the channel creating complex stream and riparian pool habitats.
- Excess fine sediment in the stream channel can impact salmonids through degradation of spawning gravel and reduction of aquatic food production. Maintaining vegetation

cover on the slopes next to the stream corridor is essential to prevent siltation of the stream channel.

- Most of the park is considered "edge" forest. This refers to the microclimatic difference between the conditions found at the edge of a forest and those found in the interior. Edges of forests have higher light levels, lower humidity, higher wind speeds, greater temperature fluctuations, and greater movement of wildlife. Edges are inherently less stable, more dynamic parts of the forest. This, combined with the surrounding urban environment, has made this forest susceptible to loss of "interior" forest conditions, the kind of conditions that we see in forested wilderness areas. Management activities can only partially mitigate "edge effects". Therefore a goal to develop "old-growth" forest character is probably not realistic.
- Park users enjoy the experience of being in a mature native forest reminiscent of "old-growth" forests they may have experienced elsewhere. Edge effects have to be controlled or mitigated to maintain this type of forest character.
- All alternatives for this park include control of invasive exotic plants (e.g. blackberry, holly, laurel, ivy). Some restriction of these plants must be achieved to sustain the forested condition of this park.
- Invasive exotic plants cannot be eradicated, only controlled to target levels. Control of invasive exotic plants will employ either ground layer disturbance or the targeted use of herbicides, or both. Either technique is best employed as part of an integrated strategy for successfully controlling the target plant with the least amount of external consequences. For example, a strategy for controlling blackberry might consist of digging out roots initially, with subsequent control accomplished by sponge application of Roundup® herbicide. This would avoid repeated digging and confines chemical use to resprouting shoots.
- Strategies requiring heavy equipment, such as logging, will not be used to manage the forest.
- Wildlife habitat will be managed to promote species diversity and to ensure that populations of indigenous species are maintained. This can be best achieved through the maintenance and enhancement of habitat values. Habitat values that lead to species diversity include the following elements: breeding, foraging, watering, rearing, hiding and thermal cover.
- Wildlife management within Pioneer Park is focused primarily on the protection and enhancement of key habitat and structural components that are utilized by a diversity of species. Snags and down logs will be maintained through the retention and recruitment of snags over time. Snags are used to some degree by all major groups of wildlife species found in Pioneer Park. Their primary value is as a nesting and roosting site, or foraging for insects. Species excavate their own cavity, utilize previously excavated cavities or utilize natural cavities and crevices. Other species use the tops of larger snags as nest and roost sites. Species in Pioneer Park that use cavities in snags include hairy woodpecker, chestnut backed chickadee, red-breasted nuthatch, screech owl, violet-green swallow, brown creeper, Douglas squirrel and two bat species. Species that nest or roost at the top of snags include red-tailed hawk, raven, and osprey. Retention of dead and down materials are particularly critical in riparian areas.

- Woody debris and snags will be left in the park as much as possible, except where they present a hazard, or are located in landscaped edges where their habitat value is diminished and aesthetic quality is also a consideration.
- All wildlife management will be conducted under the jurisdiction of the Washington Department of Fish and Wildlife. Nuisance wildlife species will not be managed by changing or reducing habitat in the park unless management activities target only the nuisance species.
- Clearance for power lines must be maintained by Puget Sound Energy according to state law. There is some cooperative basis for managing trees around power lines, but this will not remedy the fundamental incompatibility of mature native trees near power lines. A combination of inspection and new horticultural strategies may provide a more stable landscape in the power line clearance zone.
- Utility boxes in the right-of-way require gravel pads and access. Vegetation can mitigate their visual impacts to a limited degree. Such mitigation will be developed where it is missing or inadequate.
- At intersections and curves in the road, there are sight distances that must be maintained for traffic safety. Vegetation may be pruned or removed to maintain this sight clearance.
- Turf edges to the park will be maintained along the west sides of the southeast and northeast quadrants and along the east and south sides of the northwest quadrant.

12. Appendix B: Alternative Forest Management Scenarios

The following descriptions illustrate general long-term results that could be expected from distinct goals for managing the forest vegetation. All typologies tend towards a more conifer-dominated forest, which is the natural direction of forest succession in this region. Please keep in mind:

- These typologies could be applied to the entire park or to only a portion of the park.
- Strategies within each typology are not necessarily exclusive to that typology.
- There are gradients of choice in between these alternatives. Distinctions between typologies have been created for the purposes of discussion.
- The final "vision" for Pioneer Park's forest may contain an intermediate typology or one that is not described here.

Deep Forest

Goal: The overriding goal of this alternative is to create interior forest habitat in Pioneer Park to promote the survival of trillium, sword fern and other native understory species. This goal recognizes the historical existence of a lower-growing understory that was found in the park when it was purchased by the City in the 1960's.

Strategy: The primary strategy for this alternative would be the establishment of dense conifer overstory and dense evergreen edge plantings. Additional strategies include control of invasive exotic plants, planting of some semi and non-native tree species that would improve the canopy integrity, and selective thinning of deciduous trees once conifers are established. Some tall overstory (e.g. elderberry, hazel, Indian plum) would be trimmed back to favor salal, sword fern, Oregon grape, etc.

Invasive Control: Blackberry would be the highest priority for control, since this indicates high light levels. These areas would be densely replanted with trees. Ivy and other invasives would be controlled secondarily to limit the spread of such plants until less favorable forest conditions are created, or to protect new tree plantings.

Character: The character of this forest type in thirty years would be a noticeably denser forest of adolescent conifer trees mixed in with existing mature trees. Light levels in the forest would be lower. Views into the park would be restricted by dense vegetation along the edges.

Costs: Short term cost is expected to be highest because of the extensive planting and invasive control. However, long-term cost of this alternative is expected to be lowest of all the alternatives because the dense overstory provides the most effective control of invasive exotic plants.

Limitations: One limitation of this alternative is that it is most effective if applied to an entire quadrant. More limited applications will reduce the effective interior area. Application to less than half a quadrant would probably be ineffective. Another limitation of this alternative is its initial expense.

Purely Native

Goal: This alternative would utilize only the native plant species currently found in the park. Genetic conservation of plant populations in the park could also be a secondary goal.

Strategy: Management activities would consist of aggressive control of invasive exotic plant species and dispersed planting of evergreen and deciduous overstory species. Native regeneration of overstory and understory would be utilized as much as possible. Canopy gaps would be managed or created for forest regeneration. Since root rot is a significant management issue, choices of overstory trees would be limited in affected areas and tend to favor red cedar and deciduous species which are resistant.

Invasive Control: Invasive control is the cornerstone of this strategy. As much as possible, existing native vegetation would be "liberated" from invasive exotic species. Natural regeneration of understory would be preferred over replanting where practical, even if this results in less diversity.

Character: The character of this forest in thirty years would be a mixed forest of predominantly mature deciduous trees with adolescent conifer trees dispersed throughout. Cedar would predominate as regeneration, with hemlock represented to a lesser degree, alder and bigleaf maple in remnant canopy gaps and Douglas fir in edges along the south and west quadrant boundaries. Understory vegetation would consist primarily of taller "brushy" species, including elderberry, Indian plum, and hazel. Trillium, salal, Oregon grape and sword fern would be expected to become less prevalent. Edges of the park would be moderately permeable.

Costs: Short term costs are expected to be somewhat lower than for the Deep Forest alternative, since it places less emphasis on planting. Because this alternative does not effectively reduce light levels in the park, long term control of invasive exotic plants will keep long-term costs higher than for the Deep Forest alternative.

Limitations: One limitation of this alternative is the long-term expense of continually controlling invasive plants. These costs should become less with adequate initial efforts, but routine control efforts will be necessary at substantial levels to achieve goals. Another limitation is the loss of understory species that are both environmentally and aesthetically desirable.

Basic Canopy

Goal: This alternative would be the most flexible about the content of the forest, instead focusing on retaining an attractive forest character for park users and existing wildlife. The primary goal would be on maintaining a continuous tree canopy.

Strategy: Tree selection would be primarily native, but selected semi and non-native species would be used as in the Deep Forest option to improve canopy integrity. Understory content would be less important than maintaining a balance of vistas and enclosures along trails and in the periphery of the park. Woody debris would be managed more actively to move down logs outside of trail corridors.

Invasive Control: Invasive exotic plants would be controlled, but more selectively than in the Deep Forest and Native Only options. Emphasis would be on low visual impact strategies and maintaining planted trees.

Character: The character of this forest in thirty years would be a mixture of evergreen and deciduous canopy, intermediate in conifer character between the Deep Forest and Natives Only alternatives. However, the understory would be more diverse than either of the above scenarios because tall "brushy" species would be controlled in areas to provide visual landscape diversity.

Costs: The short term cost should be lowest of the three alternatives, but long-term costs are expected to be greater.

Limitations: One limitation of this alternative is the continuing costs for invasive control, which is expected to remain fairly constant for the long-term. Another limitation is the loss of native plant populations as the park is managed for structure, rather than for species content.

	Deep Forest	**Purely Native**	**Basic Canopy**
TREES: What trees are planted/fostered? How are they located? How are existing trees handled?	Mostly conifer species, including some non-native species are planted or selected from on-site regeneration. The trees are planted densely to get new canopy going quickly. Existing deciduous trees are pruned or "snagged" to favor conifer species.	Any native trees are considered acceptable. They are selected from existing regeneration that occurs from invasive weed control and understory management.	Trees are only planted in canopy gaps. Any native trees are considered acceptable. Conifers are preferentially planted in gaps where root rot is not prevalent.
Density of tree regeneration	High – with subsequent thinning	High with subsequent thinning	Low – only in gaps
INVASIVES: How much are invasives controlled? How are they controlled?	Invasive plants are controlled aggressively everywhere. Ivy is weeded out of native groundcovers.	Invasive plants are controlled aggressively everywhere. Ivy is weeded out of native groundcovers.	Invasive plants are controlled where they inhibit canopy growth (ivy on trees, blackberry patches) or threaten to significantly encroach on the forest (seed-producing holly). Ivy on the ground is allowed to remain.
SHRUBS: What understory plants are encouraged?	Native evergreen groundcover (sword fern, salal, Oregon grape) are fostered where they exist, and are replanted where they are absent. Tall native shrubs are cut back where needed to allow this.	All native understory plants are considered acceptable, except where they compete with canopy regeneration. Invasives are aggressively weeded out.	Understory is only manipulated along trails, selectively encouraging evergreen groundcovers to provide more openness for park users. Otherwise, understory is only controlled around planted trees.

13. Appendix C: Criteria for a Sustainable Urban Forest in Pioneer Park

(after Clark, et. al. ***Model of Urban Forest Sustainability*** 1997)

13.1. Vegetation Resource

Goal		Criteria
Soil Conservation	Protect the park's soils to insure biological function, nutrient cycling and soil building processes	Forest soils are living systems that build soil and provide the rooting environment for all vegetation in the park. Compaction, disturbance, changes in drainage and other human influences damage the health of the soil ecosystem. Protection and periodic additions of organic matter preserve the soil ecosystem.
Canopy Structure	Achieve appropriate canopy cover and layering	Canopy should be mostly continuous over the site. Multiple layers of understory are desirable for habitat and canopy integrity. Gaps should be created or replanted to manage for structural diversity.
Age Distribution	Provide for uneven age distribution	A mix of young and mature trees is essential if canopy cover is to remain relatively constant over time. Planting or recruitment of native regeneration will increase age diversity.
Species Mix	Provide for a diversity of primarily native species	Species diversity is important for the long-term health of the forest. Dry soil conditions and the persistence of laminated root rot makes species selection very site-specific.
Invasive, Non-native Species	Control the extent of blackberry, ivy, holly, laurel and other species identified as such	The introduction of invasive, non-native species has changed the ecology of the forest. Native plants, including trees, will be displaced unless the invasive plants are controlled. Eradication is not a goal of this plan, however.

Habitat	Preserve and enhance habitat features to maintain native wildlife populations	The park contains wildlife that depend on particular forest features, such as tree canopy, gaps, nesting cavities, perched wetlands, etc. Identify native wildlife species and their habitat needs to inform management objectives.
Edges	Manage park edges to maintain forest integrity and character	Edges must contain dense vegetation to protect the forest interior from wind and sun. Edges along public right-of-way should also allow some views into the forest.

13.2. Community Framework

OSCT Leadership	OSCT board members create initiatives to carry out plan goals	The OSCT board members communicate the long-term direction for the park. They develop connections with constituents, educate the public and recruit resources on behalf of the park.
Neighborhood involvement	Neighbors of the park and nearby residents take active role in park projects and park monitoring	Local residents assist the City by monitoring the park and reporting problems to City staff. Residents work with City staff to implement restoration projects according to plan. City staff develop technical competence in "core" volunteers.
Education	Materials and planned activities help the greater community become aware of Pioneer Park and learn the value of its ecosystem	Island residents benefit from Pioneer Park, but their understanding of the park depends on different strategies for outreach that are tailored to the various levels of awareness among island residents.
Volunteerism	Volunteers provide a significant amount of the labor for restoration projects	People come to volunteer at the park for scheduled project events. Volunteers are both individuals from the community and members of service groups. City staff and core volunteers provide training and leadership.

Local Businesses	Local businesses promote involvement in the park and support projects with cash and in-kind donations	The South Mercer shopping center and food service businesses are current places for partnerships. Business connections should be expanded island-wide.
Green Industry Capability	Landscape and tree care firms that work in the park meet plan goals	The restoration work proposed for the park is not traditional work for the Green Industry. New work skills and methods are needed to accomplish plan goals.
Public Agency Cooperation	County and State agencies provide technical assistance and regional perspectives	Issues facing Pioneer Park are common for all urban forests in the Pacific Northwest. Projects such as regional ecosystem analysis can help educate the greater public about the benefits of urban forest canopy.

13.3. Resource Management

Management Plan	Develop a forest management plan with input from stakeholders	A management plan should represent a consensus of the community about the future of the forest. The plan guides the resource managers in their operations and projects. It also provides a way for citizens and private groups to participate as partners in forest management activities.
Funding	Develop and maintain adequate funding to implement this management plan	Public and private funding for Pioneer Park depends on recognition of the park as a resource for the greater community. Mercer Island City Council currently funds all forest management in the park.
Staffing	Employ and train adequate staff to maintain and manage the park	Mercer Island Parks and Recreation is responsible for maintenance and management of the park. Staff have various levels of involvement with the park according to their areas of responsibility. Currently, staff do not perform all work associated with forest management in the park.

Planning and Assessment tools	Develop methods for documenting site conditions, operations and projects. Evaluate activities and improve future projects with resulting input.	The City maintains a GIS database that serves as a top level planning tool for forest management. Additional planning and assessment tools such as protocols and forms must be developed. This information is useful when it is stored systematically so it is accessible to future managers.
Citizen safety	Maximize public safety with respect to trees	Managing hazard trees requires inspection protocols and schedules, plus ability remedy hazards a timely manner. Fire safety depends on prevention and response capabilities.
Vegetation protection	Trees and shrubs are protected from damage by park users, management activities and neighbors	Protection of vegetation in native forest settings focuses on preventing compaction and disturbance to the soil around trees and shrubs. Theft or vandalism of vegetation is also an issue.
Species selection	Species are selected to fit the particular growing conditions where they are located	To preserve the plant communities in the park, native species are strongly preferred for planting wherever possible. Certain coastal northwest species may be used where locally native species cannot perform as needed for plan objectives.
Standards for tree removal	Trees are removed to achieve management goals	Clear policy concerning tree removals is needed avoid arbitrary and ad hoc decision-making by managers.

14. Appendix D: Park Invasive Plant Report and Recommendations

PIONEER PARK
Invasive plant report and recommendations
Sarah Reichard, Ph.D.
November 7, 1996

There appear to be four non-native species of concern invading Pioneer Park. They are discussed in order of their threat to the integrity of the natural area and to the native species.

Hedera helix (English Ivy)
Biology: Ivy is a woody evergreen vine native to Europe. It has two forms: the juvenile plant has lobed leaves and does not flower or fruit. The vine may persist in this form for 15 years or more. The mature form has leaves that are less lobed and more egg-shaped. The mature form is more commonly found on plants growing up a vertical surface such as a tree trunk. The flowers are formed in the fall and are pollinated by bees. The fruits form the following spring and are eaten and dispersed by birds.
Threat: Ivy is capable of covering the forest floor, even in areas that are in dense shade. It has been shown to inhibit herbaceous species that would normally inhabit the forest floor. In addition, it inhibits the growth of young woody plants. In the Pacific Northwest native trees often germinate in the forest and then remain in an almost dormant state until growth conditions (such as a gap opening due to blow-downs) are favorable. If the young plants are not there in the dormant state it may increase the probability of colonization of the gap by other invasive species. Ivy may also increase the weight on the tree, aggravating blow-downs.
Control: Chemical control is generally not very effective because of ivy's thick waxy leaves. Mechanical control, such as removal, is recommended. Volunteerism for this task should be actively encouraged. Getting volunteer groups involved will increase both the speed of the work and a sense of community commitment to the Park.
Recommendations:
1. To prevent further spread by seeds it is important to target fruiting plants first. Ivy generally fruits on vertical surfaces so trees in the Park should be surveyed and those with fruiting vines should be targeted first. Cutting the first four or so feet of the vines will kill the upper portion and has been working well in the Park.
2. Control on the ground is more difficult and time-consuming. The Park should be surveyed for the integrity of native communities and those that are the least disturbed and have the highest native species to non-native ratio should be considered a priority. Removal should be carefully done to prevent undo disturbance to the forest floor. All pieces should be removed because it is possible for the plants to regenerate from fragments if roots are attached. Replanting with native species is recommended to decrease the probability of reinvasion and to increase the regeneration of the native community.

Geranium robertianum (Herb robert)
Biology: Little is know about the biology of this European species but it appears to be a winter annual (germinates in the fall rains and overwinters as a small rosette, ready to

grow and flower in spring). It is pollinated by insects and may also be reproductively self-compatible. Each mature plant can produce 20-40 fruits each containing 100-200 seeds. The seeds are small and are spread by wind and by people picking the seeds up on shoes and moving them from place to place.
Threat: It is capable of covering a forest floor and appears to exclude natives when it does. It is possible that chemicals in the leaves actually poison other plants, a process called "allelopathy." This species is actively spreading in Washington.
Recommendations: Apparently no studies have been done on control of herb robert. The Washington Park Arboretum has had some success with standard spot applications of glyphosate. It is easily pulled when the ground is wet.

Rubus discolor (Himalayan blackberry) and ***Rubus laciniatus*** (Evergreen blackberry)
Biology: Blackberry is a biennial vine; the first year is mostly vegetative growth and most of the flowering and fruiting is done the second year. Any population of the species will have canes at both stages. The vines arch over and root at the tip, allowing the species to "walk" and expand the population. The species retains some leaves all winter and has green stems which allow it to photosynthesis during our mild wet winters. This likely accounts for some of its success here in the Northwest. The flowers are formed in the spring and are pollinated by bees as well as being agamospermic (producing seed without any pollination). Fruit are found mid to late summer.
Threat: Blackberry forms dense thickets that exclude native species. The thickets are also ideal habitat for unwelcome animals such as rats. I do not place it as a higher priority, however, because the species is shade intolerant and will thus only establish in open areas such as the border of the Park. It should be controlled in these areas to prevent being a nuisance to Park neighbors but is not considered a threat to the integrity of native communities. It may possibly become established in the blow down area and that area should be monitored.
Recommendations: Blackberry responds fairly well to topical applications of glyphosate (3 lbs./acre), especially in the fall. Cover all foliage thoroughly but not to the point of run-off. Repeat applications will probably be needed. Protect nearby native vegetation from overspray. Do not spray if rain is expected within six hours or frost within 1 week (efficacy is reduced). Be sure to spray the foliage after fruiting has finished to prevent accidental ingestion of herbicides by berry-pickers. It is also possible to control through mechanical removal but this method is not popular because of the sharp thorns on the vines. Small populations may be controlled by cutting the vines and treating the cut stumps with a glyphosate mixture. The Center for Urban Horticulture has had success using this method and following with plantings of snowberry (*Symphoricarpos alba*) and red current (*Ribes sanquineum*).

Ilex aquifolium (English holly)
Biology: Holly is an evergreen tree with a conical shape native to Europe. It is dioecious, which means that there are male and female plants. Small greenish flowers form in the spring, followed by fruits on female trees in the fall. Flowering trees that do not bear fruit are likely male. Birds disperse the fruit throughout the winter.

Threat: Holly has not been shown to have a serious negative impact on native species but is of concern to some in the Northwest because it adds a tall shrub layer to the forests which is not present in native forests.
Recommendations: Holly is not yet bad in most parts of the park so it should be easy to remove. The trees may be cut with a chainsaw and the stump treated with glyphosate to prevent resprouting from the cut stump. Seedlings may be pulled but care should be taken to correctly identify the seedlings first - they superficially look like the native mahonia (*Berberis aquifolium* and *B. nervosa*).

General Priorities, Summary:
1. Control all currently flowering ivy by cutting the stems before fruit are formed next spring.
2. Identify invaded areas that are largely composed of native species and control ivy and herb robert in those areas first.
3. Keep blackberry populations from spreading beyond their current dimensions and control existing populations as much as possible.
4. Remove holly plants.

Other Recommendations:
1. All workers and volunteer assistants should be aware that they may be spreading seeds. After working in an area they should either change footwear or carefully brush their footwear before moving to an additional area.
2. Develop a program for seasonal monitoring (such as spring and late summer) of trailsides for new weeds and weed populations.
3. One person should record the actions taken in each area, when they were taken, and the efficacy of the action. These notes should be used in coming years to refine monitoring and control efforts.

15. Appendix E: Management Plan for Tree Diseases in Pioneer Park, Mercer Island

MANAGEMENT PLAN FOR TREE DISEASES IN PIONEER PARK, MERCER ISLAND

REPORT TO

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1. Introduction

Pioneer Park on Mercer Island is a 120 acre park in south central Mercer Island (Figure 1). It consists of three separate sections of second-growth forest naturally regenerated after logging of the original old-growth forest, probably in the 1920s. I designated these sections as northwest, northeast and southeast quadrants. The major tree species in the park are Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), big leaf maple (*Acer macrophyllum*), vine maple (*Acer circinatum*) and Pacific madrone (*Arbutus menziessi*). Dominant understory species include salal (*Gaultheria shallon*), Oregon grape (*Berberis nervosa*), swordfern (*Poystichum munitum*), and bracken fern (*Pteridium aquilinum*). Exotic plants are also present, particularly holly, ivy and blackberry.

A number of tree diseases are present on the site. Table 1 shows the diseases, fungi causing the diseases, and the host tree species. The most important disease on the site is laminated root rot caused by *Phellinus weirii* in Douglas-fir. This fungus causes considerable tree mortality.

The objectives of this study were to:

1. Determine the extent and spatial distribution of tree diseases in Pioneer Park,
2. Report of the general health of the forest in the park, and
3. Development a management plan for root diseases, particularly laminated root rot.

A glossary of terms that may not be familiar to the reader is found at the end of this report on pages 12 and 13.

2. Brief Descriptions of the Important Diseases

Laminated root rot

Disease symptoms and development

An excellent description of this disease is in the publication by Thies and Sturrock (1995). The fungus causing this disease, *P. weirii*, spreads by root to root to contact and not by airborne spores. Typical signs and symptoms of this disease are shown in Table 2. Symptoms include mortality occurring in clumps or pockets. The pocket can be of considerable size and includes blown over trees with exposed root balls with large woody roots that have laminated decay, standing dead trees, trees in various states of decline with thinning crowns, and excess cone crops. Fallen trees in disease centers tend to occur in a random pattern of crossed trees or stems - unlike storm blowdown, where trees usually fall in one direction, all at the same time. When a tree uproots, major roots that are decayed usually break off close to the root collar and only short stubs remain close to the tree, forming the characteristic root wads or balls. Living Douglas-fir trees rarely break off at the root collar. Standing dead trees, however, may break off at the root collar leaving the roots in the ground, or they may break off higher up where other decay fungi have weakened the tree. In stands where mature Douglas-fir are predominant, disease centers may range from a few trees to 2.5 acres or larger. Standing dead or symptomless live trees typically are present around the edge of infection centers and scattered among them. In some areas, a high proportion of *P. weirii*-infected trees may actually killed by bark beetles and not the fungus. If seedlings of susceptible species become established in centers they usually become infected and die at a young age, while tolerant conifers, like western redcedar, may continue to grow. Susceptible, tolerant, and immune tree species are shown in Table 3. Large patches of immune species such as bigleaf and vine maple and red alder may develop in disease pockets.

In the early stages of decay the colonized wood appears as reddish-brown to chocolate-brown irregular patches or crescent stains, usuallly in the outer heartwood, like those on a stump in Pioneer Park (Figure 2). In living trees, the stain usually extends less than 3 feet above the stump. Advanced decayed wood, which may be obvious on stump tops, easily separates along the annual rings, hence the common name "laminated root rot." Pits occur on both sides of the laminated sheets. As the decay progresses, the wood becomes a stringy mass and lower bole may become hollow leaving only a shell of bark as illustrated from a stump in Pioneer Park (Figure 3). Interestingly, few of the roots associated with such stumps may be infected.

Laminated root rot begins in a stand when uninfected roots of a susceptible tree contact infested stumps or roots left from a previous stand and are colonized by *P. weirii*. As the new stand develops, the fungus spreads among live trees via root contact. Once

inside the host roots, the fungus causes decay, resulting in reduced uptake of water and nutrients and weakened structural support to infected trees. After about 5 to 15 years crown symptoms appear and trees eventually dies while standing, is windthrown, or breaks off aboveground. This breakage may occur in windstorms, but it can occur in still conditions. The fungus typically spreads from root to root of the trees at about 1 foot year. The fungus does not grow through the soil and rarely spreads by airborne spores.

Site may influence where the fungus is located on the landscape. In the Oregon the incidence of *P. weirii* was highest on ridges and decreased downslope (Kastner, Goheen and Edmonds 1994). Distribution of laminated root rot differs within stands. Symptomatic, diseased trees often appear aggregated into fairly discrete infection centers, but the centers may be randomly dispersed in the stand. In other stands distribution may be diffuse and difficult to detect. In old-growth stands the fungus is probably kept at low levels by natural processes. However, after cutting of the infected old-growth stands the disease intensifies in second-growth stands. The fungus remains on the site in old-growth stumps. When the site regenerates stem density is higher and the fungus spreads to the new trees surrounding the stumps and from them to adjacent trees. Thus many more trees are infected in the second-growth stands than the original old-growth stand. *Phellinus weirii* can survive in large stumps for more than 50 years, but a lesser time in smaller stumps. The disease is most notable in Douglas-fir stands that are between about 15 and 80 years of age.

Management of laminated root rot

A number of strategies have been developed for management of laminated root disease. *Phellinus weirii* is an agent of forest disturbance that generally increases ecosystem diversity. It selectively kills susceptible conifers providing growing space for less susceptible conifers and immune hardwoods and shrubs. It contributes to structural diversity in the stand providing coarse woody debris in the form of logs and snags. Thus one option for managing this disease is "no treatment" if wildlife enhancement and biodiversity are management objectives.

Thinning is another option. All trees in centers and those within 50 feet of visibly infected trees or stumps can be cut. This strategy is used when the goal is to prevent spread of the disease into healthy portions of the stand. However, this increases the opening size and may increase the probability of windthrow.

Other strategies involve active inoculum reduction and include: stump removal, push-over logging, fertilization, stump fumigation, and biological control. Stump removal is practiced on gently sloping, high quality sites with light soils. Stump removal is done with heavy equipment, such as backhoes, and is expensive and can result in soil disturbance and compaction. With push-over logging root systems are removed from the ground. It was originally thought that nitrogen fertilization would reduce the inoculum through increased competition from other organisms. However, fertilization has generally proved to be unsuccessful. Stumps can be treated with fumigants such as chloropicrin, Vapam and Vorlex, but this does not seem a feasible option in urban areas because of the high human hazard. Biological control agents have promise, but as yet none are being used operationally.

Using alternative species to Douglas-fir is an effective means of disease management. The best alternative species in western Washington are the tolerant conifer, western white pine, the resistant conifer, western red cedar, and immune hardwoods (red alder and bigleaf maple) (Table 3). Western hemlock is a possible choice although it is intermediately susceptible. As yet resistant Douglas-fir are not available. However, it may be possible to plant Douglas-fir at a wide spacing. Roots of trees planted more than 13 feet apart growing in deep soil may not come in contact until age 60 in which case the inoculum remaining on the site may have disappeared. Planting species mixes including Douglas-fir may be effective.

Armillaria root disease

Laminated root rot can be confused with Armillaria Root Disease. They can be easily distinguished, however. Typical symptoms and signs of Armillaria Root Disease are shown in Table 4. Armillaria root disease in western conifers is caused by *Armillaria ostoyae* and can be identified by white- to cream-colored mycelial fans that develop under the bark, the presence of rhizomorphs on the roots, and resin flow on the base of the tree, on roots and in the soil (Morrison et al. 1991). Most conifer species in western Washington are susceptible, but usually only when they are under stress from competition, drought or other causes. Hardwoods are also susceptible, but a different species of Armillari a is involved. This fungus spreads by rhizomorphs and root to root contact rather than by airborne spores, although mushrooms are produced in the fall. Trees commonly die standing up and suppressed trees are particularly susceptible. Large disease pockets

usually don't develop in western Washington. Stump removal is an effective treatment for Armillaria root disease, as it is for Laminated roor rot. Few other treatments are effective, but treatments to reduce stress may help. Thinning may reduce stress, but remaining stumps may harbor the fungus. Fertilization may also reduce stress.

Annosus root and butt rot

Annosus root and butt rot is caused by the fungus *Heterobasidion annosum* (Allen et al. 1996). It has a wide host range and is noted particularly to occur on western hemlock, red alder and Pacific madrone. It does have decay that separates along the annual rings, like *P. weirii*, but with less pitting and the advanced decay usually includes large black specks. The fungus spreads by airborne spores that infect stumps and wounds and can also spread by root to root contact and through root grafts. A butt rot typically develops in western hemlock. Above ground symptoms may take years to develop and trees may appear to be green and healthy. There is usually little windthrow and large pockets of dead trees do not occur. Treatment of stumps and wounds with borax is an effective means of preventing infection by airborne spores, but does not help stop root to root spread once the fungus becomes established in the stumps and roots.

Other diseases

Other diseases that occur in Pioneer Park are Schweinitzii butt rot caused by *Phaeolus schweinitzii* and Arbutus canker caused by *Nattrassia mangiferae*. *Phaeolus schweinitzii* causes a brown cubical rot in the butt and roots of Douglas-fir and western hemlock usually in larger trees (Allen et al. 1996).

3. Root Disease Survey of Pioneer Park

Aerial survey

In October, 1998 aerial photographs of Pioneer Park were taken by Reinhard Schroeder of Aerial Reconnaissance Northwest, Inc. of Poulsbo, Washington. Reinhard has developed a computer assisted system for identifying individual root diseased trees and disease pockets, particularly those caused by *Phellinus weirii* in Douglas-fir stands. Figure

4 shows the 50 root disease centers and dead trees identified by his analysis. Fifty feet diameter circles are drawn around each dead tree identified as a root rot tree. Apparent root disease centers were detected in the area of numbers 1, 7, 9, 1, 15, 22, 29, 42, 45, 47, and 49. Root disease appears to occur in all three sections of the park with scattered individual root rotted trees as well as the well defined centers.

Verification of aerial survey results and disease assessment

Verification of aerial survey results

In November 1998 the site was visited by Reinhard Schroeder, Brent Johnston and myself to verify the aerial survey results. Table 5 shows that most of the trees were correctly identified as Douglas-fir with laminated root disease. Forty-one out of 50 were Douglas-fir with laminated root rot. A rough vegetation map compiled from my walking the trails in the park is shown in Figure 5. There are a number of large healthy Douglas-fir trees particularly in the north section of the northwest quadrant (Figure 6) and the northeast quadrant . However, large sections of these two quadrants are now dominated by hardwoods (red alder and bigleaf maple), probably resulting from laminated root rot in Douglas-fir. There are also large areas with exotic invasives such as ivy and holly (Figure 5). The active root disease centers occur in the areas currently dominated by Douglas-fir. A number of dead hardwoods (Figure 7) in the northwest quadrant (particularly Nos. 2, 3, 5, 6, 8, and 14 in Table 5) were misidentified as Phellinus killed trees. Numbers 16, 25, 35 were also hardwoods. Numbers 1 and 12 were western red cedars and No. 50 was a madrone.

Disease assessment

Root disease

Root disease is widespread in Pioneer Park (Figure 4), mostly caused by *Phellinus weirii* causing mortality in Douglas-fir. There are several well developed active centers with standing dead trees, particularly numbers 9 and 10 and number 11 in the northeast quadrant, number 29 (Figure 8), numbers 40, 42, 44 (Figure 9), 46, 48 and 49, and number 45 and number 47 in the southeast quadrant. Well developed centers in the northwest quadrant are numbers 7 and 15 and 22, 24 and 27 (Figure 10). Dead tree 27 broke in a storm in November and fell across the trail (Figure 11). There were also single

root diseased trees scattered throughout the park. An example is tree No. 4 in the northwest quadrant (Figure 12). This tree has been attacked by bark beetles and was well utilized by woodpeckers that create openings in the bark (Figure 13). Decay develops in these snags and cavity nesting birds can utilize this habitat. Birds were noted to be utilizing cavities in both Douglas-fir and hardwood snags in the park.

As well as laminated root rot, other diseases were noted to a minor extent. Armillaria root disease was noted on a dead hemlock in the area between trees 7, 13 and 16 and a fruiting body of *Heterobasidion annosum* was found on a hemlock near tree no. 7 and a dead alder tree to the north of No. 40. Schweinitzii Butt Rot was also noted on a hemlock between trees 4 and 7. There was considerable decay and mortality in the hardwood trees (red alder, big leaf maple, and Pacific madrone). The largest area of mortality in red alder and bigleaf maple was in the area involving trees 2, 3, 5, 6, 8 and 14 in the northwest quadrant and number 35 in the southwest quadrant. Such decay and mortality is not uncommon in hardwood trees of this age. Stem decay is commonly caused by *Ganoderma applanatum*. Armillaria root disease probably causes their final demise as they weaken. Big leaf maple branches are also prone to decay and may fail and fall.

Most of the Pacific madrone trees scattered throughout the park are suffering from dieback and death. Figure 14 shows declining madrone near the corner of Island Crest Way and 58th SW in the northeast quadrant. Pacific madrones throughout the Puget Sound area suffering from a canker disease caused by *Nattrassia mangiferae*. At this stage there is little that can be done to save these madrones.

4. Management Alternatives

Pioneer Park is suffering from a range of diseases. These are native diseases, except perhaps for Arbutus canker, which may be an introduced disease. Laminated root disease is the most serious concern. It tend to be worst in areas where the understory is dominated by salal. These are usually the highest areas in the park and the driest. After cutting of the original old-growth Douglas-fir forest laminated root rot probably increased for the reasons discussed in the background material. This root disease killed the second-growth Douglas-fir trees and is currently very active creating pocket or centers of disease. Immune hardwood trees will eventually dominate these pockets. This is probably why there are such extensive areas of hardwoods in the park. Hardwoods may also develop in moister areas along with western redcedar. Laminated root rot can be expected to continue

to kill trees. This is not all that bad since the disease creates snags and logs that provide habitat for many birds, small mammals and invertebrates. However, standing dead and dying trees do create a hazard for power lines and structures surrounding the park if they are in the range of a tree when it falls. Also there is some concern about the safety of people walking or riding horses in the park from snag breakage and tree fall. Several snags fell across trails during storms in November, 1998, notably tree No. 27 (Figure 11) and a tree in center No. 29. Decayed hardwood trees might also be hazard in storms. For example, a decayed red alder broke and fell across the trail in November, 1998 at the northwest corner of the northeast quadrant. Some areas of the park (notably areas B, E, and G - Figure 5) are relatively healthy, but most of the other areas may need some management for disease problems.

Introduced plants such as ivy, holly and blackberry need to be controlled if the native state of the park is to be maintained. Ivy is a particularly bad problem, but can be managed by mechanical removal, perhaps by the use of volunteer groups. The weight of ivy on tree stems and branches can sometimes cause more rapid failure when stems and branches are rotted. Blackberries can be removed mechanically, but tend to return rapidly and some chemical control might be considered. However, since blackberries are more of a problem in open areas once a coniferous tree canopy is restored they should be less of a problem. Holly is the least problem of the three and can be easily managed by mechanical removal.

Management by alternatives

Table 6 presents seven management alternatives for diseases, particularly for laminated root rot, including the pros and cons for each alternative. There are more possible alternatives available with different combinations of alternatives. It is assumed that the major management objective is to maintain a "natural" forest condition. Managers need to determine the proportion of conifers to hardwoods that is desired. Each alternative is discussed below. Management alternatives for the vegetation areas in Figure 5 follow the discussion of alternatives.

Alternative 1 - Do nothing

Doing nothing to manage the diseases will allow natural succession to proceed, but the forest will continue to change to a more hardwood dominated forest. The older maples

and alders on the site, however, will continue to decline. Pacific madrone trees will also decline and many will die. Tree breakages and falls will continue to occur and could cause property, power line and personal damage. Biodiversity may actually increase and the site should provide good habitat for birds and other animals.

Alternative 2 - No dead tree felling but planting of seedlings

In this alternative dead trees would left on site to provide wildlife habitat and seedlings would be planted in the areas where the dead trees occur. Most of the dead trees are infected with *Phellinus weirii*. so Douglas-fir probably should not be planted because the fungal inoculum is still present. Low light conditions on the forest floor would also probably not allow the Douglas-fir seedlings to grow very well. Western redcedar, western white pine, and western hemlock seedlings could be planted. The laminated root fungus will continue to spread and Douglas-fir trees will continue to decline and die. However, the progression towards a hardwood dominated stand would be halted by the planting of conifers.

Alternative 3 - Manage only for hazard trees

This basically is the same as Alternative 1 with exception that hazard trees will be removed, particularly those likely to hit power lines. Trees can be topped like those already topped along SE 68th St (Figure 15). The forest will continue to change to more hardwood dominated forest.

Alternative 4 - Manage only for currently most active large laminated root rot centers

Eight large active laminated root disease pockets are designated on Figure 4 as (1) Nos. 7 and 15, (2) Nos. 9 and 10, (3) No. 11, (4) Nos. 22, 24 , and 27, (5) No. 29, (6) Nos. 39, 41, 43, and 45, (7) No. 47, and (8) Nos. 40, 42, 44, 46, 48 and 49. These are areas where Douglas-fir is dominant and dying. Several management activities are possible as shown in Table 6. All dead and dying trees and living Douglas-fir trees within 50 feet of of visibly infected trees should be cut. If the fungal inoculum is not reduced then western red cedar and western hemlock should be planted. Western white pine could also be planted since it is resistant to the diseases, although it is currently not present in the park.

Some Douglas-fir could be planted with the other species, but pure Douglas-fir should not be planted. Douglas-fir needs considerable light to do well while the other species are more shade tolerant. If inoculum is reduced by removing stumps and roots then Douglas-fir can be planted. Fertilization with urea might be considered to make the conifers grow faster. Wildlife habitat should not decline.

Alternative 5 - Manage for all laminated root rot centers

Laminated root rot is well distributed through the park and as well as the seven major centers there are many single trees with the disease. In addition there are stumps in the hardwood dominated areas that still have the fungus. It is possible to remove all the dead and dying trees and stumps, but this would be an expensive and disruptive operation. I would only remove stumps and roots in the major centers and plant cedars, and hemlocks and a few Douglas-firs in the areas with single trees.

Alternative 6 - Manage for laminated root rot and Arbutus canker

Recommendations here are the same for Alternatives 4 and 5 for laminated root rot. Madrones with diseased branches could be pruned, but if cankers are on the main stem the trees will eventualy die. They could be left or taken down and replaced with madrone seedlings, although these will continue to be attacked by the disease until resistant trees can be developed or a practical control is found. The other alternative is to replace the madrones with hardwoods or not manage for them at all.

Alternative 7 - Manage for all diseases

Recommendations here are the same for laminated root rot and Arbutus canker. Additional recommendations are for the management of diseased big leaf maples and red alders. The most diseased of these trees have considerable stem rot and may be hazard trees. It may be best to simply take down the most decayed trees and replace them with either hardwoods or conifer seedlings.

Management by areas indicated in Figure 5

Area A. Hardwoods and some large conifers - Ivy should be managed in this area. This area could be left alone. The large dead and dying hardwoods will eventually fall or could be removed if they are deemed to be hazard trees. Western red cedar and Douglas-fir could be planted or hardwoods.

Area B. No management

Area C1. Scattered big Douglas-fir. Blackberry, holly and ivy should be managed. More conifers could be planted.

Area C2. Douglas-fir here is very susceptible to Laminated Root Rot. Manage for blackberry and ivy. Manage for laminated root disease. Plant conifer seedlings. There may be some hazard trees here. Madrones could be pruned.

Area D. Dominated by hardwoods. Ivy needs to be managed. Considerable number of decayed alders and bigleaf maples here. Consider replanting with hardwoods, conifers or mix.

Area E. No management .

Area F. Large scattered Douglas-fir with red alder and big leaf maple. Consider planting conifers in open areas. Western red cedar, hemlock or Douglas-fir could be planted. Do not plant Douglas-fir near old stumps that have Phellinus weirii. Manage for ivy.

Area G. No management

Area H1 and H2. Typical second-growth Douglas-fir stand. Manage for laminated root rot and ivy and holly removal.

Area I. No management

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Glossary

Colonized - expresses the occupancy of wood by the fungus. e.g., colonized wood.

Cone crops - the total amount of cones produced by an individual tree. Douglas-fir does not start producing cones until it is about 15 years old. It produces large cone crops every 7 years or so with low cone crops in between. Excessive cone crops (beyond normal) are produced in response to root diseases. Cones are usually smaller than normal.

Dieback - refers to slow loss of needles from the crown of conifers or thinning foliage in hardwoods over time. Dead branches may occur and trees may eventually die.

Inoculum - the fungal infecting the host; spores, rhizomorphs, fungal mycelium in a stump that can grow along roots to infect new host roots.

Lower bole - the part of tree stem (or bole) that is from the ground surface up to about 15 feet.

Mycelial fans - usually refers to the white fungal tissue that grows unde the bark at the base of a tree infected with Armillaria. The fungal tissue grows in the shape of fans.

Occluded - obstructed. For exampe, the aerial view of some of the root rotted trees was obstructed by trees above them

Rhizomorphs - black or brown shoestring like fungal structures that grow through the soil from infected trees or stumps to infect new host. Armillaria commonly has rhizomorphs. They resemble roots (rhizomorph = root like).

Root ball - refers to the root area of fallen trees infected by *Phellinus weirii*. Large roots are so severely rotted that they break off near the stem and only stubs of the larger roots remain.

Root collar - area of a tree where the tree bole intersects the ground and the roots start.

Root wad - same as root ball.

Windthrow - trees that have been blown down by wind. Having root disease makes trees more susceptible to windthrow during wind storms.

Table 1. Common tree diseases occurring in Pioneer Park. Causal fungal species and hosts are also shown.

Disease	Causal organism	Hosts
Laminated root rot	*Phellinus weirii*	Douglas-fir western hemlock grand fir
Annosus root and butt rot	*Heterobasidion annosum*	western hemlock red alder Pacific madrone
Armillaria root disease	*Armillaria ostoyae*	Douglas-fir, western hemlock western red cedar
	Armillaria spp.	Big leaf maple red alder
Arbutus canker	*Natrassia mangiferae*	Pacific madrone
Madrone canker & dieback	*Fusicoccum aesculi*	Pacific madrone
Maple decay	*Ganoderma applanatum*	big leaf maple

Table 2. Typical symptoms and signs of laminated root disease

Symptoms (tree responses)
Reduced height growth
Formation of root disease centers
Wind thrown trees with distinctive root balls lying in many directions
Standing dead trees
Excess cone crop
Thinning and yellowing foliage
Wood in roots and butt of tree delaminating at annual rings
Incipient decay stain in butt of tree (Figure 1)
Hollow internal tree butts (Figure 2)
Signs (features of the fungus)
Buff colored ectotrophic hyphae growing on outside of roots
Red setal hyphae (whiskers) growing in wood
Annual fruiting bodies on upturned roots with brown pore surface (very rare)

Table 3. Susceptibility of tree species to *Phellinus weirii* in lowland Puget Sound

Common name	Scientific name
	Highly susceptible
Douglas-fir	*Pseudotsuga menziesii*
Grand fir	*Abies grandis*
	Intermediately susceptible
Western hemlock	*Tsuga heterophylla*
	Tolerant
Lodgepole pine	*Pinus contorta*
Western white pine	*Pinus monticola*
	Resistant
Western redcedar	*Thuja plicata*
	Immune
Bigleaf maple	*Acer macrophyllum*
Red alder	*Alnus rubra*
Vine maple	*Acer circinatum*

Table 4. Typical Symptoms and signs of Armillaria root disease

Symptoms
Reduced height growth
standing dead trees
Small trees may die quickly; needles turn red then brown
Excess cone crop
Resin flow at base of tree and on roots
Flat side on trees
Signs
Black rhizomorphs in soil coming from roots
Clusters of honey colored mushrooms at base of tree in fall
white mycelial fans under the bark

250 1000

0 500 1500

Scale in Feet

N

+ Root Rot Tree

Root Rot 50' Buffer

25 Root Rot ID Number

NAR

NORTHWEST AERIAL RECONNAISSANCE, INC.

28205 State Hwy. 3 NE
POULSBO, WA 98370
(360) 697-2266

PARCEL:

Pioneer Park

DATE: 10/27/98

PREPARED FOR:
Mercer Island Parks & Recreation

Table 5. Field verification by Brent Johnston and Reinhard Schroeder of dead trees identified as killed by laminated root rot (11/11/98)

Identification No (Figure 4)	Tree species	No. dead Douglas-fir	Notes
1	Western red cedar		3 red cedar
2	Hardwood		
3	Hardwood		
4	Douglas-fir	1	
5	Hardwood		
6	Hardwood		
7	Douglas-fir	1	
8	Hardwood		
9	Douglas-fir	1	Dead top
10	Douglas-fir	1	
11	Douglas-fir	3	
12	Western red cedar		1 red cedar
13	Douglas-fir	1	
14	Hardwood		
15	Douglas-fir	2	
16	Douglas-fir		
17	Douglas-fir	1	
18	Douglas-fir	1	
19	Douglas-fir	2	
20	Douglas-fir	1	Red needles
21	Douglas-fir	2	Plus 1 occluded DF
22	Douglas-fir	4	
23	Douglas-fir	3	
24	Douglas-fir	4	
25	Hardwood		
26	Douglas-fir	1	
27	Douglas-fir	1	
28	Douglas-fir	1	
29	Douglas-fir	9	Classic root rot pocket
30	Douglas-fir	1	Plus 1 occluded DF
31	Douglas-fir	1	
32	Douglas-fir	1	Plus 3 occluded DF
33	Douglas-fir	2	
34	Douglas-fir	1	Plus 1 broken top DF
35	Hardwood		
36	Douglas-fir	1	
37	Douglas-fir	1	
38	Douglas-fir	1	
39	Douglas-fir	1	
40	Douglas-fir	2	

41	Douglas-fir	1	Plus 1 occluded DF	
42	Douglas-fir	4		
43	Douglas-fir	2	Lacey top	
44	Douglas-fir	1		
45	Douglas-fir	2		
46	Douglas-fir	1		
47	Douglas-fir	2		
48	Douglas-fir	2		
49	Douglas-fir	4		
50	Madrone		Possible madrone	
	*Hardwood=big leaf maple or red alder			

Table 6. Alternatives for managing diseases and forest health in Pioneer Park

ALTERNATIVE	1	2	3
Description	Do nothing	No dead tree removal	Manage only for hazard trees
Management activity	None	Active planting of alternative species such as shade tolerant western red cedar and western hemlock. This could be done in areas where hardwoods are a major component and in active Laminated Root Disease centers.	Remove Laminated root diseased Douglas-fir trees or dead or heart rot decayed hardwood trees that are likely to hit targets (power lines, vehicles, houses, hikers or horseback riders). The strong wind direction is from the SW, S and SE, but trees in root rot centers often do not fall in the wind direction
Pros	Laminated root rot and other diseases are natural components of Douglas-fir stands like those represented in Pioneer Park. They influence forest succession and the tree species on that occur on site. They create biodiversity and allow wildlife to occupy habitats in snags, particularly cavity nesting birds.	Conifer component of the stand will be increased and hardwoods decreased. Wildlife using snags will be enhanced	Minimal disturbance to the park. Protects people and property
Cons	The forest will tend to have less of a conifer component and more of a hardwood component when Laminated Root Disease is active. Douglas-fir mortality will continue to occur. Standing dead trees will continue to fall during high winds and could be a hazard to power lines and hikers The forest may not look visually attractive because of declining trees, mortality and downed trees.	Laminated Root Disease will continue to be active killing the Douglas-fir trees, particularly in the active pockets. Tree fall will continue. There is some concern about hazard trees in the alternative.	Will do little to improve forest health and laminated root rot will continue to spread.

Table 6

ALTERNATIVE	4	5
Description	Manage for only currently most active large Laminated Root Rot Centers	Manage for all Laminated Root Disease Centers
Management activity	**OPTIONS IN ALTERNATIVE 4** (1) cut dead and dying DF trees and trees within 50 feet of visibly infected trees. Sound trees could be shortened to 15 foot snags (see Figure 15) if desired. Plant western red cedar or a mix of cedar, hemlock and Douglas-fir. (2) cut dead and dying DF trees and trees within 50 feet of visibly infected trees in large pockets or centers. Stumps and roots can be removed from the soil using a backhoe. Douglas-fir can be planted or a mix of conifers (3) thin DF trees within 50 ft around large pockets. The fungus does not spread easily in dead roots Plant western red cedar and/or hemlock in the center.	**OPTIONS IN ALTERNATIVE 5** (1) cut all dead and dying DF trees in the park and plant western red cedar and hemlock. Sound trees could be shortened to 15 foot snags if desired (2) cut all dead and dying DF. Remove stump and root systems in active pockets with backhoe. Plant Douglas-fir in large pockets. Cedar and hemlock could be planted in other areas (3) thin DF trees within 50 feet of large active pockets and single trees. Plant western red cedar and/or hemlock in the center.
Pros	Spread of the fungus in the most active centers will be reduced and the fungus will gradually die off. In options 1 and 2 some standing dead trees will be retained in other areas to provide wildlife habitat In option 3 wildlife habitat will retained in snags in the center.	Spread of the fungus will be reduced over the whole area. Conifer cover will increase.
Cons	Option 2 will cost more than option 1 since heavy equipment will be needed. Heavy equipment in option 2 will cause considerable soil disturbance Public may not like the use of backhoes.	Option 2 will cost more than option 1 since heavy equipment will be needed. Heavy equipment in option 2 will cause considerable soil disturbance Public may not like the use of backhoes. Wildlife habitat will be reduced.

Table 6

ALTERNATIVE	6	7
Description	Manage for Laminated Root Disease and Arbutus Canker	Manage for all diseases
	OPTIONS IN ALTERNATIVE 6	**OPTIONS IN ALTERNATIVE 7**
Management activity	Same as Alternatives 4 and 5 for Laminated Root Rot Arbutus and Madrone canker on Pacific madrone - removal of dead madrone, pruning of cankered branches Planting of madrone seedlings to replace removed madrones.	Same as Alternatives 4 and 5 for Laminated Root Rot Same as Option 4 for Arbutus and Madrone cankers Annosus Root and Butt Rot, Armillaria Root Disease and Schweinitzii Root and Butt Rot Disease are not at a level worth managing. Heartrot of red alder and bigleaf maple - this is a particular problem in Areas A, C1, D, G, Fig. 5 Red alder and big leaf trees are now at the age of decline and many have stem and branch decay. It is desirable to have some hardwood component in the park, but it may be desirable to remove dead and declining alders in Areas A, C1, D and E. Some big leaf maples in areas D and G have considerable decay and might be considered for limb pruning or removal. A mix of Douglas-fir, cedar and hemlock might be considered for planting
Pros	Same as Alternatives 4 and 5 for Laminated Root Rot. Health of madrones will be increased in the short run	Same as Alternatives 4 and 5 for Laminated Root Rot. Health of madrones will be increased in the short run Health of hardwood stands will be improved and some areas will be converted to conifers
Cons	Same as Alternatives 4 and 5 for Laminated Root Rot. Pacific madrone subject to infection by canker fungi in the long run.	A large amount of the park may need to be treated which may bring negative public attention. Treatments could be phased in over a long time period.

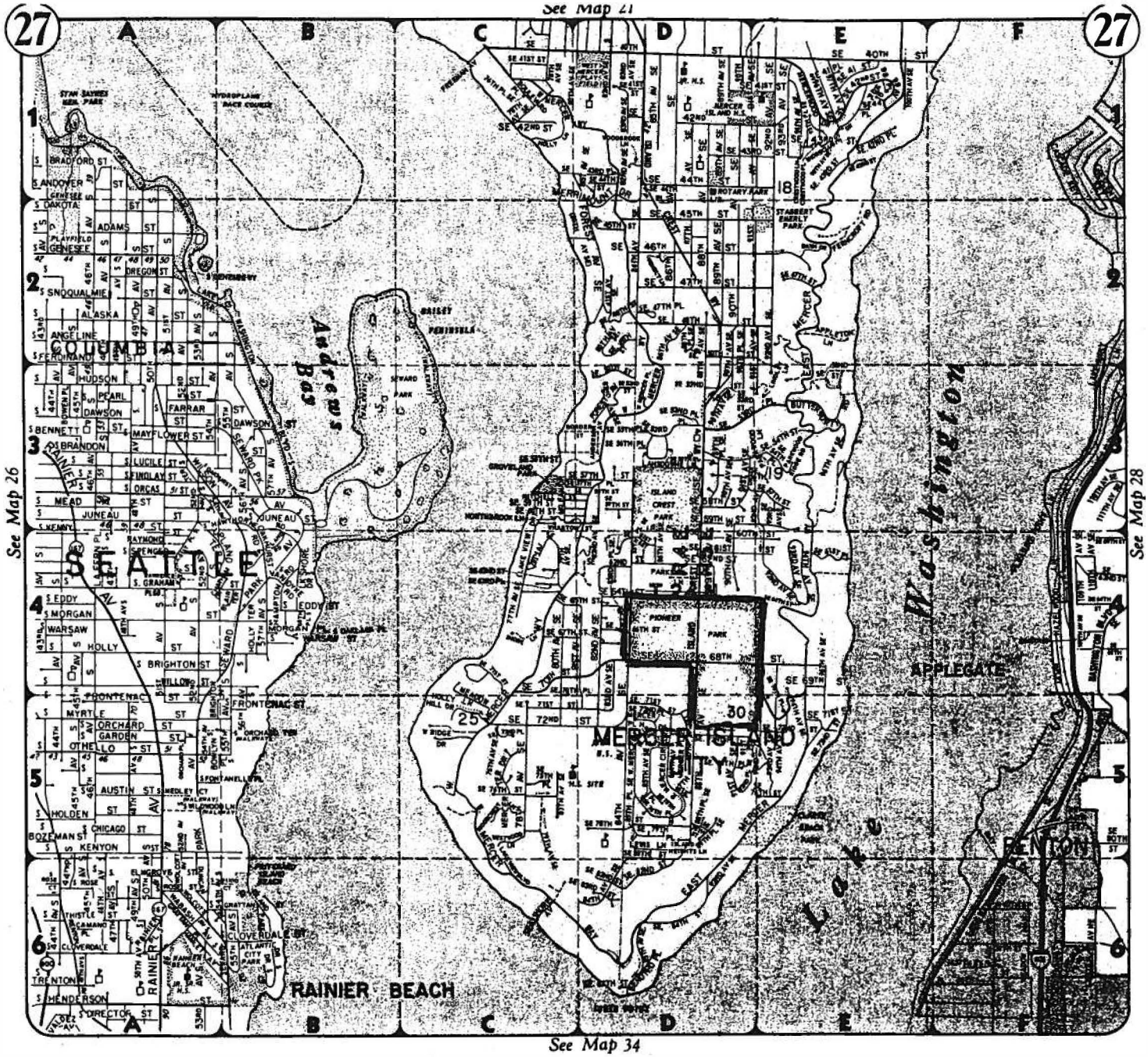


Figure 1. Map of Mercer Island showing location of Pioneer Park.

Figure 2. Incipient decay red-brown stain caused by Phellinus weirii in the outer sapwood of a Douglas-fir stump along the powerline on SE 68th St in the SE quadrant of Pioneer Park.

Figure 3. Advanced decay (white rot) caused by Phellinus weirii in in a Douglas-fir stump along the powerline on SE 68th St in the SE quadrant of Pioneer Park. The wood becomes a stringy mass leaving only a shell of bark. Note laminated decay sheets of wood on left center of photo.

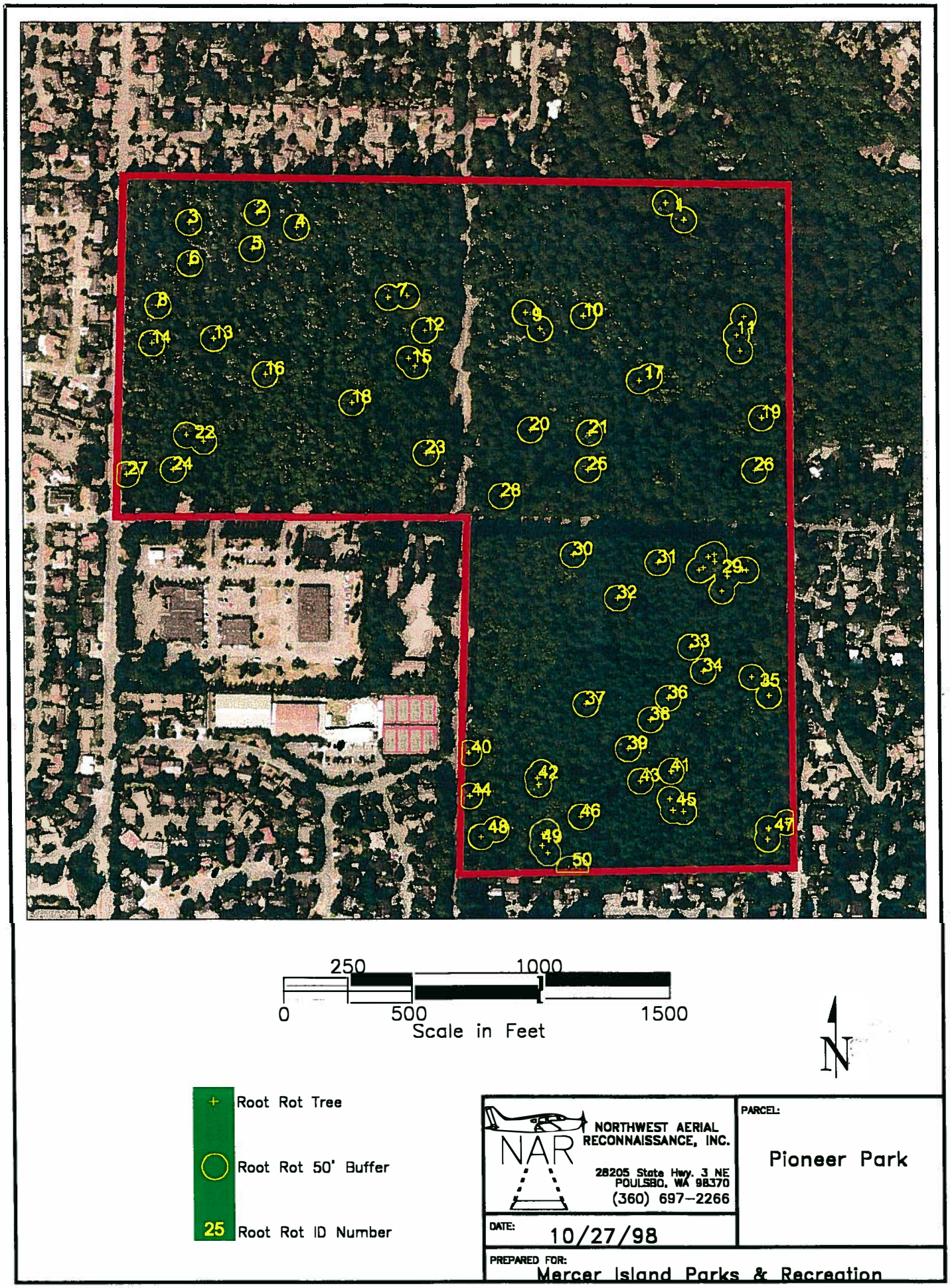


 Figure 4. Location of root rot centers

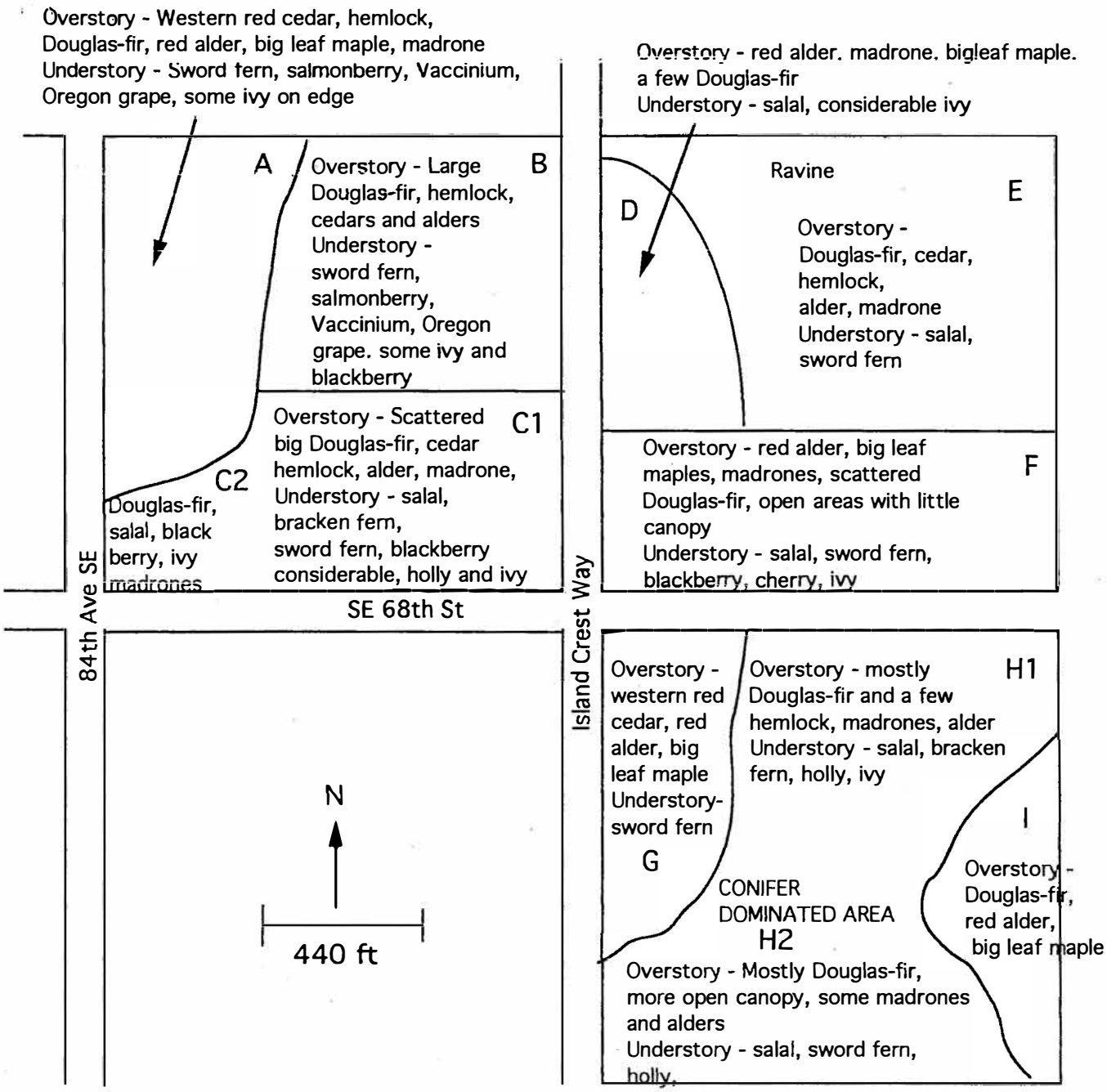


Figure 5. Rough vegetation map of Pioneer Park

Figure 6. Large Douglas-fir tree on the northside of the NW quadrant to the east tree #4. This is probably the most natural portion of the park with little disease.

Figure 7. Dead alders (probably trees 8 and 14) in the NW quadrant.

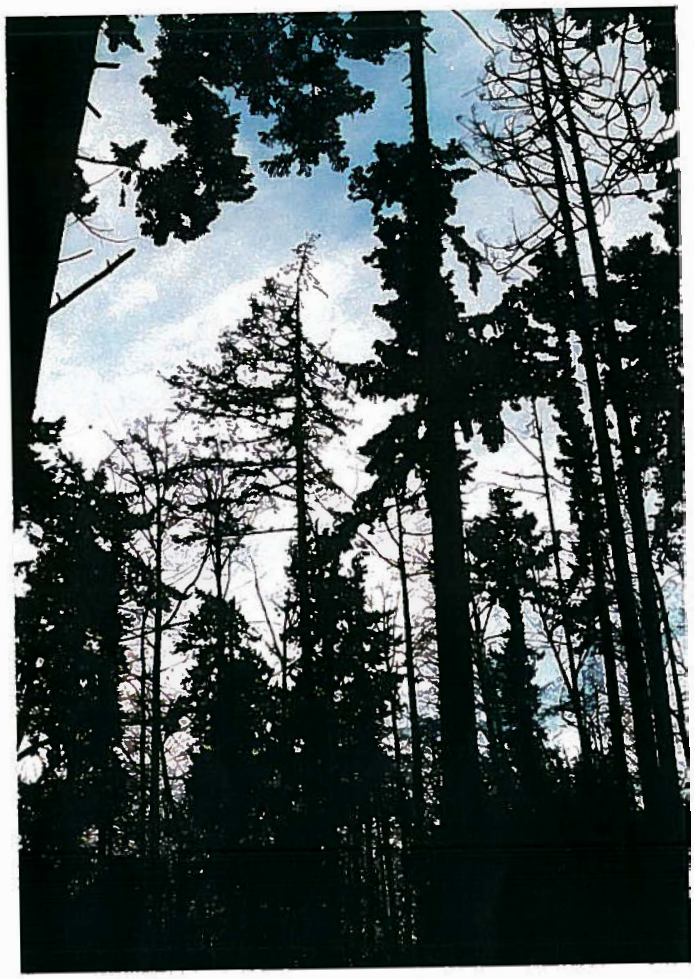


Figure 8. Standing dead trees in area No. 29 in the SE quadrant of Pioneer park. This is a classical Laminated Root Rot center or pocket.

Figure 9. Dead tree numbers 40 (left), 42 and 44 in the SE quadrant. All died from Laminated Root Disease.

Figure 10. Dead tree No. 27 on the west edge of the northwest quadrant broke in a storm in November, 1998. It is located in active Laminated Root Disease center.

Figure 11. The top of Tree No. 27 which broke in a storm in November, 1998 lies across the trail.

Figure 12. The top of dead tree No. 4 in the northwest quadrant. There is evidence of considerable use of this snag by woodpeckers.

Figure 13. Holes in the bark near the base of Tree No. 4 showing bark beetle attack and use of the tree by woodpeckers. Small mushrooms are fruiting in the top cavity.

Figure 14. Declining madrone trees in the NE quadrant at the corner of SE 68th St and Island Crest Way.

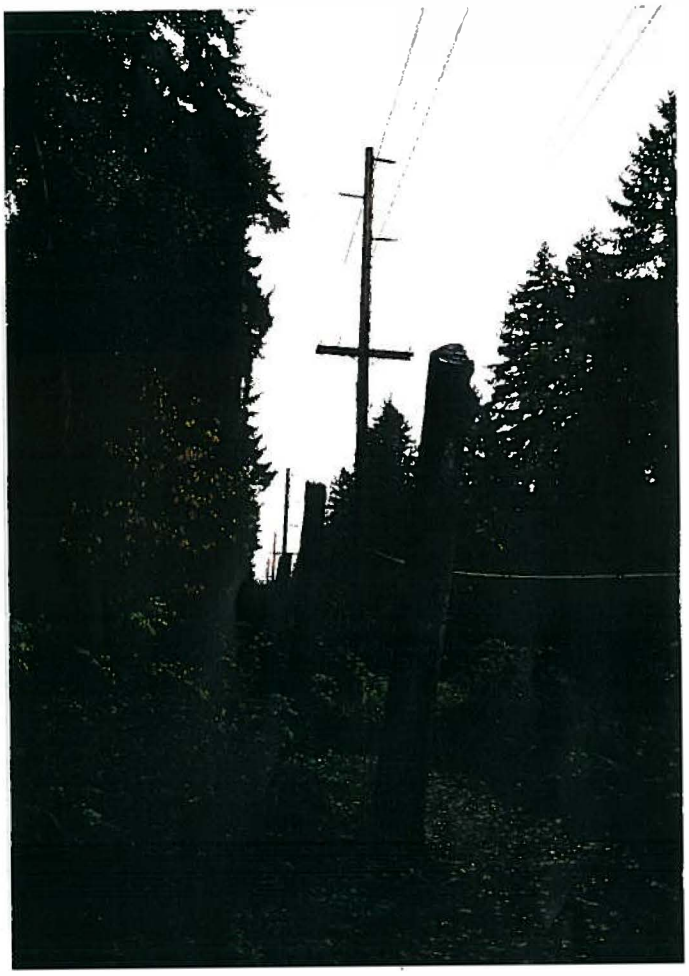


Figure 15. Topped trees along the powerline in the SE quadrant along SE 68th St.

16. Appendix F: Pioneer Park Ravine Habitat Assessment memo

DATE: 29 April 2002
TO: Paul West, City of Mercer Island
FROM: Marcia Fischer and Elissa Ostergaard, Sheldon and Associates
SUBJECT: Pioneer Park Ravine Habitat Assessment

The habitat of the ravine area in the northeast corner of Pioneer Park is mature, floristically diverse second-growth forest surrounding a steep-sided ravine through which flows a small creek. The riparian habitat along the creek and ravine is unique within the park, which is primarily upland forest. The riparian area is a mosaic of diverse microhabitats characterized by hillside slope wetlands, dense forested canopy cover, and open canopy areas. The forest is a mixture of coniferous and deciduous trees dominated by bigleaf maple, Douglas fir, and western hemlock. Black cottonwood dominates where the ground is moist. Habitat succession is in evidence, with large early successional species such as bigleaf maple and Douglas fir making way for western red cedar and western hemlock saplings.

The steep slopes of the ravine, intensity of stormwater flows, and geology of the ravine allow for frequent tree blow-down. Downed trees have opened the forest canopy, allowing dense undergrowth to flourish. Downed trees function as nurse logs for young tree and shrub saplings, and woodpecker holes can be seen at very close range. Gaps left by upturned rootwads provide opportunities for pioneer species to become established. Understory plants are very diverse, and include native species such as devil's club, salmonberry, Indian plum, salal, western hazel, large-leaf avens, trailing blackberry, long-leaved Oregon grape, horsetail, and stinging nettles, among others. Long-lived plant species such as red huckleberry, trillium, at least six fern species (sword, deer, lady, bracken, maidenhair and licorice), and giant conifer stumps are indications of the mature forest which once was present at the site. Non-native plant species are relatively uncommon, present primarily in isolated areas of recent disturbance. Non-native species include Himalayan blackberry, English ivy, English holly, English laurel, mountain ash, and a horticultural variety of St. John's wort.

The diversity of the microhabitats and the presence of water associated with the stream and hillside wetlands attracts a wide variety of wildlife species, including invertebrates, amphibians, reptiles, mammals, and birds. Riparian systems are generally extremely productive in terms of invertebrates and plants. They attract wildlife for feeding and nesting, and often function as migration corridors. Invertebrates in the stream may include mayflies, caddisflies, midges, true flies, worms, and snails, among others. These are a food source for numerous terrestrial predator species. The moist riparian woodlands are likely inhabited by terrestrial salamanders such as Ensatina and western red-backed salamanders, which prefer hiding under abundant downed logs and leaf litter. If shallow ponds are present nearby, the riparian area may also attract Pacific tree frogs, long-toed salamanders, and red-legged frogs. Pacific giant salamanders may breed in the stream and burrow underground in the moist forest. Garter snakes are likely to prefer basking in large brush or rock piles or along sunny slopes in the riparian area, where food is abundant. Raccoon, Virginia opossum, bats, and small mammals such as the creeping vole, dusky shrew, Trowbridge shrew, vagrant shrew, and deer mouse are also likely to inhabit the riparian area. Douglas squirrel, a relatively uncommon native squirrel, was observed at the site (April 24, 2002).

The area provides excellent opportunity for passive recreational use by hikers, educational groups, and nature lovers, birdwatchers in particular. Migratory birds are attracted to large trees such as those present along the ravine, and warblers are particularly attracted to black cottonwood trees. Pileated woodpeckers are found in the area, and abundant snags provide myriad habitat opportunities for cavity-dwelling birds such as chickadees, swallows, downy woodpeckers, and nuthatches, among others. Birds of prey such as red-tailed hawks, Cooper's hawks and sharp-shinned hawks tend to be attracted to such areas where they can be seen to hunt for small birds and mammals.

17. Appendix G: Summary of Forest Management Projects to Date

17.1. Revegetation projects

In 1997, a slope revegetation project was completed at the Twin Cedars Overlook in the northeast quadrant.

In 1998, a crew of 2-5 removed 11 tons of invasive plants during a 2 month period.

Beginning in 1999, the City Council funded forest management CIP projects for Pioneer Park. This funding initiated the first large-scale approach to forest management in the park. That year, the southeast quadrant was replanted in areas of root rot as identified in the report by Edmonds on tree diseases.

Year 2000 was the first major project. This project built on the experience gained from previous projects in 1997, 1998 and 1999. Brian Gilles was hired as a consulting arborist to plan and direct the project in cooperation with Bob Stagman from the Open Space Conservancy Trust Board. A crew of 10 from Green Life Landscaping was hired and spent three weeks clearing 36 tons of invasives from the park and planting 1600 plants. Volunteers helped to plant a portion of the plants.

In June of 2001, Parks and Recreation rehired Green Life Landscaping to weed the plantings which were being overgrown. Mortality on coast redwood and ponderosa pine was noticed in several areas. New seedlings of native elderberry were observed "volunteering" in many planting areas. This native regeneration was an unexpected benefit of this project.

In the Fall of 2001, the previous year's plantings were weeded again, and new trees were planted in existing planted areas. New areas in the northeast and southeast quadrants were planted as well. A total of 875 trees and 1900 shrubs were planted. Shrubs were concentrated in forested areas along the east side of Island Crest Way. In response to public comment from the previous year's plantings, only native plants were used in the 2001 plantings. In some areas of the southeast quadrant, debris piles were made to avoid hauling off organic waste.

In Spring of 2002, the previous two years of plantings were weeded. In Fall, 2002, a fourth round of weeding was completed. At the time, one-fourth of the 2001 trees were dead or dying. In contrast, year 2000 plants were surviving well. The cause was attributed to an exceptionally dry summer and early fall, combined with the sandy, well-drained conditions. One hundred trees were replanted where the previous year's trees had died.

These projects have provided us with a wealth of experience that has been analyzed and used to formulate management prescriptions for Pioneer Park. See Sections 8 and 9 (above).

17.2. Transmission Line Project

In late fall of 1997, Puget Sound Energy sponsored a project along the south side of SE 68th Street to protect the transmission lines that provide electricity to Mercer Island. This stretch of roadway had a history of outages from tree failures. The project removed Douglas fir, bigleaf maple, red alder and madrona that were underneath the clearance zone of the lines. Replacement plantings included hazel, vine maple, elderberry, ocean spray, salal, sword fern and huckleberry. Resprouting maples were recut in the fall of 2002.

18. Appendix H: Summary of Stand and LIDAR Analyses

Overstory of the park was surveyed using a combination of digital aerial imagery, Light Distancing and Ranging (LIDAR) data and ground observation. Staff delineated stands using ArcView GIS software and 1999 color orthophotos. Stand delineation was based on canopy composition, except where topography or hydrology was observed to be a strong environmental influence. Therefore, ravine areas containing steep slopes (>40%) or wetlands were considered separate stands. The two most dominant tree species found in each stand was recorded. Based on this analysis, the park contains 32 acres of conifer forest, 45 acres of broadleaf forest, and 40 acres of mixed broadleaf-conifer forest.

Marshall and Associates conducted an analysis of LIDAR data captured in late 2000 and early 2001. This data was collected by flying over the area with laser equipment to measure ground level and intermediate heights of objects that the light beam intercepted in a 6' spacing. For the purposes of this analysis, the difference between the height of the "first return" and the ground level was considered to be the canopy height in each 6' x 6' "pixel". Canopy heights were grouped into classes as follows:

0-4 feet	bare earth, prone vegetation
5-15 feet	shrub vegetation
16-30 feet	small trees
31-50 feet	medium trees
>50 feet	tall trees

Areas of six pixels (216 square feet) or greater in prone or shrub vegetation were considered canopy gaps. Each non-gap pixel was also rated for actual height variability in comparison to its neighbors. A window of seven by seven pixels around each pixel was analyzed for height variability. That is, within the seven by seven pixel frame, the standard deviation of the height in each pixel was calculated relative to all the pixels within the frame. Areas of low variability were considered "closed" canopy using a standard deviation breakpoint of 875. Areas of high (standard deviation above 875) variability were considered "fragmented" canopy. The center pixel of the frame was then labeled with a code for either "closed" or "fragmented" . The entire frame was then moved over one pixel and the calculation redone.

Results from this analysis are as follows:

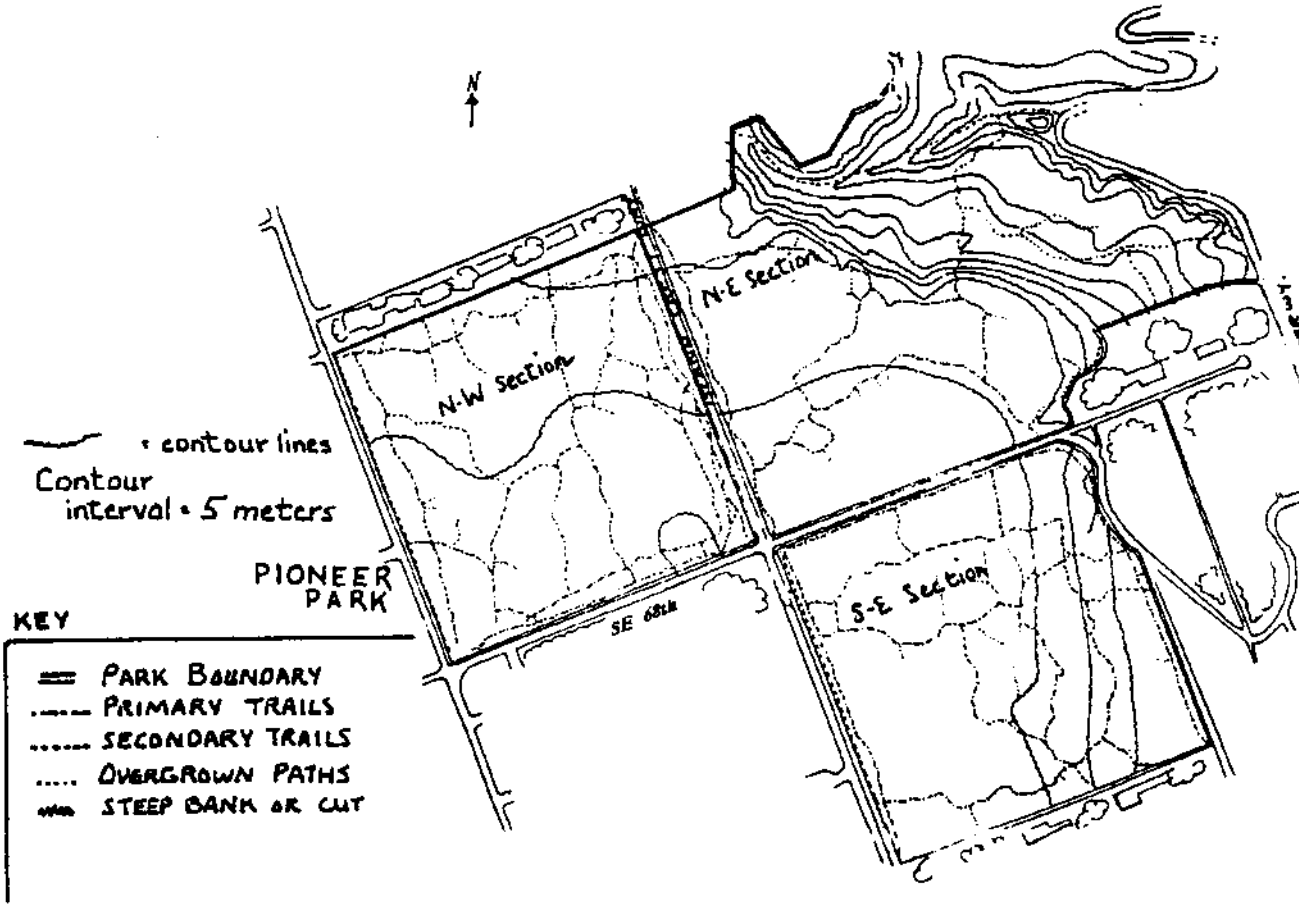
	Northwest	**Northeast**	**Southeast**
Canopy Gap	19.9%	15.5%	13%
Fragmented Canopy	14.5%	17.8%	16%
Closed Canopy	65.5%	66%	71%

Percentage of the total area of each quadrant containing each canopy condition

Ground surveys with the resulting data in May of 2003 verified the accuracy of both the extent and the location of these canopy conditions.

19. Appendix I: Pioneer Park: a natural history

PIONEER PARK
a natural history



PIONEER PARK
a natural history

MERCER ISLAND PARKS AND RECREATION DEPARTMENT

1990

TABLE OF CONTENTS

CREDITS:

Photographs by Henry Steinhardt

Back: Map Courtesy of Dave Enger, copyright 1985,
Sammamish Orienteering Club
Edited by Mary Kenady

TABLE OF FIGURES

Preface

This book isn't just about 120 acres we call Pioneer Park. It's about us. Because Pioneer Park is us: our property, our lifestyle, our heritage.

When you read about Pioneer Park's soils, terrain, vegetation, birds and animals, you're learning the characteristics of your own property—or, what your land would be like had it not been cleared to build your home.

Pioneer Park is the last sizeable chunk of Mercer Island that looks, feels, and smells like the Mercer Island found by the early settlers 75 to 100 years ago. Tramp through those woods, let your eyes climb the trunks of the 100-foot Douglas fir and cedar trees, and cast your gaze downward through the Oregon grape and salal at the mosses, ferns and young trees growing out of the rotting stumps and windfalls. Here you have the living forest, at work.

Pioneer Park consists of three 40-acre woodlands on the northwest, northeast and southeast corners of the intersection of Island Crest Way and Southeast 68th Street. It is located in the south-central portion of Mercer Island: an hourglass-shaped land mass, five miles long and from one to three miles wide, that rises as high as 350 feet above the surrounding Lake Washington. Mercer Island, an incorporated city of almost 22,000, is only 15 to 20 minutes from two major urban centers: Seattle to the west, and Bellevue to the east.

Privately owned until 1931, when Mrs. Maud Walker-Ames willed the property to the University of Washington, Pioneer Park like the rest of Mercer Island had been logged of most of its virgin timber before the turn of the century. While a few old-growth trees have been identified, most of the park's tall trees, some by now more than 100 feet high are second-growth cedar, Douglas fir and hemlock.

Upon Mercer Island's incorporation in 1960, the new government and its citizens began planning for a park system. Learning the land then known as "the University properties" was available, Mercer Islanders in 1964 passed a bond issue to buy the property.

Citizens took a hand in 1969, when it appeared imminent that 80 acres would be cleared for a municipal golf course. On an advisory ballot, 64 percent of 6,000 voters—a whopping turnout for a by-election—opted to keep the park natural, virtually as it had been since the last century.

The issue of preservation or development at Pioneer Park resurfaces regularly, most recently early this year when some citizens asked the city for a 40-acre golf course on Pioneer Park. At this time, the issue of golf facilities for Mercer Island is again under study.

The park thus far has been touched but lightly, with trails around the periphery and through each section. You may walk the trails or ride horseback on certain trails so designated, but no bicycles or motorized vehicles are permitted. In a 1983 park bond issue, $100,000 was earmarked for Pioneer Park, to include trail improvements, signs, benches and interpretive material.

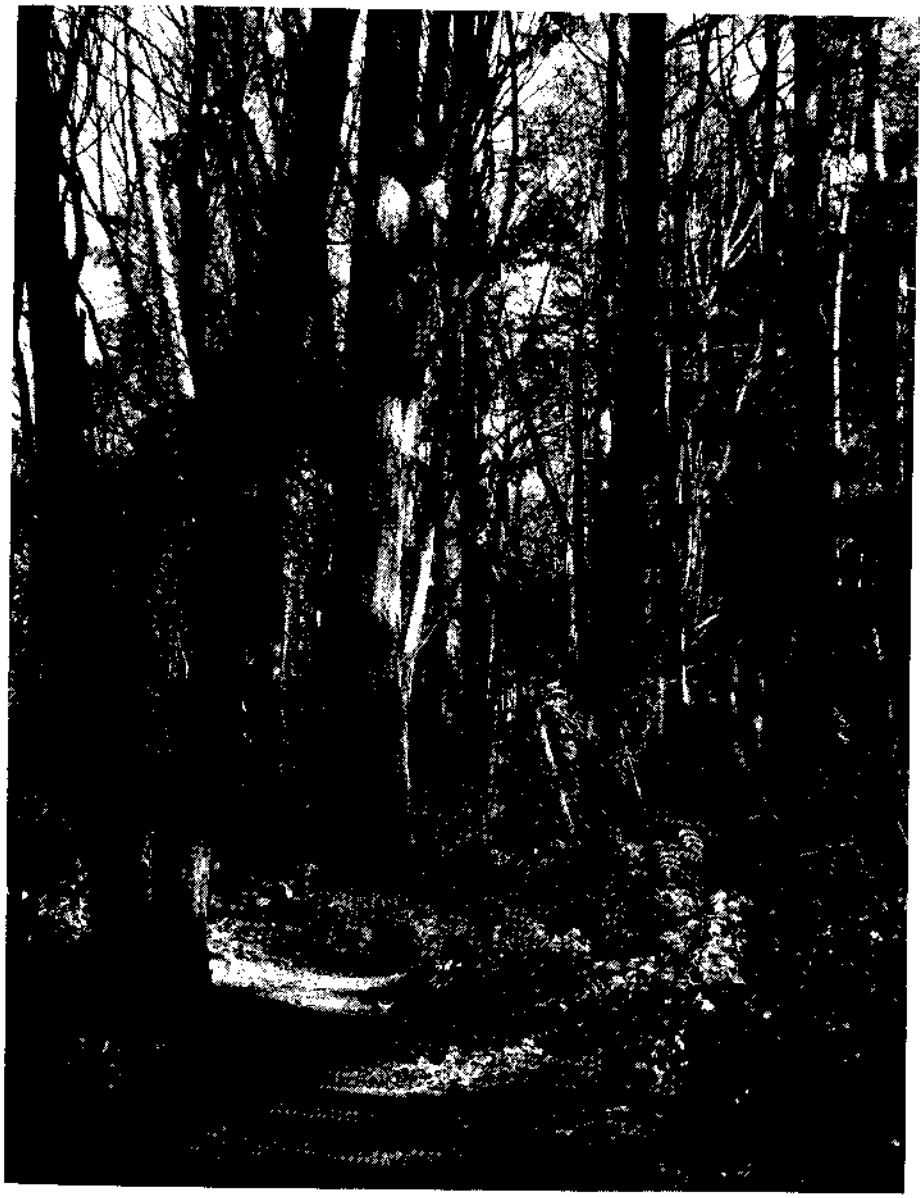
During the 1969 campaign for preserving the park, preservation's proponents discovered the public knew very little about their parkland. In 1970, the Mercer Island Park Board delegated a study to a committee of volunteers from the Mercer Island Environmental Council. Their work became the first edition of *The Natural History of Pioneer Park*, completed in 1972. Only a few hundred copies were printed; they sold out shortly after appearing at the community's book store.

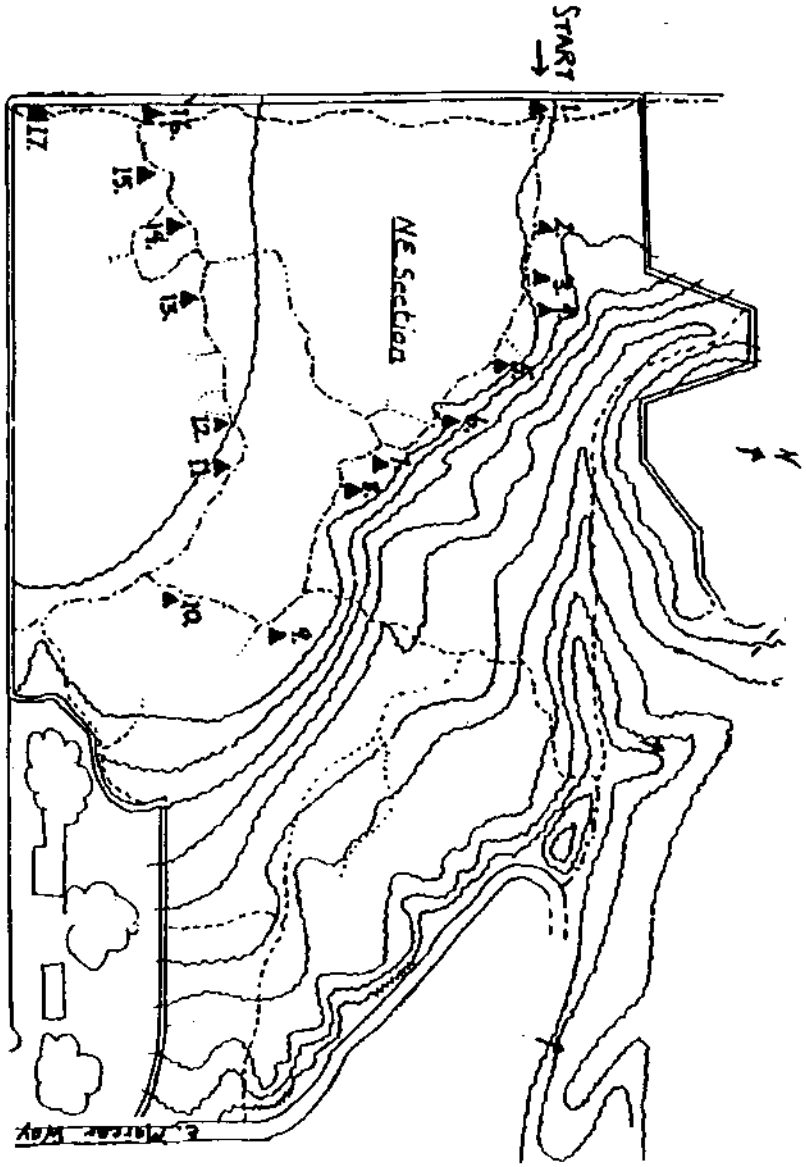
Because all citizens on Mercer Island deserve to know Pioneer Park—and thereby their own land—a new group of old volunteers, most of those who brought out the original book, have revised and updated *The Natural History of Pioneer Park* for this second edition.

The book contains authoritative studies of the soils, topography, plants, fungi, birds, and animals of Pioneer Park. It provides illustrations, an orienteering map of the park, and an additional map, of the nature trail in the northeast section.

I recommend you first pore through these studies, and then take the book along on hikes through the park. It will provide a new dimension of knowledge to your path, through the park and throughout your life on Mercer Island.

Peggy Reynolds





A WALK IN PIONEER PARK

by Laura Dassow
and Mary Kenady

The purpose of this chapter is to allow Pioneer Park users to follow a numbered trail in the Northeast Section of the park, using the notes given here which are in sequence if the trail is followed from the farthest north entrance on Island Crest Way (see map).

1. The Forest Edge

The forest edge is like the wall of a fortress, protecting the inside by absorbing the impact of outside forces, such as weather. The front of dense vegetation springs up in response to light. This fortress wall of foliage is massed to capture as much light as possible. The plants are able to use strong light and to withstand quite severe temperature changes as well as to tolerate crowding. Each plant species has slightly different demands, expressed in its unique form and size, so many different species can fit themselves into the limited space available. We see a spectrum of plants: elderberry, hazel, blackberry, nettle, and dozens more, all growing together.

Take a look at the forest as a whole. It is a dynamic and changing community which looks different now from the way it looked twenty years ago, and will change again in the coming twenty years. Notice the patterns of growth—the canopy of mature trees, the understory of smaller and younger trees, which someday may grow to replace taller ones, and the tall shrubs which reach for whatever light escapes the trees above.

2. Behind the Walls

Behind the fortress wall of the forest, the inner character begins to emerge. The species clustered at the edge are here scattered across the forest floor, massed only where a break in the canopy of trees allows more light to enter. In the shelter of the deeper forest, shade-tolerant plants come into their own. Vanilla leaf and trillium

suffer if exposed to strong sunlight, and Oregon grape prefers forest shade.

Another characteristic shared by the plants along this part of the trail is a preference for moist places. Here, at the lower end of a long slope, drain-water collects, keeping the soil moist. Water is important to plants—they are composed largely of water, and what is continually lost by evaporation must be replaced. Also, the nutrients that plants require cannot be used by plants without the medium of water transport.

3. Natural Clearing

A very large big-leaf maple has created a subcommunity under its large spreading leaves. This is a phenomenon more notable 15 years ago than it is now, as time, good moist soil, and perhaps some natural pruning of the maple to let in more light have allowed a small thicket of elderberry to begin taking over the clearing. As the elderberry grows, small plants such as the vanilla leaf and trillium are crowded and their habitat is reduced.

One can still see the general pattern of the interior of the park here. Most of the area was logged about 65 years ago, leaving stumps scattered throughout the park. One such is the large Douglas fir stump near the trail, crowned with a healthy head of salal. Clearing the land opened it to new plant colonizers and disrupted the uniform pattern of the forest by leaving some spots undisturbed, piling slash in others and burning in still others. But the same forces which gave the original forest its pattern are working to restore it. Succession, the process which guarantees that one species of plant or one community will not normally continue indefinitely in any one spot, will bring a series of communities of plants to the park again, with the final great hemlock-cedar groves to come in some far future time.

4. Forces of Nature

A fine natural stand of young Douglas firs grows throughout the area here, especially to the south. Where trees grow in crowded conditions (as in the southeast section of the park) the competition

is so keen that they fight one another almost to a standstill, and you will see what is essentially a stagnant stand of trees. Eventually, however, some of the trees will fall, allowing more light to others, and the forest will continue to grow and mature, as we see here.

5. Beginning of Ravine Edge

Some time ago there was a tree house here, built by children who are adults now. Some remains of the tree house can be seen if you look up the trunks of the trees just to your left.

The slopes on the left here are becoming steeper as we get closer to the ravine, where flows the only year-around stream in the park.

The world of the ravine bottom is quite distinct from that of the upper forest, and it should be visited in a separate trip, going in from East Mercer Way, to view its moist, cool environment. Many wet-site plants grow only here: the skunk cabbage, rushes and horsetails and devil's club. Birds find a natural sanctuary here and the spot where we are now is a good place to watch for them as they fly back and forth below and to the trees above. Many native birds find protection in these deep woods—especially the woods-loving birds. Watch year-round for the pileated woodpecker, winter wren and song sparrow. Listen, in summer, for the rising trill of the Swainson's thrush. In spring and fall, migratory birds are attracted by the water and by the abundant fruits and seeds of elderberry, huckleberry, maple, Douglas fir, and other plants.

This stream exists mainly because of the layers of hardpan in the hillsides above. Ground water accumulates above and comes out in various springs to feed the ravine watercourse. The soils of the steep hillsides are extremely unstable and subject to erosion. Plants growing there help to keep the soil in place.

6. Continuation of Ravine

Looking outward and downward here, you can see huckleberry growing on a stump. Logs, stumps and even snags often provide rootholds for woodland shrubs, especially huckleberry and salal. Birds and mammals eat the berries and deposit the seeds, sometimes

high above the forest floor.

Green plants cannot take nutrients directly from dead wood. The nutrients are "trapped" in the dead trees, locked into complex molecules. The vital function of the agents of decay is to break down the cells into simpler elements. The agents of decay—water, bacteria, fungi, insects, worms—make the elements available as food to the roots of the living plants.

Decomposers most noticed are the fungi, which come in a variety of forms and shapes, from the perennial bracket fungus to the short-lived gilled mushrooms. Watch carefully for mushrooms, especially in the fall after the first heavy rains. They may appear anywhere, but not for long. The mushroom you see is the ephemeral above ground form that grows from the masses of mycelia existing underground. The body above ground exists only to release spores to create new mycelia and mushrooms. Fungi have no chlorophyll and cannot photosynthesize. They take their food by secreting enzymes which dissolve the material around them, then absorbing through their cell walls the products they need—a sort of external digestive system.

7. Twin Cedar Overlook

Here near the rim of the ravine is an interesting red cedar, probably formed when a single tree was bent over to the ground and two of its upper branches took over the job of being the treetop, or leader. The ground around this cedar is quite bare, indicating a heavy use of this part of the park.

The unique ravine ecosystem is apparent from this point. The upper slopes and their characteristic plants intergrade with those at the bottom. The trees vary the least here: mixed stands of maple, hemlock, red cedar, Douglas fir and alder grow throughout. Several old trees in the ravine bottom escaped logging and stand as relics of the virgin forest. The stumps of truly large old cedars show this species once flourished here and likely will again if the forest were left to proceed naturally.

One large stump below serves as a "nursery" tree for a hemlock,

which grows out of it. Hemlock seeds often take root in logs and snags, but if the roots do not reach the soil before their support rots away, the trees will not reach maturity.

The unstable slope supports quantities of sword fern, which likes to grow where seepage brings both water and nutrients from above. Ferns are found in moist, shady places usually, for a young fern requires moisture at just the right time if it is to grow. As they reproduce by tiny, light spores instead of seeds, ferns are found on tree trunks, rock walls, and other places where seeds would seldom lodge.

8. Ravine Overlook, continued

Curious root patterns of the tree at the left here show that this hemlock began its life on a nurse log, which has since fallen away to expose the twisting, groping roots.

Below, devil's club grows in spiny profusion. Avoid this plant at all costs, as it can not only be painful but sometimes causes itching and burning of the skin to those who are allergic to its spines.

Delicate green layers of algae are sometimes apparent on the trunks of trees here. This is a primitive plant sometimes seen in deep woods. Tree bark has special breathing pores through which oxygen and carbon dioxide pass, leaving powdery deposits of dead cells. Often these deposits are washed off by rain, but where the trunk is sheltered, a minute green alga is able to live on the bark, using the mineral residue from the dead cells as food. Algae, unlike fungi, are green plants which need some minimal amount of light to survive. Algae thrive best in the sea or in lakes, and are not so successful on land—those that live in the woods are weak and minor, occupying a very small niche where there is scant competition.

9. Battered Maple

A big maple below the trail shows signs of heavy pruning—perhaps by wind, or heavy snow loads, or, since maple fractures easily, limbs breaking from their own weight. The crown of an old maple often holds a large dead branch or two which may come

crashing down in a storm. High winds are detrimental to single trees, or to a few left of a large stand when logging is finished. Left together in a large stand, they offer one another protection, as well as becoming a wind barrier for other, smaller plants.

Mild winds, of course, can have a beneficial effect. They prune out small dead branches and they help to pollinate the inconspicuous flowers of the forest trees in spring and disperse the seed in fall for further forestation.

From this spot there is another panoramic view of the second-growth forest. By now you are probably aware of certain patterns of growth: below the towering canopy of mature trees lives a varied selection of understory species including some young trees destined to reach the canopy, and others—such as dogwood—which will never grow as tall. A layer of tall shrubs, such as elderberry and ocean spray, takes its place below the trees, and underfoot grows the lowest layer, the ferns, Oregon grape and herbs. This principle of "layering" allows a maximum number of species to use the energy of the sun, and the entire ecosystem to be more productive.

10. Second-Growth Fir-Hemlock Forest

A change in the character of the forest, barely perceptible in this area, becomes more obvious as one follows the trail. The difference is most definite in the undergrowth, as salal begins to displace the sword fern. Trees change slightly, too, the emphasis shifting from maple and alder to Douglas fir and hemlock, with madrone and willow increasingly evident.

What causes the change? It is certainly not a climatic difference in such a short distance—all areas here receive much the same rainfall. Rather, it is the soil. Alderwood soils are replaced in this small corner of the park by more porous, sandy soils, which the water drains through more rapidly, taking nutrients along with it. This results in heavy competition for the available moisture and an edge is gained by those plants with deeper taproots or greater resistance to drought.

Competition is a relationship which occurs when the environment

does not supply all the needs of all the population (as of course it never can). Each individual and species is, to some extent, disadvantaged by the close presence of other individuals. We talk of a "limiting factor," which in this case is water. One element necessary to the entire population is in short supply—moisture—and all are competing for the amounts that are necessary to their survival. In a particularly moist spring many small seedlings may sprout that will never receive enough water later in the year to grow, and will be found withered and dead. This happens frequently with maples, which are prolific seeders.

11. Forest Clearing

Here and there in the woods a break in the canopy of trees allows full sunlight to come through and, freed from the dominion of large trees, numbers of smaller plants respond eagerly to the light. Many of the plants here are the very ones missing from the ravine—ocean spray, salal, bracken fern—indicating a drier environment. Surrounding and scattered through the clearing are smaller, second-growth trees—dogwood, willow, Douglas fir and madrone—eating away at the clearing in a process that will result in its complete disappearance before many years have passed.

The layers, or levels of plant growth, are clearly revealed. In the absence of the tall canopy the large shrubs crowd together, completely shading out the smaller herbs, which are displaced to the more open forest or to holes in the thick shrub cover. The smaller, faster-growing understory trees are the first to advance into the clearing; as the shrubs thin out under their shade, larger species will move in and grow to shade out the understory trees unless they, like the dogwood, can tolerate a lack of light.

Clearings like these provide an abundance of food for birds and small mammals, which are attracted to the fruits of salal, hazelnut bushes, blackberry, dogwood and madrone. Early in the year the air here will be humming with insects, brought out by the warmth of the sun and the richness of blossoms. Most flowering plants depend upon insects to spread pollen and thus fertilize the blossoms. Without

insects, hard times would fall upon birds and blackberry pickers.

12. Brush Field in Transition

Here not more than 15 years ago was a very clear opening with predominantly below-the-eye-level species. Today it is changing rapidly. Nettles are growing where they would have been hard put to survive only a few years back. The soil is still that sandy Indianola stuff, but over these intervening years more organic matter has been added to the soil as annual plants die back and needles and leaves from the trees fall. This has improved the quality of the soil. Nettles are lovers of good soil, and if they are not exactly the friendliest of plants, they do indicate the presence of organic matter and good growing material below.

As the trees above have closed in the canopy, less sun and more shade have also been factors in the now-changing environment. Again, we see the process of succession in the growth and evolution of the park.

13. Madronas

The Pacific madrone is found only in a narrow strip from southern British Columbia to northern California. Many of our local trees have taken on a scraggly, dark look. Compared to the glowing reddish bark and shiny leaves of a healthy tree, as seen on some of the San Juan Islands, ours are poor examples of their kind.

The Pacific madrone has a hard time of it, trying to survive encroaching disease. This is most apparent among the trees on Mercer Island. To the left of the trail is a surviving specimen, fighting to exist in the forest of other species, very much an isolated individual. Some trees are more resistant to disease than others. Perhaps at some time a few madronas will occur that are disease-resistant and produce a more hardy strain than now exists. This has happened to some extent with eastern elms and the virulent Dutch elm disease.

Notice how the salal, seen in the lower part of this section as a small, straggling bush, here grows into a tall, vigorous shrub virtually

smothering the forest floor. Salal is possibly our most abundant shrub, and its glossy evergreen leaves can be found nearly everywhere on the west side of the mountains at lower altitudes. The Indians used the dark, mealy berries for food, but today they are less popular with people—more popular with birds and other wildlife. Some salal is cut and shipped to florists across the country.

14. Old Soil Pit and Mountain Ash

Off to the left here was once a very visible soil pit where this Indianola type soil could be viewed. Shrubs have grown in over the pit so it is now a concealed trap to anyone who ventures into the brush. What could be seen was a thin layer of organic matter over layers of sand. Soil is rock, rock disintegrated by weathering, water, wind, et cetera, and the action of primitive plants. The top layer that could be seen here is reddish-brown, 9-12" deep, with the second "horizon" a yellowish sandy loam, mixed with some gravel. Much gravel is found in the deeper sublayers. The gravel-clay parent material was ground and dumped thousands of years ago by a glacier which also left rocks and boulders scattered throughout the area.

To the side of the soil pit is a tree rather rare here in the park, the mountain ash or rowan tree. This is not a native tree, but was once imported, probably as seed, from its native England. Birds are fond of the dark red-orange berries that form in late summer and have scattered seed of this tree throughout the Northwest. Other accidental species may be found throughout the park as well—especially small hollies and cotoneaster bushes, both of which are easily spread by birds.

15. Decomposing Log

Of all the soil layers, the most vital is the thin cover of topsoil built up very slowly by the decay of vegetable matter. Though in moist, temperate regions the rate of decay generally keeps up with the fall of litter, it takes about 300 years to build a single inch of new topsoil—a layer easily exposed and damaged.

Topsoil-building is continuous, going on quietly all around you.

Logs especially, such as the one before you, take a long time to decompose. It is a well-ordered process with a series of definite stages. At this stage the wood is still fairly well preserved, but the forces of decomposition are relentless and will eventually reduce it.

A weak and dying tree, or a healthy tree newly felled, is soon set upon by insects which burrow and chew their way beneath the bark and through the wood. Woodpeckers, chipping away at the surface, open it to further agents of decay. More insects find their way inside; the white mycelia of fungi spread through the tree; bacteria and micro-organisms do their own dismantling business. One fungus may follow another, each taking something different, further weakening the wood. Water percolates through and dissolves some substances; other plants take root and break up the soft mulch. Finally the log before you will have melted away into the dirt. Its substance will support generations of hemlock, salal and Oregon grape.

16. Natural Pruning

These trees are healthy, though all the dead lower limbs are misleading. As the upper branches filled out and took the light, the leaves of the lower branches had ever more difficulty maintaining themselves. Eventually these unproductive limbs died, leaving the water and nutrients to flow without interference between the healthy upper branches and the roots. Eventually the dead branches will fall, to decay on the forest floor.

In this area the character of the upper, drier forest is most fully developed. Most of the trees are conifers, and judging by the numbers of young trees, the succession of hemlock and cedar is well along. Notice that there is also a quite large western hemlock tree here in this area. The moisture– and light–dependent alders and maples are fewer in number, and the undergrowth is different from that in the lower forest. Elderberry is much sparser, and sword fern and huckleberry have decreased in importance. Here, instead, the forest supports quantities of Oregon grape, salal and ocean spray, with blackberry and bracken fern.

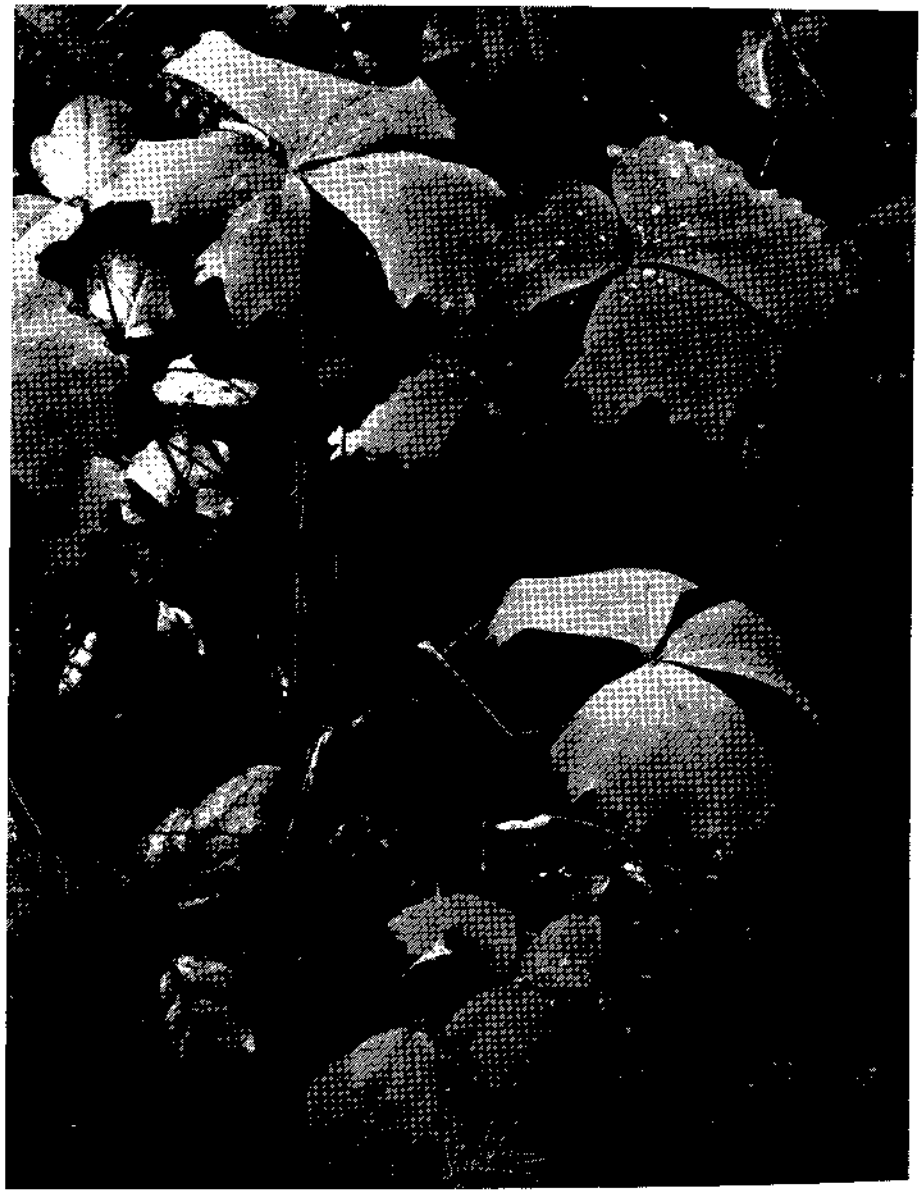
17. Mowed, Grassy Borders with Islands of Vegetation

The grassy borders are a long front where many introduced lawn and weed species can invade the Park. A few exotics, thrown out of gardens, thrive among the native plants along the residential borders. Aliens like English ivy, holly and Scotch broom have taken hold as if they belong here.

But the weeds here are mostly a different breed. Exceptionally hardy, they can withstand the most severe and variable conditions; small in size, their needs are not great; their seeds are light and abundant, easily carried far beyond their original range by wind, birds, humans, horses and other animals. Their spreading capabilities make these plants nearly universal, and it would be astonishing to find them absent here.

This "weed" tribe is first to pioneer a cleared area, and without these plants to begin the succession, hold the soil and add organic matter, other plants would have a difficult time establishing themselves. Roadsides and borders are frequently mowed, and so kept perpetually in the earliest stages of succession. The earth would look much barer without these "invisible" plants to cover it with green.

The clumps of vegetation along the mowed borders are "outpost representatives" of the woods, and fairly similar to them in composition. The abundant light and greater exposure are special conditions, and these clumps become explosions of the hardier native and introduced plants.



PLANT COMMUNITIES

by Mary Kenady

Acknowledgments

This study is not a complete evaluation of the vegetation of Pioneer Park, but is offered as a general view of those plants, bushes and trees most visible to the visitor and about which he or she might have the most curiosity. The original field work for this book was done in 1971 and 1972. Very fortunately the plants which were there then are mostly there now. At the time of the original study, I used some previous data gathered at the University of Washington on the park. I added my own observations and was fortunate enough to have the help of the other authors of this book, and their knowledge gained in studying the park helped me to formulate my own conclusions.

INTRODUCTION

The natural vegetation of Pioneer Park is representative of those dwindling forests of lowland western Washington where trees and underlying plants have been left essentially undisturbed by man for a considerable length of time. It is the result of many environmental factors — those of geology and soils, precipitation and hydrology, climate and microclimates. People are an environmental factor as well, in what is most often an unpremeditated or non-purposeful manner. As a whole, it is known by those who classify such things as typical of the Western Hemlock Zone of the Northwest Pacific slope. (See Fig. 1)

Western hemlock certainly does abide in Pioneer Park, as do its friends and cousins the Douglas firs and western red cedars, as well as the big-leaf maples and the red alders. The main reason for naming the kind of forest that makes up Pioneer Park a western hemlock forest is that if natural growth were to proceed according to the way tree experts assume a forest should go here, it would eventually end up as mostly western hemlock. But things seldom go the way the experts say they should and we have a much more

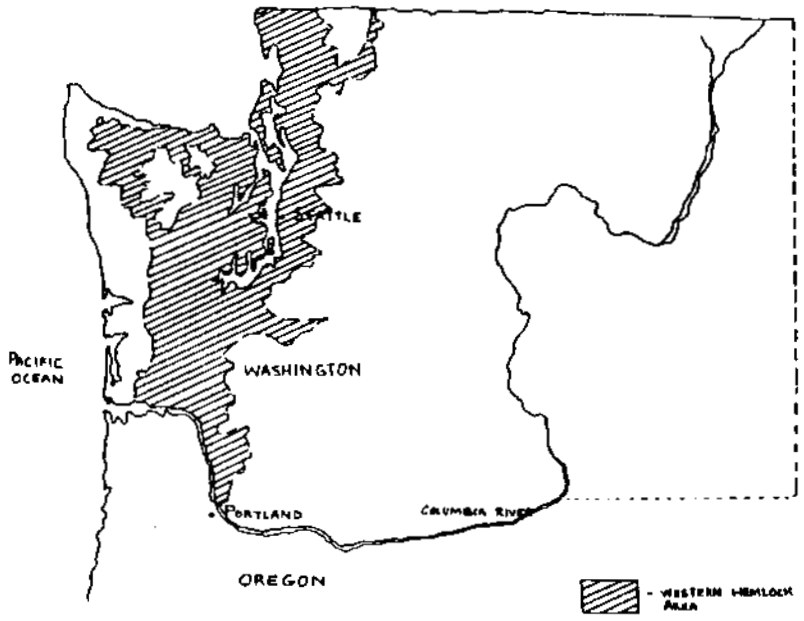


FIGURE 1
Distribution of Western Hemlock in Washington*

*after Franklin-Dyrness

diversified and pleasant environment—at least for the foreseeable future.

We have, as a community of humans living in this environment, been remarkably profligate with our western hemlock community of plants, spending it or sacrificing it as if it would go on forever. It has probably seemed to most people that it did go on forever. Nevertheless, it doesn't. In urban communities it is preserved only in small morsels as parks. In the countryside around Seattle it is laid to waste daily to provide space for endless grass lawns and millions of square feet of houses and driveways and streets, shopping malls and highways and schools for the growing population in the Puget Sound area.

We must pause and think carefully what we are doing. For the western hemlock forest is not just a group of trees. It is a whole ecosystem, a complicated habitat for many living things, and nature's best invention for clothing the earth where we now live. Destroying a western hemlock forest involves much more than cutting trees, it involves the destruction of literally hundreds of species of living organisms.

PREHISTORICAL AND HISTORICAL BACKGROUND

Soils: All of the soils and topography of the park are glacial in origin. Mercer Island is a high spot left when glaciers gouged out the troughs of Lake Washington and Puget Sound. Soils are mineral and the result of great outwashes during the melting of the glaciers during the end of the epoch. Pioneer Park is built upon bedrock, hardpan and huge deposits of gravel and sand, with heavy clays on the side slopes. Over a long period of time, the litter of the trees and plants growing in the park have built a layer of organic soil on the top of the relatively bare and puny material beneath. The trees themselves hold precipitation, add shade and wind protection, and generally ameliorate the environment so that other plants, birds, animals and insects may survive amongst them.

The section on soils in this book gives a more complete picture of the kinds of soils involved here. The variety of vegetation in the

park is almost wholly dependent on the soils in which it grows.

Topography and hydrology: The park has a narrow range of height, from about 150 feet to 350 feet above sea level. This is, however, enough to give character and definition to the land, and to determine drainage and run-off patterns. The steepest slope is that which falls into the ravine, a slope estimated at 25 percent at its maximum. The year-around stream in the ravine is located at the bottom of this slope and is fed by small sidestreams and drainage along hardpan layers with water emerging as springs along the lower slopes.

Figure 2 shows the topographic features of Pioneer Park.

Climate and microclimates: Prevailing winds during much of the year come from the south or southwest in the Puget Sound area, thus the south or west sides of the park get the oncoming gales. The northwest section will show the most effect, having no protection across its south end from winds sweeping across the shopping area and parking lots. Summer winds are often from the north, but have little effect, and except for the rare occasion when a cold east wind blows, the east sides of the park are usually most protected. Interiors of the park are little affected by winds and a person walking about inside the park during a vigorous windstorm will feel little of the wind directly. Still, the tops of the trees are being buffeted about and may drop small limbs, so it is not always the safest spot to be under the circumstances.

The park will be most dry during the months of July, August, and early September, and in some years may exhibit symptoms of severe drought, with early yellowing of leaves on shrubs and drooping of small plants. Nevertheless, the native vegetation can easily withstand these summer droughts, having evolved under just such conditions. Under no circumstances should fire be allowed in the park, however, as dry shrubs and grasses could easily ignite and the fire get out of hand.

Topography influences the availability of sunlight to plants in the park. On a sunny summer day the potential insolation (sunlight received) on the south edge of a level section will be nearly three times that of a north-facing slope in the ravine. At the same time, streets and houses reflect and absorb much more heat from the sun

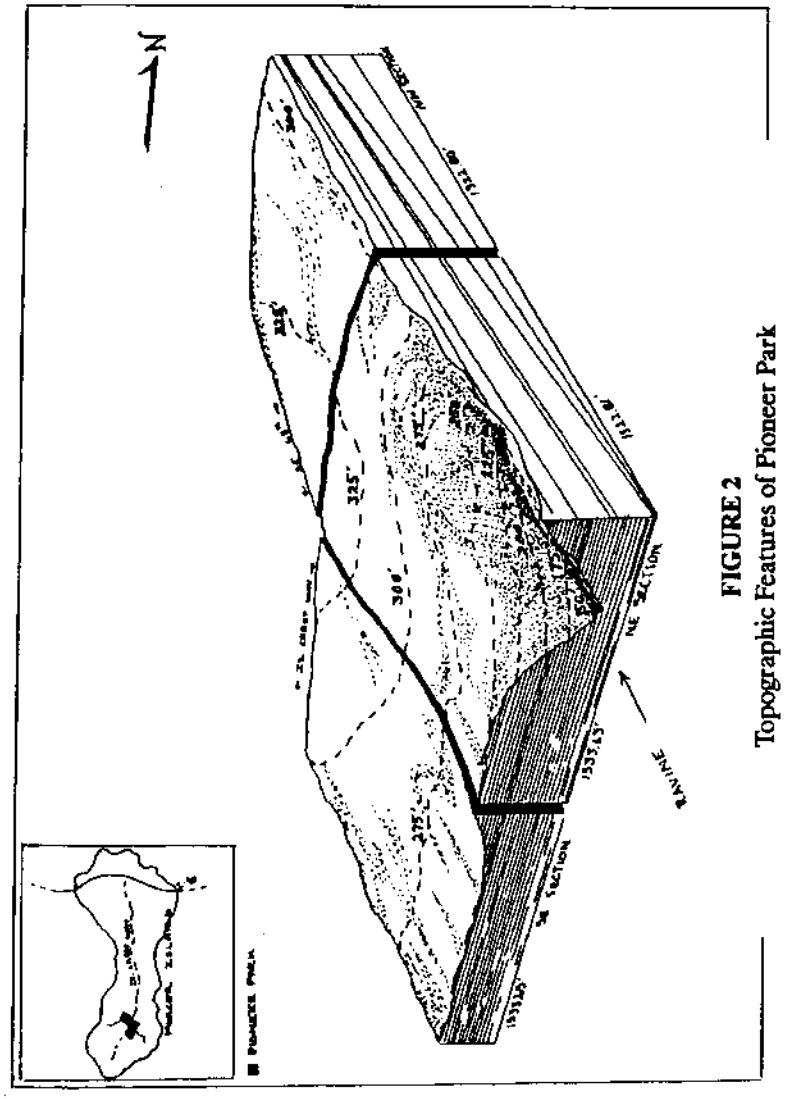


FIGURE 2
Topographic Features of Pioneer Park
showing generalized contour lines and approximate altitudes

and increase temperatures where these are close to the park.

It is possible to see in general how climatological patterns reinforce topographical and soil conditions and vice versa. The highest and driest soils are located where the most intense sunlight and strongest winds can be received (e.g., southwest corner of northeast section). Conversely, the wettest soils exist in those places where least evaporation by sunlight can take place, and where winds are generally much modified (e.g., interior northwest section). It is no surprise to find quite different associations of plants within these diversified environments of Pioneer Park.

Human Use: Up until about 75 years ago, the forest on Mercer Island was complete and mostly undisturbed. At that time, loggers began taking out the big firs and cedars and hemlocks that grew there. Large stumps, some with interesting little gardens growing out of their tops, some hidden by brush, are witness to the great trees that inhabited the park once. A very few relics from that original forest can still be found scattered throughout.

After logging, plant colonizers began to take over, probably the weedy species that we associate today with recently disturbed land that has not been planted or paved. Pockets of vegetation left were free to spread out roots and/or reseed themselves. Those remainders themselves went ahead through successional growth, probably out of phase with the rest of the newly developing woods. No doubt maples, alders, and possibly willows were the first trees to make an effective comeback. With their ameliorating shade and protection, conifers again reseeded.

The ensuing years were needed for the necessary plant succession and development so that the forest could replace itself to the point it has reached today. Since that logging activity and accompanying fire to burn slash, no consistent human activity has taken part in Pioneer Park except that of recreation.

If left to itself, the park will go on developing in a generally predictable "western hemlock climax forest" fashion. If not left to itself, it can be managed to exist in an arrested fashion by humans who selectively cut the oldest trees for more open space, selectively cut the smaller trees and shrubs to allow more vistas beneath the big

trees, or it can be clearcut. It is a certainty that the more artificial the vegetational pattern imposed by the community, the harder and more expensive it will be to maintain. (See Fig. 3)

Pioneer Park can be described as a historically determined, somewhat competitive but also mutually beneficial association of plant species which is evolving and dynamic; plant succession is directed toward an equilibrium which would be dominated by a tolerant climax association of species with the western hemlock, and, to some extent, the western red cedar as dominant trees, if no further disruption occurs.

PLANT COMMUNITIES AND PARK SECTIONS

Selecting representative plant communities: In general, the same plants are found in all three sections of the park. Simply dividing the acreage by criss-crossing streets has not cut plant communication between the sections. But the observant park user who will familiarize him- or herself will soon be convinced that there are quite distinct areas or communities within the park, in both general appearance and in actual content of plant species. There are six categories of environments that are easily identifiable: forest edges, interior forest (two types), slopes and hillsides, the ravine, and a catch-all category that can be called special areas. These communities are briefly described here and will be referred to when we look at each section of the park in detail. Figure 4, page 21, is a graphic representation of the seven separate communities identified here.

Forest Edges. Since the park is divided into three sections, there are 12 forest edges in the park. Four of them are bounded by streets and have mowed, grassy areas with clumps of trees and shrubs. Four have residences adjacent to their borders. The remaining four have streets alongside them but are not mowed. The interface between human civilization and nature is held by hardy species of plants—some of them often what we call weeds: dandelions, plantain, sorrel and thistle. The wooded edges of the park are subject to more severe weather conditions than the interior and thus are

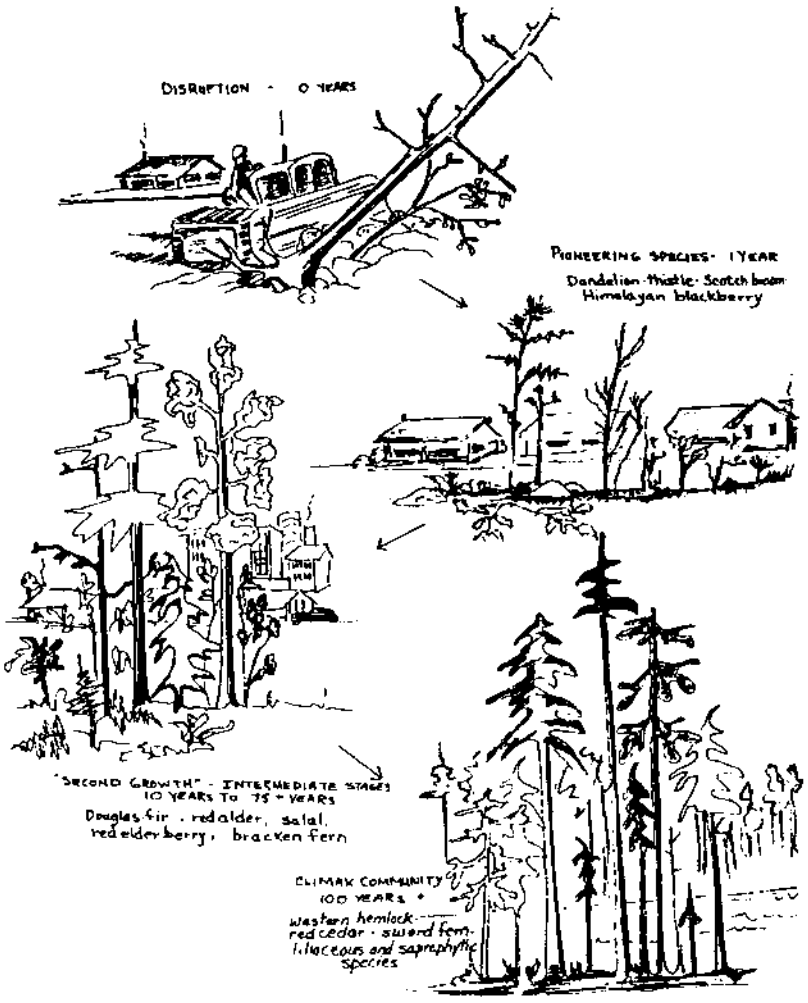


FIGURE 3
Diagram of Plant Succession Concept

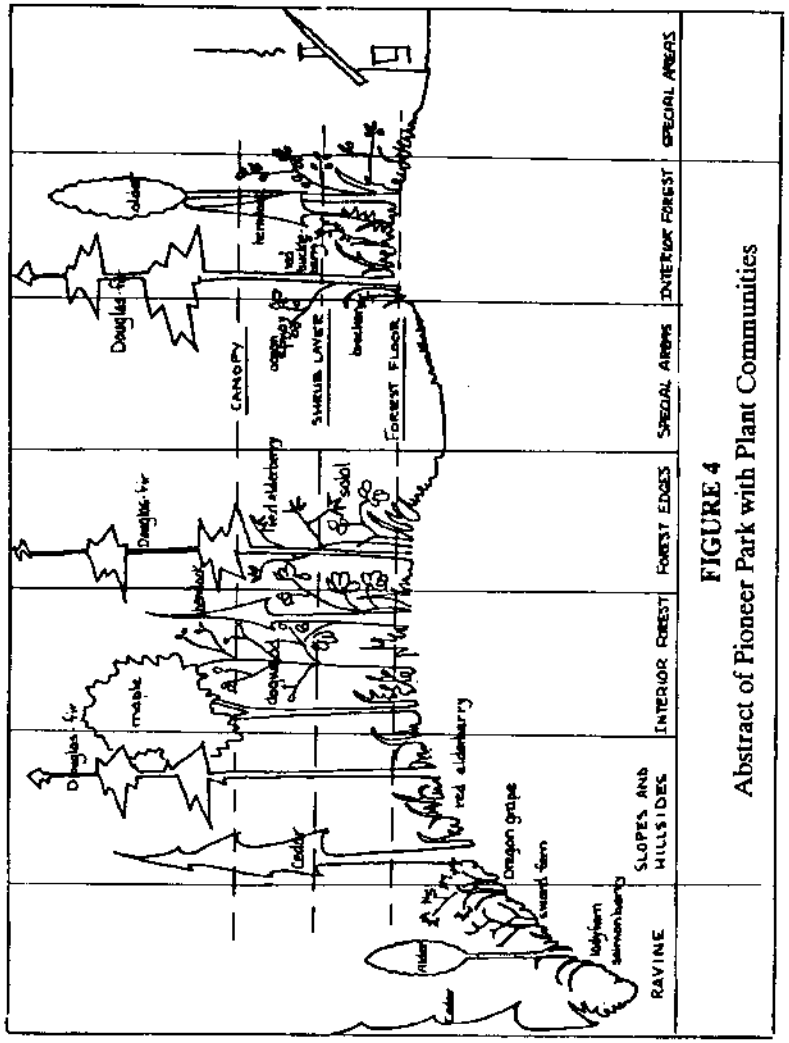


FIGURE 4
Abstract of Pioneer Park with Plant Communities

populated by the hardiest of the local species. On the whole, park edges are relatively dry and receive both more sun and more wind than the rest of the park. The most prevalent species are Douglas fir, bracken fern, and salal, all light-tolerant species of open or cut-over forests.

Figure 5 shows the tree and shrub species of the park edges in diagrammatic form.

Interior Forest, A. Except at the tops of the trees, direct sunlight is a rare commodity in the interior forest of Pioneer Park. Dappled light with little air disturbance except on the windiest days creates a mesic, or moderate, environment. Oregon grape and sword fern predominate on the forest floor. Layers of organic matter cover the soil, rotting remnants of down trees provide a moist protective mulch for the resident species. Red huckleberry reseeds itself on horizontal logs, while ferns, mosses, young trees and salal grow out of stumps. Red elderberry keeps its own company in scattered clumps and the omnipresent trailing blackberry climbs over all.

Many variations can be expected in this type of plant association, which is perhaps most widespread and can be found in all three sections of the park. The Northwest Section is most representative.

The Northwest Section is probably more homogeneous in character than the other two sections. The soil is much the same throughout, altitude varies only slightly, and no real water courses can be found. Plants change in species most from the outside edge to the center and, to a small extent, from south to north.

The peripheral trail along the four sides of this section takes the hiker or horseback rider through a great deal of tall, shrubby vegetation, with elderberry, blackberry, salmonberry, hazelnut, and blackcap noticeable. These are all food-bearing bushes and vines, providing nourishment for a number of birds.

Open spots off the main trails toward the middle of the section make ideal habitat for nettles, but also allow fine vistas of old moss-covered maples and drooping hemlocks.

Occasionally the close observer can find an unexpected patch or remnant of vegetation which stands out as being unique to the park. Such a spot might be filled with ginger root, a fine and unusual

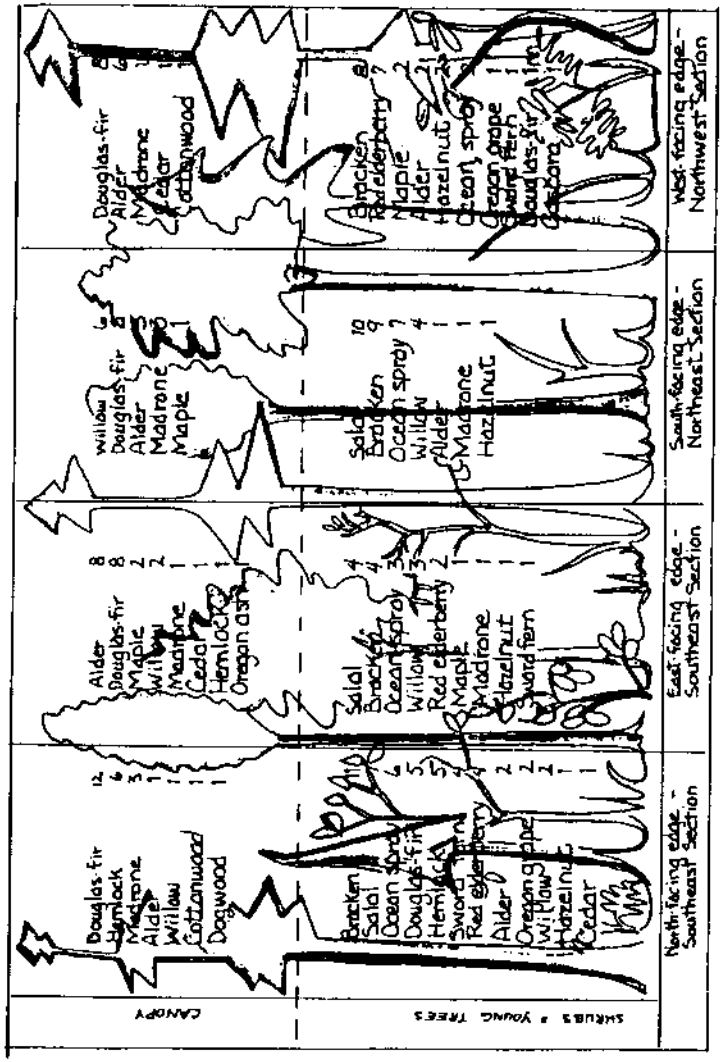


FIGURE 5

Tree and Shrub Species of Pioneer Park Edges

sampled at 50-ft intervals: numbers refer to frequency of occurrence in total samples for each edge

ground cover with a hidden dark purple flower. Other areas along the trails here are outstanding because of their particularly pleasant combination of species seen in bloom together, as a small patch of yellow violets with spring beauty and starflower, or large trillium and vanilla leaf in profuse company. A good walk for seeing changing vegetational patterns is down the central north-south trail.

Interior Forest, B. Found primarily on the relatively high plateau area of the Northeast Section, this type of interior forest is drier than type A. The soil, not the weather, creates this dryness. There is a high sand content to the soil, which creates a fast-draining and low-fertility growing environment. Madrona, honeysuckle, ocean spray, dogwood and wild rose grow here as well as bracken, trailing blackberry, salal, willow and Douglas fir.

In the southwest corner of this section a typical ocean spray–salal association exists, which indicates the driest subcommunity in the hemlock forest zone. Intermixed are trailing blackberry, wild rose and bracken. The character of the area changes as the topography slants north and west. Dogwood, willow, madrona, and Douglas fir are growing here but rather untypically far apart. Shallow-rooting herbaceous species such as bedstraw, sweet cicely and stinging nettle show the existence of surface moisture.

If one is able to make a way through the salal from SE 68th St., one can immediately notice the unusual aspect of this dry area. However, it is notable for its changing face over the past few years. A shadier and fuller canopy of trees and more organic matter added to the soil over those years have begun to give sustenance to more plants, and the existing ones are growing or modifying to adapt. See Fig. 6, page 25, for characteristic species.

Slopes and Hillsides. Those mostly east-facing areas of woods in the park which have a distinctive slope are similar to interior Forest A at the top and intergrade with the Ravine environment at the bottom; thus, characteristics of both can be found in this intermediate area. The eastern aspect, however, increases the amount of solar radiation received in the morning and during winter months when the sun's angle is low. At the same time, of course, insolation received at other times of day is less than in the rest of the

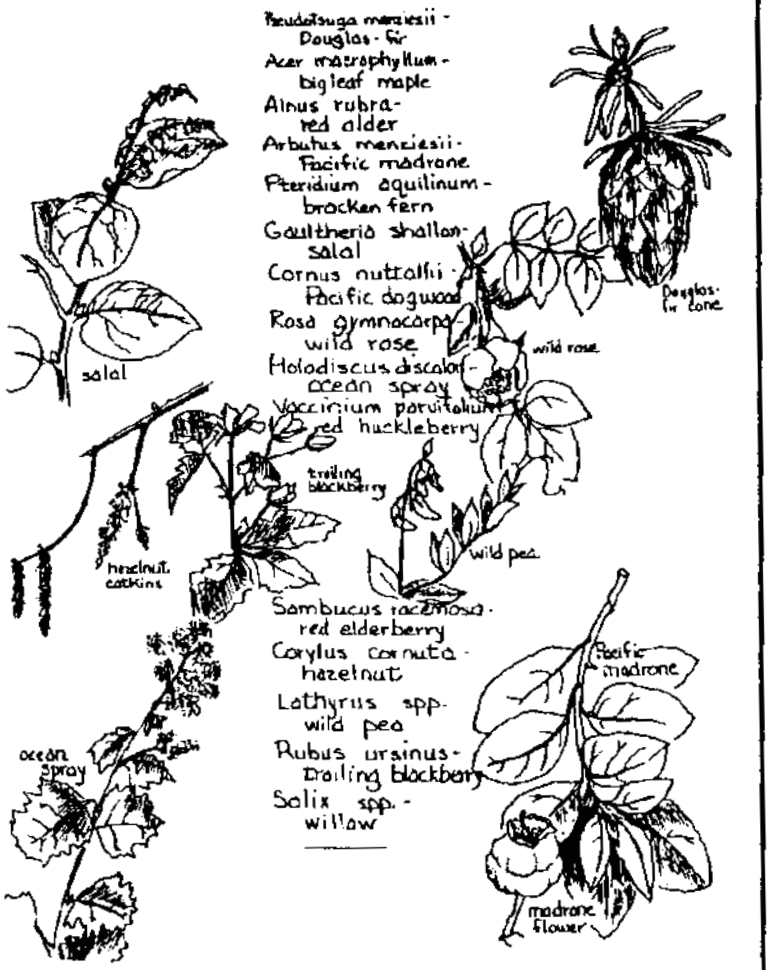


FIGURE 6
Characteristic Species of Interior Forest

park. Where the slope is more north than east there may be times of year when no direct sunlight is received. Winds will rarely be of sufficient force or of the right direction to influence the park slopes. Soils are not well consolidated on steeper slopes, probably containing progressively more organic matter as they decrease in altitude, and are usually moist.

Sword fern, shield fern, Oregon grape, hemlock, maple, Douglas–fir and cedar are dominant species, but it is difficult to characterize this area as a separate entity—it is varied and especially subject to local conditions.

Some characteristic plant species of Slopes and Hillsides: *Acer macrophyllum* (bigleaf maple), *Berberis nervosa* (Oregon grape), *Dryopteris austriaca* (shield fern), *Gaultheria shallon* (salal), *Polystichum munitum* (sword fern), *Pseudotsuga menziesii* (Douglas fir), *Rubus ursinus* (trailing blackberry), *Sambucus racemosa* (red elderberry), *Thuja plicata* (western redcedar), *Trientalis latifolia* (starflower), *Tsuga heterophylla* (western hemlock), *Vaccinium parvifolium* (red huckleberry).

Ravine. Generally speaking, the ravine environment is equable, relatively windless and cool year around. The small stream originates from many seeps and springs arising from the hardpan and clay layers of soil on the slopes above and its average temperature is that of the average soil temperature (probably 50 to 60 degrees). Plants are not subjected to stress conditions, unless excess moisture or flooding should cause some disturbance. The trees on the higher flats allow a gradual release of precipitation so that run-off is easily contained, and the stream is often running even in the driest part of the year. Plants are those which tolerate or enjoy wet conditions: skunk cabbage, devil's club, lady fern, salmonberry. Rushes, horsetail and alder follow the stream course and deer fern and maidenhair fern can be found. Huge old cedar stumps indicate the dominant species here before logging and point the way to what can be expected if the ravine is left to its natural evolution.There are some cedars and hemlocks that exceed 100 years of age in this area, which may indicate earlier or more sporadic logging in that part of today's park.

The ravine contains several plant species that are absent from or

more scarce in the other sections of the park, including enchanter's nightshade, youth-on-age, mitrewort. Nurse logs across the ravine slopes provide nurseries for young cedars, hemlocks, masses of trilliums, foamflower and vanilla leaf. Notably absent are dry-site species such as ocean spray, native rose, madrone and honeysuckle. Large concentrations of moisture-loving lady fern can be found near the bottom of the slope, Oregon grape is located mostly near the upper slopes, and sword fern is scattered throughout. These three make up about half of the total number of plants in the ravine environment.

Some notable species of the Ravine: *Adiantum pedatum* (maidenhair fern), *Athyrium filix-femina* (lady fern), *Epilobium watsonii* (willow herb), *Equisetum arvense* (horsetail), *Linnaea borealis* (twinflower), *Lysichitum americanum* (skunk cabbage), *Mitella caulescens* (mitrewort), *Oplopanax horridum* (devil's club), *Polypodium glycyrrhiza* (licorice fern), *Tiarella trifoliata* (foam flower), *Tolmiea menziesii* (youth-on-age), and *Typha/Juncus* (rushes/sedges).

Special Areas. The special-area section covers atypical small areas that cannot be easily incorporated in other types.These include:

1. Southeast Section, north-central portion, where there is an unusually dark, wooded patch. Ground cover is sparse to nonexistent.

2. Tree clumps along the edges of the park on Island Crest Way and the Northwest Section on S.E. 68th give an interesting and pleasing savannah effect to the grassy edges. Some of the clumps are quite small with only a tree and a few attendant undergrowth species; others are quite large outriding representatives of the main woods.

3. Grass boundaries and residential areas are or strongly resemble private lawns. Here and elsewhere, the legions of "lawn weeds" invade the park and add many new species that would not otherwise be found—whether we like them or not. There is varying use of these park edges by homeowners when they deposit their lawn clippings, bush and tree prunings, etc., and where children cut vegetation, dig pits, climb trees. It is possible to find an occasional exotic bush or clump of domesticated flowers thriving amongst the natives here.

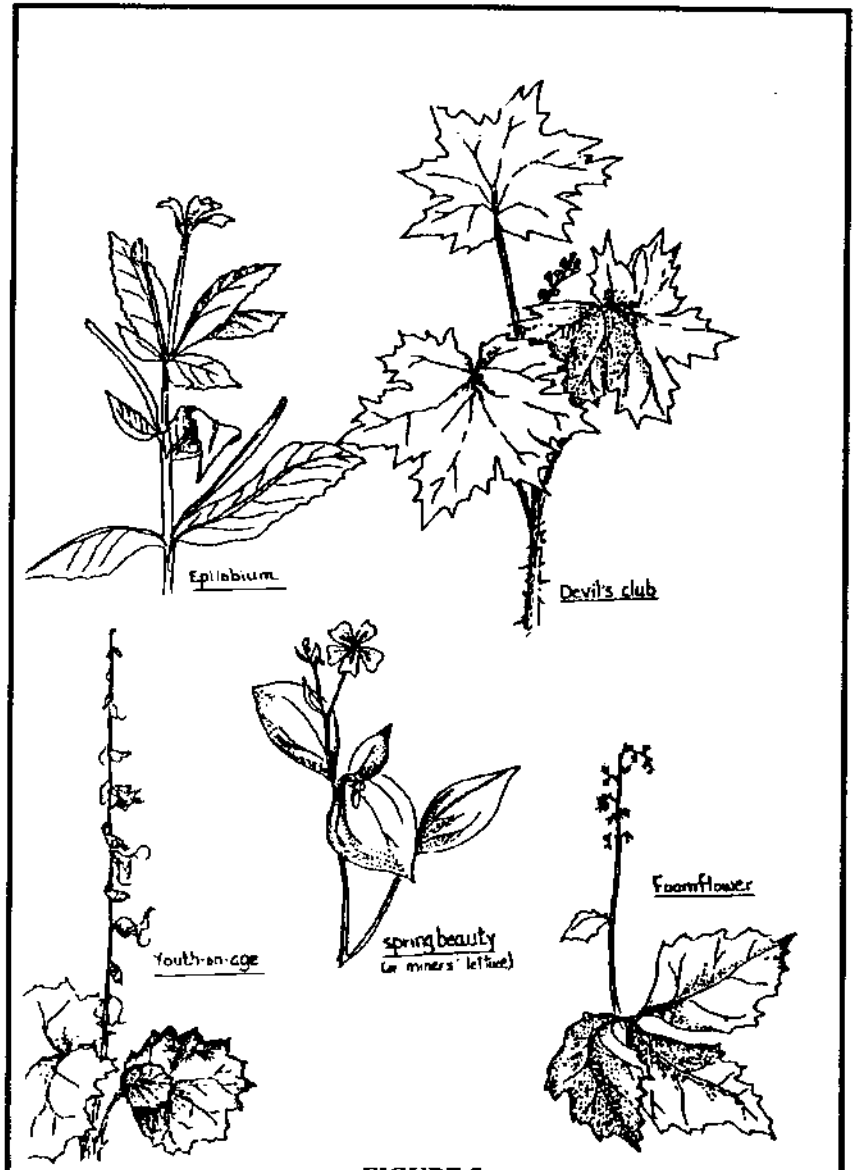


FIGURE 7
Some Typical Plant Species of Lower Hillsides and Ravine

FIGURE 8
Sketch of Residual Tree Clumps

FIGURE 9
Typical Weed and Lawn Species Found Along Grass Boundaries

SPECIES LIST
PIONEER PARK PLANT COMMUNITIES

Acer macrophyllum	bigleaf maple
Acer circinatum	vine maple
Achlys triphylla	vanilla leaf
Adiantum pedatum	maidenhair fern
Alnus rubra	red alder
Anaphalis margaratacea	pearly everlasting
Arbutus menziesii	Pacific madrone
Asarum caudatum	ginger root
Athyrium filix-femina	ladyfern
Bellis perennis	English daisy
Berberis (Mahonia) nervosa	Oregon grape
Blechnum spicant	deer fern
Cardamine oligosperma	bittercress
Cerastium viscosum	mouse-ear chickweed
Circaea alpina	enchanter's nightshade
Cirsium arvense	Canada thistle
Cirsium vulgare	bull thistle
Corallorhiza maculata	spotted coralroot
Cornus nuttallii	Pacific dogwood
Cornus stolonifera	red osier dogwood
Corylus cornuta	hazelnut
Crataegus oxyacantha	English hawthorne
Cytisus scoparium	Scotchbroom
Digitalis purpurea	foxglove
Dryopteris austriaca	spiney shieldfern
Epilobium angustifolium	fireweed
Epilobium watsonii	willow weed
Equisetum arvense	horsetail
Fraxinus oregana	Oregon ash
Galium aparine	bedstraw
Galium triflorum	bedstraw
Gaultheria shallon	salal

Geranium columbinum	crane's bill
Geum macrophyllum	bigleaved avens
Gnaphalium uliginosum	cudweed
Hedera helix	English ivy
Holodiscus discolor	ocean spray
Hypochaeris radicata	hairy cat's ear
Ilex spp.	holly
Juncus spp.	rush
Lapsana communis	Lapsana
Lathyrus spp. (2)	wild pea
Linnaea borealis	twinflower
Lonicera ciliosa	red honeysuckle
Lonicera hispidula	pink honeysuckle
Lotus micranthus	slender trefoil
Lychnis alba	white campion
Lysichitum americanum	skunk cabbage
Montia sibirica	spring beauty
Mitella caulescens	mitrewort
Nemophila parviflora	no common name
Oplopanax horridum	devil's club
Osmaronia cerasiformis	Indian plum
Osmorhiza chilensis	sweet cicely
Osmorhiza purpurea	sweet cicely
Philadelphia lewisii	mock orange
Plantago lanceolata	plantain
Plantago major	common plantain
Polystichum munitum	sword fern
Polypodium glycyrrhiza	licorice fern
Populus trichocarpa	black cottonwood
Prunus emarginata	bitter cherry
Prunus virginiana?	chokecherry?
Pseudotsuga menziesii	Douglas fir
Pteridium aquilinum	bracken fern
Ranunculus repens	creeping buttercup
Ranunculus uncinatus	buttercup
Rhamnus purshiana	cascara

Ribes spp.	currant
Rosa gymnocarpa	wild rose
Rubus laciniatus	evergreen blackberry
Rubus leucodermis	blackcap
Rubus parviflorus	thimbleberry
Rubus procerus	Himalayan blackberry
Rubus spectabilis	salmonberry
Rubus ursinus	trailing blackberry
Rumex acetosella	red sorrel
Rumex obtusifolius	sorrel
Salix spp. (2)	willow
Sambucus racemosa	red elderberry
Senecio vulgaris	senecio
Sisymbrium officinale	hedge mustard
Smilacina stellata	star-flowered false Solomon's seal
Solanum dulcamara	bittersweet nightshade
Solidago missouriensis	goldenrod
Sonchus uliginosus	sow thistle
Sorbus aucuparia	mountain ash
Spirea douglasii	hardhack
Stachys cooleyae	hedge nettle
Stellaria media	chickweed
Symphoricarpos albus	snowberry
Tanacetum vulgare	tansy
Taraxacum officinale	dandelion
Taxus brevifolia	western yew
Tellima grandiflorum	large-flowered fringecup
Thuja plicata	western redcedar
Tiarella trifoliata	foam flower
Tomiea menziesii	youth-on-age
Trifolium dubium	clover
Trifolium pratense	clover
Trifolium repens	clover
Tsuga heterophylla	western hemlock
Trientalis latifolia	starflower
Trillium ovatum	trillium

Typha spp.	cattail
Urtica dioica	stinging nettle
Vaccinium ovatum	red huckleberry
Vaccinium parvifolium	evergreen huckleberry
Veronica americana	speedwell
Viola sempervirens	evergreen violet

(There are 112 species of flowering plants, ferns, trees and shrubs in Pioneer Park.) * Taken from the 1972 complete species survey.

HYPOTHETICAL SPECIES:

(These plants occur elsewhere in open and wooded areas of south Mercer Island and are potential residents of Pioneer Park.)

Abies grandis	grand fir
Amelanchier alnifolia	serviceberry
Capsella bursa-pastoris	shepherd's purse
Chrysanthemum leucanthemum	oxeye daisy
Collomia heterophylla	no common name
Crataegus douglasii	black hawthorn
Euphorbia cyparissias	euphorbia
Fragaria vesca	wild strawberry
Lunaria annua	coin plant, honesty
Lupinus rivularis	lupine
Maianthemum dilatatum	false lily of the valley
Matricaria matricarioides	pineapple weed
Pyrus fusca	western crabapple
Ribes sanguineum	red-flowering currant
Smilacina racemosa	false Solomon's seal
Spergularia rubra	spurge
Streptopus amplexifolius	twisted stalk
Vinca major	periwinkle

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MUSHROOMS – A PIONEER PARK PRIMER

by Ethel M. Dassow

Our 120-acre Pioneer Park could be adapted to uses that would change its character forever, but as a forager's paradise it's admirably adapted just as it is. Nettles and dock, fireweed and fiddleheads in spring, berries in summer and fall, mushrooms . . .

Ah, yes! Let us consider mushrooms.

First, I should say that this isn't going to be a field guide. Mycologists write those. They're the botanists who specialize in the study of mushrooms and other fungi. I'm a mycophogist. That's Greek/Latin for pothunter. We gather for the cooking pot—and as much, perhaps, for an excuse to get out into the woods and the meadows, see what goes on out there, meet some of the species that share our planet.

No one could ever say for sure how many mushroom species grow in Pioneer Park, nor anywhere else, for that matter. Several thousand are known worldwide, and mycologists keep turning up more. Mutations? Crosses? Species that had so far escaped notice? Who knows? Some species are so big, or colorful, or both that you couldn't miss them. Some are so inconspicuous you have to look hard to find them. Some, in fact, live their entire life cycles underground and are found, if at all, by a swelling of the earth or by odor. Some are so short-lived that they can grow and go while your back is turned. Others are so durable you can take them home and use them for decorations.

All mushrooms get a bad press because a few species are toxic—so toxic that a mere taste could kill you. A larger few could make you sick, but wouldn't necessarily do you in. Most species probably wouldn't hurt you, but because of their looks, odor, texture and/or taste you wouldn't care to eat them. A few, maybe four or five dozen, are safe and appetizing. Those are the ones that grab the pothunter's attention.

Notes for the Novice

The quickest way to become a successful pothunter is to go hunting with an expert, not once but several times, in several areas,

and pay strict attention to what he says and does. But if there's no willing expert available, don't give up! Get a good field guide, preferably one written by a Northwest mycologist, and do some homework. You'll learn some things that may surprise you, such as:

Popular usage notwithstanding, edible and poisonous mushrooms are not differentiated as mushrooms and toadstools, respectively. The words are synonymous.

No simple, foolproof test will show you whether or not a mushroom is toxic. Nor is there any known way to render a toxic mushroom harmless. To believe otherwise could be fatal.

All mushrooms are fungi. They have no chlorophyll so they can't manufacture their own food by photosynthesis, as higher plants do, and they don't need light. They do need moisture and a food supply.

Most species are saprophytes. They recycle organic leftovers (if humus, they're terrestrial; if wood, lignicolous), and help reduce them again to soil. A few species (*Armillaria mellea*, the honey mushroom, for one) are parasites. They feed on living organisms, usually trees, and can eventually kill them.

Most of the mushroom plant is an extensive mycelium network under the ground or in the host body (wood, living or dead). When the mycelium develops to the point of reproduction, which may take as long as a decade, and when temperature, moisture and who-knows-what other conditions are right, the fruiting bodies emerge. These are the spore-producing (reproductive) parts of the plant, usually the only visible evidence of its existence and identity. They're also the parts we pothunters seek. So do squirrels, deer, elk, and no doubt other animals.

As I said, the fruiting bodies of some species don't emerge. They're the truffles, relatives of the puffballs. Even mycologists thought until recently that truffles didn't grow in North America. Now I'm hearing that they do, after all, so I suppose we'll start training pigs and breeding truffle hounds to smell them out for us, as they've long done in Europe.

The spore-bearing systems of the fruiting bodies divide mushrooms into *Basidiomycetes* (spores on club-shaped organs called *basidia*) and *Ascomycetes* (spores in minute sacs called *asci* [singular, *ascus*]), and subdivides them into gilled, pored, toothed or other.

Gilled mushrooms (*Agaricales*) bear spores on a series of platelike

extensions under the cap, called gills, which radiate from the stipe (stem) like spokes of a wheel. The thickness and spacing of the gills and their relationship to the stipe are important clues to identity.

Pore mushrooms, *Boletaceae* and *Polyporales*, have spongy tissue under the cap, perforated by tiny holes (pores), which excrete the spores. The character of this tissue—texture, resilience, color and change of color where bruised—is a visual aid to identification.

Never mind, for now, about the "toothed" and "other."

Mushroom spores are microscopic and multitudinous—millions to the fruiting body—and their color in the aggregate is a clue to identity. So are their structures and reactions to various chemicals, but let's leave the lab work to the mycologists.

Spores travel great distances on air currents and insects, on or in the digestive tracts of birds and mammals, on clothing. (How did those truffles get their spores out of the ground and across the North Atlantic? Darned if I know!) When spores come to rest in a suitable habitat, they'll settle in and start establishing mycelia. Presumably spores aren't needed to "re-seed" the immediate area, as the parent mycelium does that so long as the food supply lasts and other conditions are suitable. It seems prudent, however, to leave over-age specimens on the ground (you wouldn't take home tired lettuce or rotten potatoes, would you?) and leave the habitat as little disturbed as you can.

Those Tongue-Twister Names

Those multi-syllable Latin names, though troublesome to most of us, are to clarify, not confuse. Popular names vary from region to region, language to language. Scientific names are the same from Stockholm to San Francisco, Nova Scotia to New Zealand.

True, as mycology becomes more refined and species classification more precise, the old Friesian nomenclature is being superseded by a modern system. It's confusing to a novice collector when, for example, he finds the tasty blewitt designated *Tricholoma peronatum* in one text and *Lepista nude* in a more recent source. But that's nothing to the confusion that would arise if mushroom buffs, be they mycologists or pothunters, tried to communicate without scientific names for genera and species.

Besides, relatively few of the known species are of enough interest to the pothunter to have popular names.

How Toxic Is Toxic?

Mycologists, who write the handbooks, know very well what poisons lurk in the species known to be deadly, or even mildly toxic. Nonetheless they pay strict attention to any reports of illness or death associated with mushrooms. Maybe the mushrooms were innocent. In one widely publicized case in western Oregon awhile back, autopsy proved that carbon monoxide was the culprit. More often a bad reaction comes from individual sensitivity to a particular species. Name almost any food, and someone's sensitive to it! No one's likely to blame such well-known and well-liked species as *Cantharelles cibarius*, or *Boletus edulis*, or *Morchella esculente* (yellow chanterelles, king boletes, morels), but the suspect species may not be well-known, or the case may be one of mistaken identity. As mycologists are most cautious when lives may be at risk, the bad reaction will be dutifully translated to "doubtful" or "not recommended" in the next editions of the field guides. To ignore those warnings is to live dangerously.

If mycologists call a species toxic, don't try it unless you're tired of living.

If you must try a doubtful species, eat a very small amount and wait twenty-four hours. That's how long it takes some of the deadly toxins to act. If you're still healthy and curious, try a little more. Don't let a mouth-watering taste beguile you into rushing things. The most deadly of all mushrooms are said to be indescribably delicious. I wouldn't know first-hand, but if I'm ever asked what I want for my last meal on earth, I'll say *Amanita verna* or *A. phalloides* (destroying angel, death cup), and maybe I'll find out.

Meanwhile, though some amanitas are designated edible and choice, I can do without them all. Too many pothunters have become past tense because they *thought* they could tell the safe from the lethal.

Still speaking of amanitas: Never, but never add a white mushroom to your collection before you've checked to see whether its stem issues from a cup (volva). It may be eight or ten inches beneath the surface of the ground, but if it's there, shun that mushroom.

Controlled Growing

Why not capture some spores and grow your own guaranteed-safe mushrooms? Well, lots of people have tried, and they'll keep on trying, but not many species cooperate. The most dependable so far is *Agaricus campestris*, the meadow mushroom. Its variants *bisporus* and *alba* are grown and sold in great quantities. Whereas the yield of other crops is usually reckoned in tons to the acre, the yield of commercial mushrooms is reckoned in pounds per square foot and ranges from 2.5 under benign neglect to 7.35 under TLC.

There's a lot to be said for store-bought mushrooms, if you don't know what's out there in the fields and woods. I'm reminded of a verse-or-worse the tooth fairy whispered to me one night in my sleep:

> "We used to esteem *A. bisporus*
> Commercially grown and picked for us.
> Now we've found *Cantharelles*,
> *Boletes* and *Morchellas*,
> And now *A. bisporus* just bore us."

How to Get Started

Obviously we don't become successful pothunters by gathering some specimens, looking them up in our field guide, and cooking the "good ones" for dinner. Some species are readily recognized from the book's color photos and descriptions—*Cantharelles ciberius, Coprinus comatus, Morchella esculente, Sparassis radicata, Laetiporus sulphurous* (read that yellow chanterelles, shaggymanes, morels, cauliflower mushroom, sulphur shelf or chicken-of-the-woods). For others we need to determine spore color. To do that, simply break off a piece of the cap, lay it on a piece of paper—white if you expect dark spores, dark if you expect light, both if you don't know what to expect—cover it with a drinking glass and wait. In an hour or so you should have a spore print the size and shape of the cap scrap.

We need to recognize odors, structural characteristics, reactions to handling, in some cases association with other plants (mycorrhiza), and perhaps examine specimens from several different areas so

consistent species characteristics emerge from the extraneous intraspecific variations. It also helps to know what sort of habitat each species seems to prefer, so we'll have some idea where to look for what we want most.

We need a good knife (I carry a small hunting knife in a sheath on my belt), and a hand cultivator for an arm extension, the handles of both wrapped with red tape so they're easier to keep track of. We'll need things to carry things in. I like old flannel heating-pad covers, fuzzy side inside so some of the inevitable forest duff sticks to the flannel instead of the mushroom. Plastic bags aren't so good for mushrooms; they need to breathe, but I take a few produce bags along. You never know what you'll find out there—if only trash that some slob left behind. I also wear a whistle on a lanyard around my neck. Helps keep track of your partner, if you have one, and helps someone find you if you should get lost or hurt. (I haven't yet, but there could be a first time.)

So Let's Go Pothunting

Let's start with the southeast section of Pioneer Park. It varies in slope, residual moisture, forest growth and ground cover, and contains an old burn. Such a variety of habitat should support a variety of species, and here it does. On one short foray into this section, on a drizzly autumn day years ago, I found twenty-seven species. Those I could positively identify, some with help from a mycologist, are included in the species list that follows. A couple of weeks earlier, or later, and I might have found as many species with few duplicates.

The northwest section, being fairly level and moist and supporting much the same trees and ground cover throughout, should support the same relatively few mushroom species. My experiences there suggest that it does.

To the pothunter the northeast section is by far the most exciting of the three. The variety of habitat is greater, the number of species I've found there is in proportion, and (perhaps by happenstance), I've found more of the edible-and-choice species there than in the other two sections combined.

The grass borders between the woods and the roads, converging on S.E. 68th and Island Crest Way, look enough alike that you'd

expect them to yield the same mushroom species, but they don't—not while I'm looking, anyway. On the west side of Island Crest, scattered through the grass and in the islands of trees, I've found huge specimens of *Russula xerampelina* (purple-capped russula), several common species of *Boletus* and *Suillus*, and my first specimens of *Suillus caerulesens* and *Russula pelagonium*. The mowed strip east of Island Crest produces a few boletes and russulas, but quantities of *Lycoperdon perlatum* and *L. pyriforme* (round and pear-shaped puffballs), some small, uninteresting "scrap" species and, close to the corner, from mid-autumn through a mild winter, a widespread growth of *Amanita pantherina* (Panther amanita—pale to dark brown cap with white veil remnants called warts). This species also grows abundantly in the southeast section, mostly within a hundred yards of the corner, and as it's quite capable of doing you in, better learn to recognize and avoid it.

Not so incidentally, some of those little brown "scrap" mushrooms, the *Galerina autumnalis* and *G. venenata*, are hallucinogenic and they contain deadly amatoxins. A tiny bit could send you on a trip. A tiny bit more, and it'll be a one-way trip.

Boletes and russulas grow in the tree-islands and grass bordering the southeast section, puffballs grow in the grass, and only there (within the park) have I found *Coprinus comatus*, the coveted shaggymane. Usually there'll be one here, one there, but once I came upon a near-solid circle some ten feet across of prime shaggymanes! I gathered gleefully, greedily, filled everything I had along, went after more things to fill, and gloated as I took them home. But shaggymanes are autodigestive. They'll turn into a puddle of black ink by tomorrow afternoon, so my loot had to be eaten or preserved within hours. I gave some away. I served some for dinner. Even so, I had about six hundred shaggymanes to clean, saute and freeze, and long before I'd finished I was hoping I would never be so lucky again!

Where To Find The Experts

One mycologist, I'm told, collects and consumes two hundred and fifty different species! I'll bet that includes some that wouldn't whet my appetite one bit. When you can recognize fifty to sixty species without checking a field guide, and can eat fifteen or twenty in safety,

with pleasure, you've achieved respectable pothunter status. You can speed up the learning process by going to the experts. There's usually one in the botany department at the University of Washington. Or join the Puget Sound Mycology Society, attend the meetings and the annual exhibits, go on the field trips. You will be welcomed. There'll be labeled specimens for hands-on study, experts to identify specimens and show you why they are, or aren't, what you thought you had. The experts care about mushrooms and mushroom gatherers. They're generous with their knowledge and patient with the novice.

Just don't expect the experts to tell you exactly where to look for the choice edible species. They don't want competition on their favorite gathering grounds, and you won't, either, after you've prospected and found productive places.

When the first edition of this book was in preparation, I was strongly tempted to leave some of my favorites off the species list. Why encourage competition? Let'em do their own bush-whacking. But I had agreed to write what I knew, and so I did.

Sure enough, shortly after the book was published I went into the northeast section of the park, my taste buds tingling at the thought of blewitts for dinner. Out of the woods swarmed six or eight of my 'teenage friends, calling, "You're the very person we want to see! Do we have what we think we have?" and each showed me a mouth-watering collection of prime blewitts. Though I'll admit to a fleeting moment of disappointment, I was pleased. Those youngsters were putting the park to constructive use, and using our book to do it! I congratulated them and went off to see what else I could find.

After all, we foragers aren't competing for food, per se. The calories in mushrooms—about ninety to the pound (not gram, pound!) wouldn't fuel anyone for long. True, they're loaded with vitamins and minerals, so they could help to keep you healthy if you're lost in the woods—but in that case you'd better know what else Nature offers you to eat.

We pothunters are primarily interested in tastes, and among the dozens of mushroom species accorded choice status in this country, there's a wide variety of delicious flavors. And by gathering when they're in season and using the methods of preservation best suited to each species, we can please our palates every day of the year.

We could also impress our friends with our exotic cuisine, though I seldom try that. Some people have such a powerful prejudice against wild mushrooms that the thought of eating one would make them sick. Maybe they'd think it wonderful if I didn't tell them what it was, but then I'd be guilty of deception. And if anyone were to get sick after eating mushrooms at my table, I and my mushrooms would get blamed no matter what the real cause of the malaise. So why take a chance? And why waste fabulous food on someone who can't or won't enjoy it?

Some foragers gather (not, I think, in Pioneer Park) for wholesalers who ship to gourmet markets on the East Coast and in Europe. I frown on that, but it's their right to do so.

Some collect for mycologists who can't take time from their lab work and teaching. Theirs is a relatively young science with information gaps still to be filled. Even I once found a specimen that had never been classified. It didn't happen in Pioneer Park, but it easily could have and someday it may.

Some collect for medical researchers. Consider how many of our pain-relieving and life-saving medicines come from fungi. How many more cures are out there, waiting to be found? Maybe some Mercer Island student, out in Pioneer Park working on a botany assignment, or some housewife out for exercise, will come up with a mushroom that can cure cancer, or arteriosclerosis, or AIDS. It could happen. Who's to say it won't?

Whatever our immediate motive when we go out collecting, I think we foragers are out there for the same fundamental reason. We're following a primitive instinct, gratifying an atavistic urge. We were gatherers before we were herdsmen and farmers, before agribusinesses and supermarkets. We can't go back—not now that we've proliferated into the billions and altered much of the environment to suit our needs and our whims—and who wants to go back?

But the instinct is still strong in some of us, and when we can take advantage of what Nature produces, harvest her annually renewed resources, we feel a little less dependent upon technology, a little more in control of our lives.

Acknowledgments

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Thanks, also, to my husband, John, who is permissive if not enthusiastic about my "mushroom hang-up," and to my daughter, Laura Walls, who helps me collect, identify and clean mushrooms, draws them, and addresses my culinary creations with an unprejudiced palate.

Species List

All of the species listed here, I have found in Pioneer Park and identified, with some help of experts. I've found but failed to make positive identification of at least as many, and no doubt there are still others that I've failed to find. [A hundred and twenty acres is a lot of ground to cover.] Maybe the same species will fruit at the same times and places next year, and the next, or maybe they won't. Mushrooms follow their own rules, rules that vary with the species. We can't predict their behavior with certainty because we don't yet know all their rules. But trying to second-guess the fungi is part of the pothunter's fun.

Former names of genera and species are in parentheses.

Agaricus silvicola—isolated specimens in undergrowth, NE section.

Aleuria aurantia—orange fairy cup, SE section, usually in lately disturbed earth. Look like scattered mandarin orange peelings. Nibble on'em, raw.

Amanita gemmata—jonquil amanita. Isolated specimens, SE section. Typical amanita form, yellow with white "warts." Beautiful but deadly.

Amanita pantherina—panther amanita. Northwest kin to *A. muscaria*, the deadly fly amanita. Typical form (see drawing), pale to dark brown with white warts. Very young specimens could be mistaken for puffballs, so check for volva (cup) at base of stem. Prolific in NE and SE sections, near corner. Toxic.

Armillariella (*Armillaria*) *mellea*—honey mushroom. Abundant in NE section, on north-south trail closest to Island Crest Way, and in ravine. Also in SE section. In dense clusters, on wood. Parasitic.

Cantharelles clavatus—pig's ears, NE section. Typical chanterelle shape but in dense purple-brown clusters. Tasty.

Clytocybe nebularis—graycap.

Coprinus artramentarius—inky cap. Scattered clusters throughout. Autodigesting. Turns to a puddle of black "ink" but more slowly than *C. comatus*. Delicious, but incompatible with alcohol.

C. comatus—shaggymane. White with some grayish-brownish, hairy scales, pink gills, 2 inches to 2 feet tall (see drawing). Autodigest-

ing. Sometimes prolific in grass strip of SE section. Delicious.

C. micaceus—another of the "inky cap" group. Fragile, brittle, has golden glint; small but abundant in NE and SE sections, woods and grass. Tasty.

Crucibulum vulgare—bird's nest fungus. Grows on dead wood, all sections. Not strictly a mushroom, but fun to find.

Dacrymyces palmatus—orange jelly. SE section. Small orange blobs on dead wood. Another oddity.

Galerina autumnalis—little brown "scrap" mushrooms that could kill you.

G. venenata—also looks inconsequential but is deadly.

Gomphididius oregonensis

G. subroseus

Gyromitra infula—hooded helvella. Quaint saddle-shape you can't believe until you see it. Toxic.

Hygrophoropsis (*Cantharelles*) *aurantiaca*—false chanterelle.

Laccaria amethystina

L. laccata—looks like the *Lactaria* but has no "milk."

Lactarius luculentus (*aurantiacus*)—orange milky cap. Exudes white "milk" where cut or broken.

L. rubrilacteus (*sanguilfluus*)—exudes dark red milk.

L. rufus—red milky cap. Exudes white milk. Toxic. (You have to be really curious to sort out the eight or ten species of *Lactaria*!)

Laetiporus (*Polyporus*) *sulphureus*—sulphur shelf, chicken-of-the-woods. Yellow to orange-red "shelves" on snags or logs. Conspicuous, attractive, edible raw or cooked.

Lepista nuda (*Tricholoma personatum*)—NE section. Purplish cap and stem. Delicious. (Popular name a corruption of "blue hat," comes from England and the tricorner hat.)

Lycoperdon perlatum—round puffball. White to brown, singly or in clusters. Formless mass of white spores inside when young; skin of old specimens breaks to release a cloud of yellow-brown powder, the mature spores.

L. pyriforme—like the above but pear-shaped. Both edible when young and firm but must be distinguished from button-stage amanita, which shows mushroom form in cross-section.

Naemetaloma capnoides—smoky-gilled woodlover. Yellow cap with

throughout in late fall and most of a mild winter. Mild flavor, nontoxic.

N. fasciculare—clustered woodlover. Much like the above but green-gilled. Toxic.

Pleurocybella (*Pleurotus*) *porrigens*—angel wings. White, thin and delicate; short lateral stipe, on fallen logs or stumps, NE and SE sections. Another to nibble on, or cook. Dries easily.

Pleurotus ostreatus—oyster mushroom. Lateral stipe, shelflike, on dead alder. Meaty and tasty.

Pluteus cervinus—deer mushroom. Scattered, all sections.

Russula pelagonium—smells like geraniums.

R. rosacea—rose-red russula. Intensely peppery taste. Not recommended.

R. xerampelina—woodland or purple-capped russula. Smells like shrimp. (Dr. Ammirati lists eight species of this genus in his field guide, some allegedly edible, some toxic. One expert told me, "Nobody eats russulas!" so I never bothered to sort them out.)

Sparassis crispa (*radicata*)—cauliflower mushroom. Cream-white, like a mass of bleached ribbon kelp. Grows from a single base at the foot of a spruce. Cut it off at the base, and it should grow again next year. May weigh 5 to 40 pounds—and one may be all you'll ever find. Excellent. Keeps well, dries easily.

Strophoria ambigua—questionable strophoria. Yellow cap, lacy margin, tall and graceful (see drawing). Abundant in woods, NE and SE sections. Said to be edible.

Suillus caerulescens—blue-staining boletus. Grass strip west of Island Crest Way. (The *suillus/boletus* genera contain other blue-stainers, generally regarded as doubtful. Any bolete/suillus with red pore mouths is dangerous if not lethal. Other species are edible and choice. Once you've learned to recognize them, the trick is to beat the worms to them.)

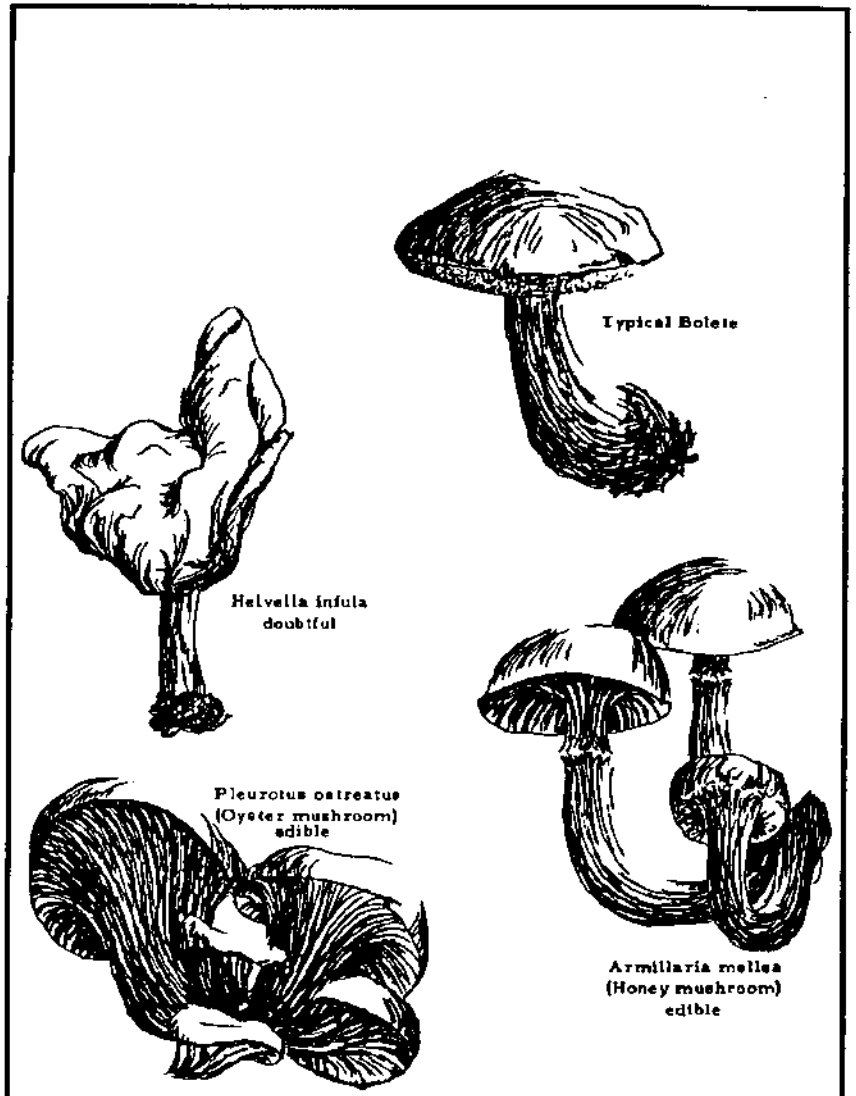

FIGURE 10
A Few Common Fungi

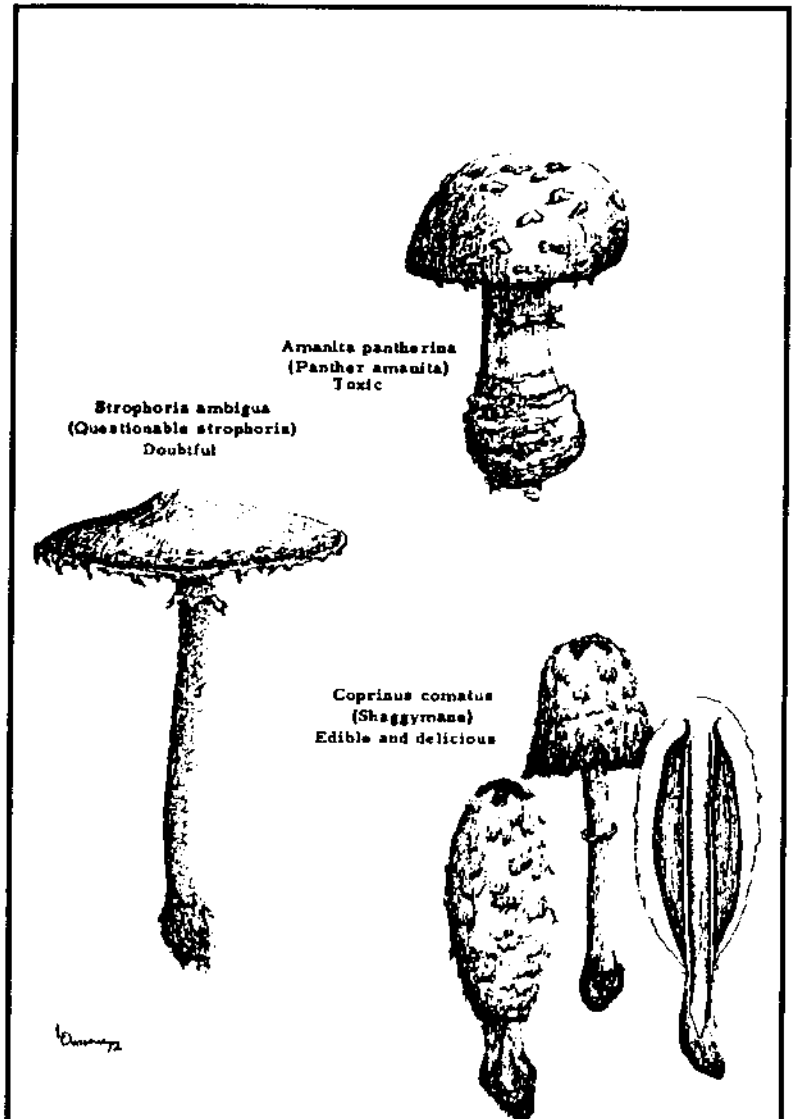

FIGURE 11
More Common Fungi

RECOMMENDED HANDBOOKS, FIELD GUIDES, COOKBOOKS

Audubon Society *Field Guide to North American Mushrooms*, by Gary Lincoff, Alfred E. Knopf, Inc. 1981. ISBN 0-394-51992-2. L of C 81-80827.

Guide to Common Mushrooms of British Columbia, R.J. Bandoni and A.F. Szczawinski, British Columbia Provincial Museum Handbook N. 74, Victoria, B.C., Canada; A. Sutton, 1964.

Guide to Mushrooms, Giovanni Pacioni; American edition edited by Gary Lincoff; Simon & Schuster; ISBN 0-671-4284-97. Originally published in Italy. Recommended for general coverage.

Guide to the Mushrooms and Toadstools, M. Lange and F.B. Hora, E.P. Dutton & Co., N.Y. 1961. Originally published in Denmark. Recommended for general coverage.

The Mushroom Handbook, Louis C.C. Krieger, Dover Publications, Inc., N.Y. 1967.

The Mushroom Hunter's Field Guide, A.H. Smith, University of Michigan Press, Ann Arbor, Michigan, 1964.

Mushrooms, Molds and Miracles, Lucy Kavaler, The New American Library, Inc., N.Y., 1966.

The New Savory Wild Mushroom, M. McKenny and D.E. Stuntz, University of Washington Press, Seattle and London, 1971. Revised and enlarged by Joseph F. Ammirati, 1987. ISBN 0-295-96480-4, paperback; -96491-X, cloth. Especially recommended for the Northwest.

Toxic and Hallucinogenic Mushroom Poisonings, A Handbook for Physicians and Mushroom Hunters, Gary Lincoff and D.H. Mitchel, M.D. Van Nostrand Reinhold, N.Y. 1977.

Wild Mushroom Cookery, Oregon Mycological Society, Inc., 6548 S.E. 30th Ave., Portland, OR 97202.

Wild Mushroom Recipes, Puget Sound Mycological Society, Globe Pequot Press, Seattle; ISBN 0-914718-04-5.

For information about mycological societies in the Northwest, write: Puget Sound Mycological Society, Monroe Center, Rm. 104, 1810 N.W. 65th St., Seattle 98117.

A BIRD STUDY

by Merilyn Hatheway

INTRODUCTION

In 1971-72, when the first edition of the *Natural History of Pioneer Park* was presented, a general species list of birds was compiled. Observations made in this bird study are emphasized, bird species are identified, and correlations with food supplies, cover and nesting areas are pointed out. This edition also includes modifications to the checklist made during the breeding season as well as for wintering birds and migratory visitors which use the Puget Sound Basin flyway.

Observers in the park will notice a seasonal influx of birds, especially in late April, May and June, when the numbers of species increase so enormously that the area seems overpopulated with birds singing from every bush and tree. On the other hand, the fall migration is almost silent, for the birds are mainly concerned with storing up food to provide the energy needed to sustain them on their return to wintering grounds.

Central to any bird study is a consideration of plumage differences. These include the marked differences between males and females of the same species as well as seasonal changes. Plumage changes result from the loss and regrowth of feathers, called molt, and are related to the age of a bird as well as to breeding activity and wintering patterns. Breeding plumage is almost always more colorful than the drab post-nuptial molt, which reflects the more silent winter season.

A knowledge of bird songs and calls is essential to any dedicated birdwatcher and this is never more evident than when locating species in Pioneer Park. Due to its dense tree canopy and undergrowth many species are more often heard than seen. Skill in this method of identification comes with experience and practice in distinguishing the repetitive calls of the various species known to inhabit the park.

The sequence of presentation of bird species in this report follows that of recent ornithological books. Birds are considered in order of their probable evolutionary development. Relatively primitive birds

are presented first, more advanced birds last. The basic unit of classification is the species. For further details of the classification of birds, the reader is referred to books such as *A Field Guide to the Birds of North America*, published by the National Geographic Society. For very specific information, refer to *Birding in Seattle and King County*, a site guide and annotated list written by Eugene S. Hunn and published by Seattle Audubon Society.

The original manuscript for this book resulted from contributions from the following people who worked during the period from September, 1970 to August, 1971: Jenny Conway, Merilyn Hatheway, Mary Kenady, Bruce and Judy Peterson, with Zella M. Schultz as principal investigator. Principal contributor to this edition was Eugene Hunn.

BREEDING BIRD CENSUS

The method employed in this study was to walk through the three sections of the park defined as the northeast, northwest, and the southeast sections, listing the different species. In addition to those birds that were seen, all birds heard singing were recorded. The principal months for breeding birds are May, June and early July, during which time a census was made. Birds not indicated as nesting species have been identified throughout the remainder of the year.

Since the females build their nests only in a territory defended by a singing male, the presence of the male is regarded as an indication of at least one pair of breeding birds. In some species, more than one female may nest in a territory of a singing male. Males defend territories against encroachment of other males of the same species which would compete with them for the food resources provided by the habitat. In general, different species utilize different resources. It is not surprising, therefore, that a male generally does not defend his territory against incursions by birds of other species, except predators such as jays and crows. Strong, dominant males establish territories which are especially rich in resources, and weak males in territories that are poorer.

DESCRIPTION OF BREEDING BIRDS

Band-tailed Pigeon

This bird is commonly seen perching in small flocks at the tops of the tallest trees, often in an upright position, with head tucked into breast. The name "band-tailed" is apparent when the pigeon sails down towards the perch and spreads its tail showing a light gray border across the end. Frequently heard are the flapping of wings along with a familiar "hoo-hoo" call.

Nests are usually in the middle canopy layer, in small firs, alders or other trees, and consist of loose arrangements of sticks balanced on a horizontal branch.

The favorite foods of this bird are elderberries, and the fruits of madrona, mountain ash and dogwood. For this reason, birds follow ripening fruits to higher elevations.

Northern Flicker

Prime habitat is semi-open wooded areas where trees and open ground are available, flickers forage for ants on the ground that make up the diet, along with bugs taken from tree trunks. A familiar ground bird, it can be observed bobbing its head or standing alert before hopping about, with its brownish back and distinct speckled breast bordered by a black collar and the unmistakable heavy, longish bill of the woodpecker family. When seen in trees, it may be clinging to a branch or trunk, or often perched on a dead limb high in the tree top uttering long, very loud "flicker" calls.

Nests in holes, primarily in dead trees.

Pileated Woodpecker

A large, black, crow-sized bird with distinct white patches on the underside of wings and a bright red tuft along the top of the head, with white stripes down side of neck.

When the bird is observed clinging to a tree trunk, one sees a long head with slim neck working back and forth with powerful strokes opening up holes and trenches in the trunks. Chips fly and fall to the base of the tree, often in large flakes. When trunks are those of dead

trees it is a noiseless operation. On the other hand, in the depths of forests on a living trunk it is like a hammer blow. Sometimes fallen logs offer loose bark and soft wood where grubs and other insects can be found.

In most written accounts, the pileated woodpecker is said to favor heavy timber stands of Douglas fir, yellow pine or other, and "does not take well to living by man's habitations. . . mostly a bird of the wilderness and to the wilderness you must go if you wish to see it." (Larrison, *Washington Birds*, 1968). Although this author has not located an active nest of pileateds on Mercer Island, large, somewhat oval holes, often at considerable heights on tall trees, are indirect evidence of nesting success.

Their foraging habits have been observed by many on the Island and in the park; they even frequent feeding stations. During the winter, pileateds are more evident as they forage on dead and dying tree trunks, leaving behind piles of chips and long, vertical trench-like openings in the decaying heart-wood.

The call is not unlike that of the flicker, except the series of notes is shorter and ends abruptly.

Hairy and Downy Woodpeckers

These woodpeckers are very close "look-a-likes." The main difference is in the size, with the *hairy* equivalent to a robin, and the *downy* to a sparrow. Their color patterns are black and white—a white area down the middle of the back, with black wings spotted with white, and black and white markings on the head. Males in both species have a small red patch on the back of the head.

Like most other woodpeckers, these birds are hole nesters. They will visit backyard suet feeders or inch up a trunk or along a limb to hammer and dig for an insect. Their rapping noise may be deceptively loud. Both of these species are common in heavily wooded and recently burned-over areas. The *hairy* is less abundant on residential Mercer Island.

The *downy woodpecker* shows a preference for medium-sized deciduous growth such as willows and alders yet can often be found

near streams where cottonwoods grow. The *hairy* must have conifers present, and generally is found in more mature, extensive forests.

Flycatchers

Flycatchers are most commonly seen in spring and summer time, more often perching upright on snags or ends of dead branches which serve as observation posts from where they dash about seizing passing insects. Four members of this family of insect-eating birds were found during breeding season in Pioneer Park. They are separated as follows:

Willow [formerly Traill's] — prefers dense brushy areas and forages in the short air-spaces between trees. Some water near the territory is required. It was formerly heard more frequently in Pioneer Park than now.

Western — prefers dark, rather dense coniferous woods with nests made of bark and moss, near the ground or on the tree roots. Often it perches in the shadows of the forest and one only catches glimpses as it sallies quickly to capture an insect, returning to the leafy cover. As in the case of most flycatchers, hearing them is easier than seeing them.

Western Wood Pewee — exhibits another characteristic of this family, a twitching of the tail or jerking motion when seen on perch, and more often than not the perching position is very upright. Like other flycatchers, the *wood pewee* dashes from its perch, swoops up the insect in flight, then sweeps back to its observation post. Since the *wood pewee* forages among the crowns and upper parts of the trees, they may be seen sitting fairly high in the canopy.

Olive-sided Flycatcher — selects the highest lookout on a tall dead tree, often a cedar or fir located on a hill or ridge from where it forages over the highest parts of the forest. Its call, often described as "quick-three-beers" is very easily recognized once learned and when compared to other flycatchers, this bird is noticeably larger than the others. Twiggy nests are generally placed fairly high up in the conifers.

Swallows

Perhaps because of their graceful flight, this family of insectivorous birds is easily recognized. They arrive early in spring. Another characteristic is their tendency to choose wires rather than tree branches for perches.

Barn Swallow — nesting material used by this swallow is mud; therefore, they require water to construct their nests on beams in buildings, under bridges, and the like. Because their low swooping flight takes them skimming over grassy areas, one has a good opportunity to see this swallow, as well as those listed below, in the boundary areas of the park.

Violet-green Swallow — this is our most common swallow, being thoroughly adapted to associating with man. This species nests in holes, either in trees, buildings, or nesting boxes.

Tree Swallow — although uncommon, since it prefers more rural habitats, these birds which show a preference to foraging over water have been observed over the park. Some experience is needed to separate its identification markings from the similar Violet-green Swallow.

Steller's Jay

Very common wherever coniferous forests exist, this jay is especially noted for harsh calls and bold manner, often alarming other birds. This strikingly handsome bird with brilliant blue body and dark crested head is sometimes a destroyer of nesting smaller birds, eating the eggs and even the young. It is omnivorous, however, and its food varies from frogs and mice to berries and hazelnuts.

Nests are a mixture of twigs and mud and are located in the zone of tall shrubs and medium-sized trees, usually in evergreens.

Common Crow

This familiar all-black bird of farming areas is also found frequently in second-growth woods near population centers having large parks. Often crows are seen in fairly large numbers, and this is especially true in early evening hours when they flock to communal

roosts. During the day they fly back and forth over the more open areas surrounding our park but it isn't uncommon to hear their harsh, often angry "caw" deep inside the woods. This bears investigation by the observer since crows are well-known molesters of hawks and owls.

Completely omnivorous, the crow feeds on the ground and at all levels of the forest, wherever it can find eggs, small mammals, frogs, garbage and the like.

It constructs bulky nests of twigs generally in the middle layer of the forest trees.

Black-capped Chickadee
Chestnut-backed Chickadee

Small, "busy" birds, both species are common on Mercer Island, both in the Park and at feeders. They prefer slightly different habitats, the *black-capped* in deciduous trees and brush, often associated with streams, and the *chestnut-backed* in denser coniferous woods. However, it isn't uncommon to see mixed flocks in Pioneer Park, and one can be quite successful in attracting them by imitating their calls with pursed lips or blowing on the back of the hand. The response is a familiar "tee-dee."

Nests are usually placed in holes in tree stumps or snags.

Common Bushtits

Tiny gray birds with disproportionately long tails, usually seen in flocks of threes to twenty or more. Their thin twittering and busy manner of insect hunting while hanging at any angle from a branch in bushes or trees attract the bird watcher to follow their movements, and often as not lead to the discovery of a nest incongruous to their tiny size. The bulky stocking-like pouch is about eight inches long, a mixture of moss and lichens, with a small opening on the side near the top where it is attached to a drooping branch of a tall shrub or tree. Both parents share in the feeding, carrying insects and disappearing completely inside the long sleeve which wiggles and shakes as the babies, perhaps 5 to 9, vie for the food.

Red-breasted Nuthatch

This is the only member of this family found in Pioneer Park. It is attracted to conifers. A small bird with stubby tail, this insectivorous species works close to the bark, either on tree trunks or limbs, over, under, and upside down.

It prefers to dig nest holes in dead snags and stumps.

The recognizable thin, nasal "yank-yank" call distinguishes it from those of chickadees, creepers, and kinglets with which it often flocks, especially in the winter season.

Brown Creeper

Another meticulous inspector of tree bark, this small, often silent, bird is seen crawling up trunks, in contrast to the headfirst downward pattern of the nuthatch. The relatively long, spiny tail adds stability as the slim curved bill probes into cracks for insects. It has a habit of starting from the base of a conifer working upwards encircling the trunk. When it reaches the highest branch it flies off to another tree and repeats the process.

Its nest is somewhat unusual, being located behind strips of loose bark, which more often than not readily peel off dead or decaying trees, especially alders.

Wrens

The melodic bubbling song of the two local species may be heard year–round in Pioneer Park. A beginning birder can often distinguish the song of the *winter wren* for its thin, rapid-fire notes go on and on as if they would never cease. In comparison, the song of the *Bewick's* wren (pronounced "Buick") is a musical variation of a three-note theme, "sweet-sweet-sweet." Very often this bird will trill in an opening in the woods and this offers the observer the opportunity to check the field marks, namely the conspicuous white stripe over the eye and the sharp contrast between the brown back and white underparts of this small bird.

The *Bewick's wren* nests in the tall shrubby layer or lower reaches of the canopy where it places its nest in cavities of trees. Active and

nervous in its search for insects, it moves rapidly about the woods, but never without vocal accompaniment.

The smaller wren of the two, the *winter wren* prefers the darker, wetter coniferous woods where ferns and mossy logs mix with the underbrush. But such a loud and joyous song while it works its territory! Nests are made of moss and twigs, placed on roots and tree stumps in the interior forest floor.

Robin

Certainly the commonest of all, this great worm-eater fully enjoys our year-round moist soil. More closely associated with lawns and open grassy stretches, it is also seen and heard wherever soft ground yields the earthworms for food and low trees and shrubs for nest building. Since mud binds together nesting material of twigs and grasses, the suitability of our wet environment is obvious.

The song is rather easily learned since it is a repetitious series of similar notes.

Swainson's Thrush

Closely related to the Robin is this member of the same family. With its spotted breast and complete brown-back appearance, it is our commonest "spot-breasted" species. One learns its call to make identification easier, since this shy bird tends to remain under the dense cover of branches and bushes, especially alders and maple woods. The song is a "rolling series of rapid flute-like notes rising up the scale" (Robbins, *Birds of North America*, 1966). Also a ground-feeder enjoying the products of the damp earth, it nevertheless is closely associated with red elderberry thickets and Indian plum, and as summer matures these fruits, it spends much time higher in the vegetation.

Nests are also mud-lined, of twigs, moss and grass, and placed at medium height in small trees and bushes.

Varied Thrush

A winter visitor, this thrush resembles the robin, but with distinct orange eyebrow and wing bars and a breast band; it prefers moist coniferous woods. It has a distinguishable call described as a long quavering whistle followed by a pause, then repeated on another note, often higher in pitch than the first. It is usually observed feeding on the ground but with colder weather it may appear at feeders.

Golden-crowned Kinglet

Tiny, greenish-toned, hyperactive insect feeders, woodland birds prefer tall conifers in our wooded park. Because they flit about incessantly, often high in the canopy, one needs to follow their motions with binoculars to be rewarded with the sight of the bird's bright yellow crown bordered with black and white stripes, and in the case of the male, a bright orange center on the middle of the yellow crown.

The call often mingles with that of chickadees but it is recognized as a thin "see-see-see."

The kinglet forages for insects through branchlets of firs and hemlocks, and constructs a mossy nest in the dense cover of similar conifer branches.

Cedar Waxwing

Although this species appears irregularly in Pioneer Park, more often in winter and spring, it is generally found in flocks at berry-bearing shrubs, which it may strip clean. Its pleasingly silky appearance is of grays and browns, the distinct black face-mask topped by a pointed crest, and with a bright yellow band at the tip of the tail. Before fruits are ripe, cedar waxwings feed on insects and near bodies of water display like flycatchers.

It shows a preference for stands of madronas and mountain ashes, as well as dogwood and hawthorne.

The nest is placed in trees, within the middle canopy layer.

Starling

This short-tailed, dark-colored introduced species is generally associated with inhabited areas, where it finds foraging for food more convenient. It is much less common in the wilderness. Perhaps the starling is best known as a pest bird, often invading tree trunk holes of woodpeckers, and it is aggressive enough to drive off the larger birds.

Two other habits are perhaps less known to the beginning birder. The starling is an excellent imitator of other bird calls, and may even learn to repeat human sounds. It is also a gregarious bird which spends the night in large communal roosts, although during breeding season it is a cavity nester.

Vireos

This family of birds is similar in its habits to warblers but moves more deliberately through the foliage in searching for crawling insects. Another distinction is the markings about the eyes, and a heavier bill. Vireos have a joyous song and since their notes are repeated frequently, one can soon learn to distinguish them.

Nests are principally cup-shaped, made from strips of bark and moss, and hung between two branches at a fork. For the three species we compare here, there are distinct locations for these nests.

Solitary Vireo — frequents a forest of mixed deciduous and coniferous trees. After one learns its song it is possible to locate this rather sluggish bird, often on the lower, more open branches of conifers and sometimes deciduous trees. During the breeding season, one might find the nest hanging from a low twig of a cedar or fir, relatively near the ground.

Red-eyed Vireo — The song may be confused with that of the *solitary*; it nests in the canopy and is more often heard than seen.

Hutton's Vireo — prefers dense mixed woods. Quite uncommon in Pioneer Park, it may be confused with the *ruby-crowned kinglet,* which may overlap with *Hutton's* during migration and the winter season. Nests are hung on low branches.

Warbling Vireo — prefers alders and big-leaf maples. This bird is more easily heard than seen, as it forages and nests in the middle to upper reaches of dense foliage. It has a similarly constructed nest, that is the hanging type, but near the canopy. Often during breeding season, while sitting on the nest, the male may be heard singing.

Warblers

Bright colors, small size, active insect hunters—these phrases describe this family better than the impression that a "warbler" should necessarily be a good "singer." Although undoubtedly other warblers have nested from time to time in Pioneer Park, only three representatives were observed in this study.

Black-throated Gray Warbler — for its food and nesting requirements, this bird prefers conifers, especially Douglas fir, with fairly dense, dry foliage. It builds its nest in the middle to top of the trees.

Wilson's Warbler — this warbler prefers brushy, moist parts of the woods where it may nest in salal or sword ferns common to the ground cover of our coniferous woods. But its habit of foraging within a few feet of the ground offers the birder an opportunity to learn its call and observe the black cap perched on the head.

Orange-crowned Warbler — prefers forest edges, thickets, brushy woodlands, generally in the lower branches; its call is a slow, low trill. This warbler probably nests in the park.

House Sparrow

Abundant wherever humans live, this introduced species is a weaver finch which resembles our native sparrows. It was observed only in the boundary area of Pioneer Park where dwellings occur. Essentially a scavenger and seed-gatherer, it relies mainly on civilization for its food and nesting sites, and is non-migratory. It competes with native birds for bird houses.

Brown-headed Cowbird

This bird has two unique habits that are worthy of mention. First, it is generally associated with cattle and horses, using their particular pastures and pathways where it forages for insects that accompany them. Obviously, this fits in our picture of the park.

Perhaps even stranger, however, is the habit of the female cowbird to lay her eggs in the nests of other birds, often in those of warblers, vireos, and sparrows. Since the cowbird nestling is larger and the foster parents are unable to distinguish it from their own young, it may demand a disproportionate share of food and attention given nestlings. This relationship is continued until, when independent of the foster parents, the cowbird begins to associate with its own kind.

Western Tanager

This is a bird one should learn, for it has a spectacular appearance and an easy song to remember. Bright yellow and black plumage is the conspicuous markings of both male and female birds, with the male displaying a brilliant reddish-orange head.

The habitat for this species is high in open Douglas fir or cedar, or mixed coniferous-deciduous forest.

The song may be confused with that of the robin, but the call of this bird is identifiable as "prit-tick," "prit-it," or "pit-er-ik."

The nest is placed on horizontal branches, usually in conifers.

Black-headed Grosbeak

A loud, clear robin-like song indicates the presence of this bird, usually stationed at the forest edge where brush mingles with big-leaf maples and other deciduous trees. It feeds on both insects and fruits, the latter attraction being those of elderberry, blackberry and dogwood.

It has a loosely constructed nest of twigs placed in small trees and bushes.

Purple Finch
House Finch

Since birds exhibit different plumages depending on age and sex, these two species are often misidentified until the bird-watcher has learned the variations in their songs. To be sure, they are generally associated with different habitats, but this rule does not apply in areas where backyard feeders are the attraction.

In general, the *purple finch* prefers the moister, darker coniferous-mixed woods, while the *house finch* accommodates itself better to populated areas, especially if water is available. The *house finch* visits drier open areas to seek the seeds of grasses as well as fruits and berries.

The *purple finch* tends to nest quite high, usually in coniferous trees, whereas the *house finch* may locate in bushes and dense shrubbery, also in vines such as ivy, often on buildings.

American Goldfinch

Some people refer to this bird as a "wild canary," because of its bright yellow plumage. It is indeed a strikingly handsome species which may often be seen in numbers as a flock works the more open areas for dandelion, thistles and other composites. When this food supply is not available, alders and cedars provide buds and seeds.

Goldfinches make neat, cuplike nests in low trees or tall bushes, especially in willows.

Rufous-sided Towhee

A very common bird in Pioneer Park, this ground-feeding species is readily observed in the brush and undergrowth throughout the park. It has several variations to its call and song but is never silent for long. In the quietness of the woods it is not uncommon to hear a scratching among the leaf litter accompanied by a whining "chee-ee."

The nest is constructed with shreds of bark and plant fibers, and is placed on or close to the ground, with preference for blackberry, wild rose and salmon-berry thickets.

Song Sparrow

This bird is very common, and our most persistent singer. It inhabits backyards and just about every area in our park, always near the ground.

This is an easy bird to "call up" into view with lip noises; it may be identified as a brownish bird with striped breast containing a dark center patch.

Nesting locations correspond to the similar habitat of the towhee, especially blackberry, wild rose, salmonberry thickets, and brush piles.

CONCLUSION

No attempt was made to list the bird species in each of the specific areas of Pioneer Park. Instead, the intent was to show approximate strata and types of vegetation in the woods that each bird utilizes.

Nevertheless, special mention should be made of that area in the Northeast section known as the ravine, which harbors large populations of several species of birds. Bordered by dense coniferous-deciduous woods within the park, by still undeveloped woods to the north, and by East Mercer Way and a continuation of the ravine eastward toward Lake Washington, and including a year-round stream, this magnificent area has many attributes for attracting birds. Observations made from the south bank, at vantage points above many of the shrub-layer and understory trees, but still below the canopy, disclosed numerous species. This has been especially true in the spring season when migratory birds, particularly grosbeaks, warblers, vireos and hummingbirds, are attracted by the combination of the water plus the fruits and seeds of maples, alders, Douglas fir, hemlocks, as well as those of the well developed shrubby vegetation which consists mainly of elderberry, red huckleberry, salmonberry and the like. During the breeding season, still other species are found, including thrushes, wrens, and *pileated woodpeckers*, to mention only a few.

Attention should also be called to the presence of the *pileated woodpecker* on Mercer Island which comes as a surprise to those who

regard it as a bird of undisturbed old-growth forests. Study of its behavior, however, suggests that conditions in Pioneer Park and the remaining wooded ravines of Mercer Island are, in fact, ideal for this species. The necessary food supply such as carpenter ants, beetle larvae and similar bugs occurs abundantly in slowly decaying trees. These may be standing trees or downed rotting stumps or logs. The park and other wooded ravines that have not been "tidied up" show abundant evidence of the presence of this species. It is also suggested that rarely more than one pair inhabit a single woods. It is probably true that the numbers of pairs have declined in the last decade, since nesting trees are found in heavily timbered, often second-growth, mixed deciduous and conifers.

A nest-tree may be successfully used for several years. Holes are excavated in either dead trees or dead limbs of live trees; the height of the cavity ranges from 15 to 70 feet above ground. Both parents participate in digging the hole, with the average cavity being 15 inches deep, 8 inches wide, with the entrance approximately 3-4 inches in diameter. Usually 3-4 eggs are laid, with only one brood per season. In general, nest-trees are fairly large, perhaps 100 feet tall, with diameter of upwards to 3 feet.

The essential point seems to be that birds such as the *pileated woodpecker* have certain habitat requirements, including large conifers for nesting and decaying stumps and logs together with berry trees for foraging. Moreover, they can be encouraged to live and reproduce in densely populated areas, provided (1) that their habitat requirements are included, and (2) that these birds are not molested by hunters as they frequently are in more rural areas. There seems little doubt that other "wilderness" birds such as *great horned owls, screech owls* and certain hawks can be induced to colonize on Mercer Island if we maintain some wooded areas in a semi-natural state.

APPENDICES

A general species list of seventy-four birds found in Pioneer Park during the study period is present in Appendix 1. This list is modified from the original 1972 publication. A breeding bird census was made and each species is described in the text with an explanation of its habits and habitats. Some preliminary observations are indicated which correlate Pioneer Park characteristics with certain bird species. Finally, an attempt to identify certain birds with the habitats in which they are found most frequently is shown in Appendix 3, the profile study of Pioneer Park.

APPENDIX 1

General Species List for Pioneer Park

[* indicates probable nesting species]

Sharp-shinned hawk
Cooper's hawk
Red-tailed hawk
*Band-tailed pigeon
Great Horned owl
Barred owl
Screech owl
Anna's hummingbird
*Rufous hummingbird
*Northern flicker
Red-breasted sapsucker
*Pileated woodpecker
*Downy woodpecker
*Hairy woodpecker
*Olive-sided flycatcher
*Western Wood pewee
*Western flycatcher
*Violet-green swallow
*Cliff swallow
*Barn swallow
*Steller's jay
*Common crow
*Black-capped chickadee
*Chestnut-backed chickadee
*Bushtit
Red-breasted nuthatch
*Brown creeper
*Winter wren
*Bewick's wren
*Golden-crowned kinglet
Ruby-crowned kinglet
Townsend's solitaire
*Swainson's thrush
Varied thrush
Hermit thrush
*Robin
*Cedar waxwing
Starling

*Hutton's vireo
*Solitary vireo
Warbling vireo
Orange-crowned warbler
*Yellow-rumped warbler
*Black-throated Gray warbler
*Wilson's warbler
Black-headed grosbeak
*Rufous-sided towhee
*Song sparrow
Chipping sparrow
Dark-eyed junco
White-crowned sparrow
Golden-crowned sparrow
Fox sparrow
*Brown-headed cowbird
Northern oriole
*Western tanager
*English sparrow
American goldfinch
*Purple finch
*House finch
*Pine siskin
Red crossbill
Evening grosbeak

OCCASIONALS

Killdeer
California quail (formerly)
Mourning dove
Bald eagle
Northern pygmy-owl
Common nighthawk
Red-winged blackbird
Hammond's flycatcher
Tree swallow
Yellow warbler
MacGillivray's warbler

APPENDIX 2: GLOSSARY

Habitat — "the place where an organism lives"
Ecological Niche — "the role that the organism plays"
in conclusion, "the habitat is the 'address' . . .
the niche is the 'profession.'"

Ecology,
Eugene P. Odum

Territory — an area "staked out" by a male and defended against other males of the same species.

Song — a group of sounds repeated in a pattern at intervals; to warn off males of the same species; in effect, attracts females.

Calls — mainly used as a device to warn other birds of the presence of an enemy; to rally a flock; food call; location determiner.

Common — a bird seen most of the time, sometimes in numbers.

Uncommon — may occur seasonally or under appropriate conditions, sometimes in numbers, but irregular in its appearance.

Rare — infrequent visitor, often noticed only by an experienced observer.

Occasionals — appearing on Mercer Island infrequently and at irregular intervals.

Probable Nesters — species for which we have no positive record of nesting in Pioneer park, but which are known to nest in similar situations in the Puget Sound Basin.

Family — a group of related birds; includes one or more genera and species; as an example, robins and thrushes are all members of a single family, *Turdidae*.

Species — an individual member of a family; i.e., robin or varied thrush.

APPENDIX 3

Explanation for Strata in the Forest Profile.

I. **Grassy areas**, including lawns and other open areas bordering the wooded areas of the Park; includes lawns separating residences from the Park boundary.

II. **Forest edge**. Areas which serve as a buffer between the grassy areas and trees; characterized by low shrubs and low vegetation, principally salal, Oregon grape, and sword fern.

III. **Tall shrubs**. Both shrubs and small trees are included up to an arbitrary height limitation of approximately 30 feet. Examples of this vegetation are red elderberry, holly, dogwood, and naturally regenerating trees.

IV. **Canopy**. All trees, including trunks and branches, above the 30-foot level to the top of the forest stand.

V. **Interior forest floor** designates the ground layer vegetation within the forest. Examples are Oregon grape, ferns and salal.

VI. **Boundary areas**. Streets, driveways, houses, and other built-up areas surrounding the Park.

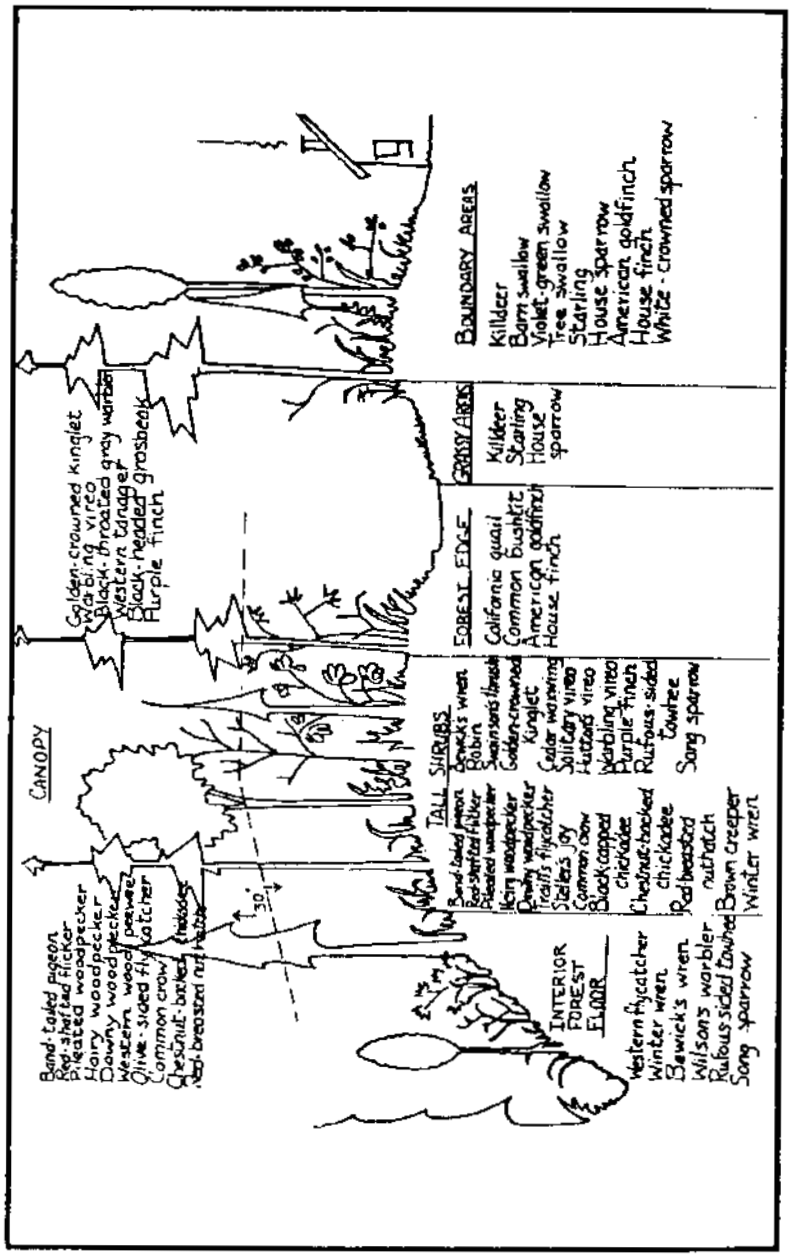

FIGURE 12
Profile of Bird Species and Forest Strata

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MAMMALS OF PIONEER PARK

by Gerry Adams

Several species of mammals have been observed in Pioneer Park. With 120 acres and a variety of habitats, the park has the potential to support a greater diversity of mammals than has been recorded. If you observe wildlife in the park, please report your sightings to the Mercer Island Park Department. The data you provide is important for keeping updated wildlife statistics.

Watching mammals can be combined with other activities such as birdwatching or hiking. Since mammals are often elusive and hard to see, look for their signs: tracks in mud, dirt or snow; scat in runways, on mounds, or on trails; and bits of fur or hair on the ground or caught on vegetation. The greatest diversity of mammals is seen during the twilight periods of morning and evening.

To identify mammals and their evidence requires a good field guide such as *Mammals of the Northwest* by Earl Larrison, or *Mammals of the Pacific States* by Lloyd Ingles. A handy guide to tracks is *Animal Tracks of the Pacific Northwest* by Karen Pandell and Chris Stall. In addition, good binoculars are essential.

INSECTIVORES

Two families, shrews and moles, make up the order Insectivore whose members eat invertebrates such as worms, insects and insect larvae.

Vagrant shrew — (*Sorex vagrans*)

Look for this brown shrew in damp areas like wet meadows or ditches, among ferns and in the runways of voles.

Trowbridge's shrew — (*Sorex trowbridgii*)

This small shrew prefers dry coniferous forests. It is dark colored with a distinctly bicolored tail. Foraging on the forest floor, it prefers a diet of insects and other invertebrates but will also eat the seeds of the Douglas–fir.

American shrew-mole — (*Neurotrichus gibbsii*)

This creature is the smallest mole in North America. It can be distinguished from shrews by its shovel–like front feet. It is found under the forest leaf mat but also forages on the surface.

Townsend mole — (*Scapanus townsendii*)

The Townsend mole is the largest mole in North America. Its presence is indicated by large mole hills in open areas.

Coast mole — (*Scapanus orarius*)

Smaller than the Townsend mole the coast mole is found in drier brush and forest areas.

BATS

Bats are the only mammals capable of sustained flight. They hunt insects during twilight periods and sometimes fly with swallows and swifts when feeding. Even though they are not considered insectivores, they eat a higher percentage of insects than shrews and moles. Bats found in Pioneer Park hibernate under neighborhood roofs during the winter when insects are not available.

Little brown bat — (*Myotis lucifugus*)

This bat is the most common bat in Pioneer Park and can be seen feeding on insects at dawn and dusk over open areas.

Big brown bat — (*Eptesicus fuscus*)

Larger than the little brown bat, the big brown bat feeds high above the ground along the tree tops.

RODENTS

Over one-half of the mammals on the earth are rodents. Their high reproductive capacity is balanced by their high rate of loss to predation.

Mountain beaver — (*Aplondontia rufa*)

The mountain beaver is the oldest known living rodent, going back to the late Paleocene, about 60 million years ago. The animal's burrows can be seen in banks in moist open forest areas. It is not a relative of the dam-building beaver (*Castor canadensis*) common in rivers and ponds.

Townsend chipmunk — (*Eutamias townsendii*)

This dark brown chipmunk lives in underground tunnels with openings about one inch in diameter. In the Pacific Northwest, chipmunks are the only true hibernators.

Eastern gray squirrel — (*Sciurus carilinensis*)

This squirrel, common to cities throughout the U.S., was introduced into the Puget Sound area in the 1920s.

Douglas squirrel — (*Tamiasciurus douglasii*)

Also known as "chickaree" this native squirrel has been on the decline in recent years due to competition with a newcomer, the Eastern gray squirrel.

Northern flying squirrel — (*Glaucomys sabrinus*)

Unlike other squirrels, flying squirrels are almost completely nocturnal and somewhat carnivorous, occasionally eating bird eggs. They are generally more common than we think because they are seldom seen. You can hear them at night, however. Their chirps can be heard from the wooded canopy, but you usually hear the sound of their bodies as they slap against tree trunks when they glide from tree to tree.

Deer mouse — (*Peromyscus maniculatus*)

Mostly nocturnal, deer mice live in the woods. They dash for protection at the slightest noise. Their fur is dark above and white on the belly, extending the length of the tail.

Oregon vole — (*Microtus oregoni*)

Sometimes called Creeping vole or Meadow mouse, their runways are sometimes found in the forested and grassy areas of Pioneer Park. Their runways are often used by the Vagrant shrew.

Norway rat — (*Rattus norvegicus*)

Also known as Common rat, Brown rat, Water rat. This European species has thrived since it was accidentally introduced, probably with some of the first human immigrants from the Old World. The saving grace of this otherwise vile creature is that it is the preferred food of the Great Horned owl in urban areas. Owl predation will probably prevent any rat population explosions.

CARNIVORES

While most carnivores eat only other animals' flesh, carnivores such as raccoon and coyote also eat berries and plants. Their offspring are usually born blind and require extended parental care.

Coyote — (*Canis latrans*)

This relative of the wolf looks like a medium-sized domestic dog. Coyotes are not a danger to people but are known to mistake small

dogs and cats for wild food. Although coyotes are still common in the Snoqualmie Valley and some other eastside locations, they have not been seen in Pioneer Park for many years.

Raccoon — (*Procyon lotor*)

The "mask" on a raccoon makes this common resident easy to recognize. Its feet make human, hand-like prints in soft mud when near water where it likes to feed. After a snowfall its prints may be seen along the park trails. Although raccoons are primarily nocturnal, those that live in urban areas are often seen during daytime looking for more available food around human habitation.

HOOFED MAMMALS

Our native hoofed mammals have an even number of toes on each foot. Cattle, bison, elk and deer are examples.

Mule deer — (*Odocoileus hemionus*)

Another common name for this deer is Black-tailed deer. Formerly considered a separate species, our local variety indeed has a tail that is basically black on the upper surface. Mule deer usually only have black on the tip of their tail. Although once common at Pioneer Park and elsewhere on Mercer Island, they have now been extirpated from the area.

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SOILS —THE PARK'S FOUNDATION

by Henry Seidel

Three major soil types occur in Pioneer Park. They differ greatly in texture and thus in drainage characteristics. Formerly soils with poor internal drainage, such as the *Alderwood* series, supported stands of western red cedar. Nowadays, cutover lands on such soils are colonized by red alder and bigleaf maple. The much better drained to dry *Indianola* and *Everett* series are usually colonized by conifers, especially Douglas fir, but the broadleafed evergreen Madrona is almost always found on very well drained soils.

Alderwood Series

The major soil series found in Pioneer Park is the *Alderwood* series. The soils of the *Alderwood* series have two main types, known as the *Alderwood gravelly sandy loam* and *Alderwood gravelly loam*. The predominant soil in this area is the gravelly loam. The *Alderwood* soils are covered with 3 to 4 inches of forest litter and have a reddish brown friable surface soil. The profile of the soil shows that the soil grades to a yellow brown and finally to a slate-like color at 30 to 36 inches, where it is underlain by a heavy cemented drift. This cemented drive continues to great depths. Gravel and occasional stones are scattered throughout the profile. This indurated, cemented substratum is composed mostly of sand with a small percentage of clay, making the soil slowly permeable to water. As a result, these soils have poor internal drainage. The cemented substratum also has the same effect on plant roots which can only penetrate the cemented layers to shallow depths.

The Alderwood gravelly loam is a cold soil which takes a long time to warm up. When this soil occurs on slopes ranging from 0 to 3 percent, there is a tendency for the soil to puddle and stay wet because of its poor internal drainage. This condition occurs predominately in the NW section along the trails and cleared areas. The continual walking or riding of horses on these trails if no vegetative cover is provided tends to compact the soils so that even the fair drainage in the surface soil is destroyed.

The *Alderwood gravelly loam* occurs in the NW and NE sections. The major drainage of the park is to the northeast. The steepest slopes in the park are found in the NE section. When cleared the *Alderwood* soils on steep slopes are subject to very intensive sheet erosion and if a great deal of water accumulates, they have a tendency to slip. The *Alderwood gravelly loam*, because it has its heavy cemented substratum, is a prime candidate for soil slides. In this area particularly, the forest cover above the slope and the vegetative cover on the slope should not be disturbed. Rain falling on unprotected soils of this type penetrates the shallow topsoil vertically and then, on reaching the compacted subsoil, moves laterally down the slope. If the surface soil becomes saturated, the hazard of slippage is immediate and can be disastrous. In general, these soils should not be cleared if their position is such that a slip of more than 15 percent is created. With special precautions, the soils have been cleared in the 15 to 25 percent gradient. Over 25 percent slopes represent a hazard. Usually the best method of reducing the hazard is to leave the native cover as is.

Indianola Series

The *Indianola* series of soils occurs in the upper areas of the park. This series is closely associated with the *Alderwood* series. The predominant type is the *Indianola fine sandy loam*. The soil has a more developed surface soil, and in virgin area is covered with partially decomposed vegetative material. The surface soil will range in depth from 9 to 12 inches. The soil is moderately acid and is reddish brown in color. The upper subsoil is a yellowish brown sandy loam containing some gravel. The deeper substrata are stratified and contain a high content of gravel.

The *Indianola* soils have good surface and internal drainage. They are generally easy to work. Their fertility is low, particularly when the surface organic matter is removed. The nutrients of these soils are easily washed and leached through the profile. The predominant cover of these soils consists of Douglas fir with a few hemlock. When cleared, these soils can produce fairly good pasture and hay crops if carefully managed. These soils are not as subject to

erosion as the *Alderwood* series, primarily because of their position in the park.

Everett Series

The *Everett* series intrudes into the *Indianola* series in the park. This series and the *Indianola* series are generally associated with the *Alderwood* soils. The *Everett* soils are moderately acid, gravelly, porous and droughty. They have a pale, reddish brown gravelly surface soil with a thin layer of organic material in their surface. There is little textural or structural development in this series. These soils, like the *Alderwood*, are derived largely from granite but include some basaltic material.

The *Everett* series of soils should not be cleared. If these areas are cleared in the park, legumes and grasses should be planted to maintain a permanent cover.

Soil and Forest Development

Soils develop as the product of the interaction between parent materials—the underlying rocks and other geological deposits—with their environment. Important environmental factors include climate, slope and other factors affecting drainage, the activities of living organisms, such as plants, earthworms, and bacteria, and age. The Pioneer Park soils are young, having developed on materials deposited during the last ice advance, about 10,000 years ago.

The *Alderwood* soils developed on relatively fine-textured glacial till which became much compacted at various depths below the surface. Roots are generally unable to penetrate these cemented layers, and drainage is impeded during the wet season. Because of poor aeration, organic matter is slow to decompose and builds up as a dark brown mat in old, undisturbed forests.

The *Indianola sandy loams* and the *Everett gravelly sands* developed on coarse-textured glacial deposits called eskers and kames. These deposits of gravel and sand were formed by water flowing through tunnels or depressions in the ice or along its borders. As already noted, the *Indianola* and *Everett* soils are very well to excessively drained. Because aeration is good, microorganisms

decompose dead organic matter quickly and thick layers do not build up.

The pre-settlement forests of Mercer Island were dominated by conifers: Douglas fir, western red cedar, western hemlock, and, to a lesser extent, grand fir. When these forests were removed around the turn of the century, much of the organic matter at the surface of the soils was lost, because of increased rates of decomposition and, occasionally, fires which started in the dry logging debris. Seeds of remnant conifers, principally Douglas fir, germinated quickly in the exposed mineral soil. Seedlings of red alder also became established along with the conifers. Red alder is a short-lived tree which because of its inability to compete with the giant conifers had been virtually restricted to sites along streams and in other wet places in the pre-settlement forests.

In the competition on the logged-over lands Douglas fir seedlings outgrew those of the other conifers and alder in well drained and dry situations, that is, on the *Indianola* and Everett soils. Red alder seedlings, however, generally outgrew the conifers and shaded them out on the wetter *Alderwood* series. Since alder trees live only seventy to ninety years and their seedlings are unable to survive long in the shade, the Pioneer Park alders which have dominated the NW section since it was logged are now dropping out. They will gradually be replaced by longer-lived species adapted to relatively wet forest conditions, such as red cedar, grand fir, and big-leafed maple. On the drier *Indianola* and *Everett* soils Douglas fir dominance will continue indefinitely, but conifers such as western hemlock and red cedar, which are able to persist in shade, will become increasingly abundant in the understory.

NOTE: Soil descriptions taken from *Soil Survey of King County*, 1952.

Gerry Adams of Duvall is Vice President of the Seattle Audubon Society. His interests as a naturalist include extensive studies of the effects of urbanization on wildlife. Among his recently publications is *Mammals of Discovery Park.*

Ethel Dassow is an editor with Alaska Northwest Publishing Company, and was a magazine editor for twenty years. An amateur naturalist, she is an outdoor forager of fungi, berries and fish. With her husband, John, now retired from the U.S. Fish and Wildlife Service, she has lived on Mercer Island thirty-four years.

Merilyn Hatheway has been a birdwatcher since the mid-60s. She has taught classes for birders on Mercer Island, at the UW Arboretum and for the Seattle Audubon Society. Along with Dassow, Kenady and Seidel, Hatheway wrote the first edition in 1972. She operates a small desk-top publishing business and produced the manuscript for this book.

Mary Kenady has extensive interest and experience in Pacific Northwest plant identification and study, as well as work with ornamental and vegetable gardens. She is the author of *Pacific Northwest Gardener's Almanac* and is presently at work on two other regional books. She lives on the west slope of the Snoqualmie Valley near Duvall and professionally is co-owner and co-manager of a company which presents training courses for natural resource managers.

Henry Seidel, Univ. of Idaho, B. S., Soil Scientist-Conservationist; Budget Director, King County; AA Administrative Assistant to Cong. Brock Adams; School Director, So. Kitsap Schools; Trustee, Bellevue Community College; resident of Mercer Island for twenty-six years.

Henry Steinhardt, who made the photographs, has lived on Mercer Island since 1963. He was for many years an architect and has been a full-time photographer for eleven years. His work has been published in several magazines and is in numerous collections. Exhibits of his works locally were held in 1986 at the Mercer View Community Center and in 1989 at the Seattle Chapter of the AIA. He claims to have taken over 3,000 walks in Pioneer Park, a statistic confirmed by his dog, Nora.

Laura Dassow Walls studied art with Mercer Island's Ren Haugland and at Cornish Institute of the Arts in Seattle. She currently is teaching 19th Century American literature and working on her Ph.D. at Indiana University in Bloomington. The daughter of Ethel and John Dassow, she has been married to Robert Walls since 1982.

20. Appendix J: Summary of Management Resources for Pioneer Park

Management resources are the people, funds and "tools" that are dedicated to the park on an ongoing basis. The "tools" are not so much hardware as the plans, standards, policies, codes and protocols used in the management of the natural resources. It is important to establish whether these "tools" meet industry standards (so-called "Best Management Practices") and whether they are based on "Best Available Science."

20.1. Parks and Recreation

The City of Mercer Island's Parks and Recreation Department has primary responsibility for managing Pioneer Park. Multiple staff have responsibilities in Pioneer Park. The Director is the liaison to the Open Space Conservancy Trust that owns the park. The Park Arborist has the responsibility for planning and management of trees and natural vegetation in the park. The Parks and Recreation Manager directs overall staff operations in the park. This position makes decisions that affect the park's overall character, such as annual trail maintenance schedule or permanent improvements. The Park Generalist works for the Parks and Recreation Manager and manages the daily schedule of the crews. The Park Team Leader has primary responsibility for maintenance in the park and supervises other employees that work there. The Team Leader directs or performs litter pick up, mowing, brushing trails, weeding beds, blowing leaves, servicing trash cans, clearing down trees, and inspecting the site routinely. A three-month seasonal position supports the Team Leader in carrying out these tasks during the summer months.

20.2. Maintenance

The City's Maintenance Department has management responsibilities in and adjacent to the park. The Assistant City Engineer is responsible for maintaining the watercourse in the ravine as a drainage utility. Pioneer Park has significant vegetation in the adjacent right-of-ways. The City's Right-of-Way Manager is responsible for maintaining the streets and public improvements in the right-of-way. This position makes decisions about vegetation in the right-of-way, such as the need for routine trimming of vegetation along the roadway or removing trees that are a hazard. The Park Arborist consults with the Right-of-Way Manager as needed on such issues. The Right-of-Way Manager utilizes City staff and independent contractors to perform such work.

20.3. Development Services Group (DSG)

The City's Development Services Group administers the City's Land Use Code, as well as develops the public infrastructure on the island. The Traffic Engineer is responsible for designing roadways and pedestrian access on the island. Vegetation and trees are issues for sight distance, roadway clearance, roadway safety, etc.

DSG also maintain the City's geographic information system. This system is a computer-based system that contains topography, orthophotos, boundaries, and other digital data that can be useful for forest management. They own a differential geographic positioning system (GPS) that can be useful for pinpointing the location of trees or other objects in

the field. For example, Pioneer Park's trail system was mapped using differential GPS. This technology has limited usefulness under tree canopy, however. Most work must be done during winter months for it to be effective.

DSG also develops and administers the City's tree ordinance and critical areas regulations. Work in the ravine area in the northeast quadrant of Pioneer Park must adhere to these regulations when trees or vegetation are removed. The Parks and Recreation Department obtains an annual permit for tree removals that are necessary for forest management city-wide. The City's Code Officer issues this permit in consultation with the City Arborist.

20.4. Puget Sound Energy

Puget Sound Energy has responsibility to maintain electrical transmission lines on Mercer Island. PSE contracts with Asplundh Tree to perform pruning on trees within the clearance zone of its power lines. This is done on a three to five year cycle. PSE receives a permit for this pruning through the City's Development Services Group. In Fall of 1997, PSE and the City completed a vegetation management project under the power lines on SE 68th Street to replace existing trees that were causing power outages with lower-growing trees. PSE returned in 2002 to remove maples that had resprouted.

20.5. Contractors

A resource often overlooked in planning is the availability of qualified contractors to perform work as it has been planned. Much of the work in this plan requires specialized training and experience to achieve plan objectives. Landscape contractors that specialize in forest restoration will enhance the outcome of project work. To date, the City of Mercer Island has contracted with Green Life Landscaping for the majority of the restoration work in the park. This contractor has proven experience in implementing restoration projects in the park. However, future projects may have different objectives or strategies from those previously implemented. It can be difficult to find qualified contractors for this type of work.

20.6. Technology

Technology for forest management is changing as new research and products become available. The potential of technology is to decrease costs or increase efficiency. However, new technologies also require a "learning curve" that requires an investment of time and resources before it begins to yield benefits. Technology choices will influence the way projects are implemented. For example, one area of experimentation in Pioneer Park is with watering supplements. These are slow-release tubes of water in gel form that are installed at planting. These supplements may improve survival of plants, however they are considered experimental at the current time. Using this technology on a trial basis will help the adaptive management strategy determine whether this has real potential for all projects.

20.7. Funding

Funding for Forest Management has been provided by City Council in the form of a Capital Improvement Project. Fifty thousand dollars per year has been allocated to the park since the year 2000.

20.8. Standards

There are numerous standards that apply to tree care operations. They include:
American National Standards Institute A300 – Pruning (2001)
American National Standards Institute Z133.1 – Tree Care Operations
International Society of Arboriculture *Best Management Practices: Tree Pruning*
American Nursery and Landscape Assoc. *American Standard for Nursery Stock*
Council of Tree and Landscape Appraisers *Guide for Plant Appraisal, 9th Edition*

There are other publications that are not technical standards, but are recognized as the most current and thorough information on the subject. These publications were written by leading experts and have withstood peer scrutiny. Publications that fit this description include:

Trees and Development: a technical guide to preservation of trees during land development
A Photographic Guide to the Evaluation of Trees in Urban Areas
Evaluating Trees for Defect
Flora of the Pacific Northwest
The Natural History of Puget Sound Country
Gardening with Native Plants of the Pacific Northwest
The Once and Future Forest: a guide to forest restoration strategies
Urban Forestry: Planning And Managing Urban Greenspaces
Arboriculture: integrated management of landscape trees, shrubs, and vines. 3rd Ed.

A third category of publications are those developed by local agencies and non-profits with technical information useful for forest management in this region. They are not standards, but they offer the best compilation available on the subject. Examples are:

Naturescaping - A Place for Wildlife
A Manual of Native Plant Communities for Urban Areas of the Pacific Northwest
Slope Stabilization and Erosion Control Using Vegetation
Guideline Specifications for Nursery Tree Quality

This plan recognizes these resources as representative, but not inclusive of the best available science in the field of urban forestry. While a reasonable effort has been made to compile leading information, there may be additional resources that would be valuable to this forest management plan. Furthermore, information becomes more complex over time. The value of new standards should be evaluated and ranked as were the resources listed above.

21. Appendix K: Summary of Community Resources for Pioneer Park

Community resources are the people, funds, expertise and political support that are volunteered in support of the park. Unlike management resources, they are not necessarily dedicated to or fit for a particular service. However, these resources have proven to be indispensable for the long-term sustainability of urban forests. They are a challenge to include in a plan, since they may be available only for limited commitment or go away without notice. Therefore, it is difficult to develop a plan that relies heavily on community resources for implementation.

21.1. Open Space Conservancy Trust

One of the strengths of Pioneer Park is that it has a dedicated body of citizens that serve as a bridge between management resources and community resources. The Open Space Conservancy Trust was chartered in 1992 to own the park and oversee its management. Its board consists of seven members that are selected by City Council. The Board's primary responsibilities are to direct the long-term management of Pioneer Park and to provide input and feedback to the Parks and Recreation Department about its short-term management of the park. It also has responsibilities to communicate with citizens about the park. The Board meets monthly to review management issues germane to Pioneer Park. The Board also publishes a newsletter and periodically hosts open houses to exchange information and ideas with the greater public about the park.

21.2. Ivy Brigade

The Ivy Brigade is a group of volunteers that meet monthly during the non-winter months to remove ivy from trees in the City's parks. Some members also do ivy removal on their own schedule as time permits. They are coordinated by a part-time volunteer coordinator and a Park Team Leader.

21.3. Committee to Save the Earth (CSE)

CSE maintains the native plant garden at Mercerdale Park, and is interested in conservation activities. To date, they have not had explicit involvement in Pioneer Park, but have been involved in tree planting on School District property.

21.4. Youth and School Programs

High school students from the Youth and Family Services E-team have worked in the park during the school year, and the YFS VOICE program sponsors similar summer projects for high school youth. Islander Middle School 8th grade students have turned out occasionally to earn service hours as required for their graduation. Eagle Scouts have also accomplished significant trail work in the park.

21.5. Businesses

Starbucks Coffee Company has expressed interest in supporting some volunteer efforts in the park. The extent of this interest has not been explored. Other businesses in the South End QFC shopping center have not yet been approached for support.

21.6. Churches, Synagogues, Mosques, Temples

Religious groups often organize community service activities. These activities are usually one-time events. Some religious groups have holidays that relate to environmental stewardship. For example, the Jewish calendar includes a tree planting holiday called Tu b'Shevat. To date, this kind of volunteering has played a limited role in Pioneer Park.

21.7. Service Groups

Service organizations such as Rotary Club, Seattle Works, and United Way may be available for volunteer projects. These groups typically seek a large project on a one-time or annual basis. Large projects require recruiting or training volunteer leaders. Discussions about this type of involvement may help find ways to achieve more continuity with these service groups throughout the year.

21.8. Environmental Groups

Individuals affiliated with environmental groups, such as Seattle Audubon and Washington Native Plant Society, have volunteered in the park. These individuals have demonstrated technical competence in their interest area and have contributed substantially to the management of the park. Contacting other such individuals through the local chapters of environmental groups could be very productive.

21.9. Neighbors and Concerned Citizens

Neighbors of the park are potential park stewards. They can help in several ways: monitoring forest conditions, maintaining the edge of their property, preventing dumping in the park, and partnering on restoration projects. To date, Parks and Recreation has made no effort to recruit this kind of help. However, several neighbors have volunteered and are awaiting direction from Parks and Recreation staff.

Individual park users can play a role in environmental stewardship. They often call the Parks and Recreation Department to report problems in the park. Volunteers also can work on their own, once they are registered and oriented as volunteers. Parks and Recreation staff would help them find tasks that achieve forest management goals. Undirected "guerrilla" projects in the park are discouraged because they are likely to work counter to the goals of this plan.

22. Appendix L: Project Planning Form

Pioneer Park
Restoration Project Planning Form

Name of Project_____

Project Manager:_____ Contact Phone_____

Dates of Project:_____ Duration of Project_____

Location: Quadrant:_____ Address or Area:_____ (*show on attached map)*

Size of Project (sq ft)_____ Number of trees being removed_____

Describe Project:_____

_____

_____

Objectives:

GOAL	Objective	Quantities
Tree regeneration		
Invasive control		
Understory treatment		
Community Involvement		

Is this project identified in the Pioneer Park Forest Management Plan? Yes/No

If yes, what project number? _____ Page number in plan ____ Phase _____

If no, does this project conform to the goals and objectives of the Plan? Yes/No
Explain:

Project was reviewed by Parks and Recreation staff on _____date

Project was reviewed by the OSCT Board on _____date Approved? Yes/No

Who will perform the project? Please give names and contact information.

Contractor_____

City Staff_____

Volunteers_____

Cost for the project _____ Fund source _____

Public notification for the project _____

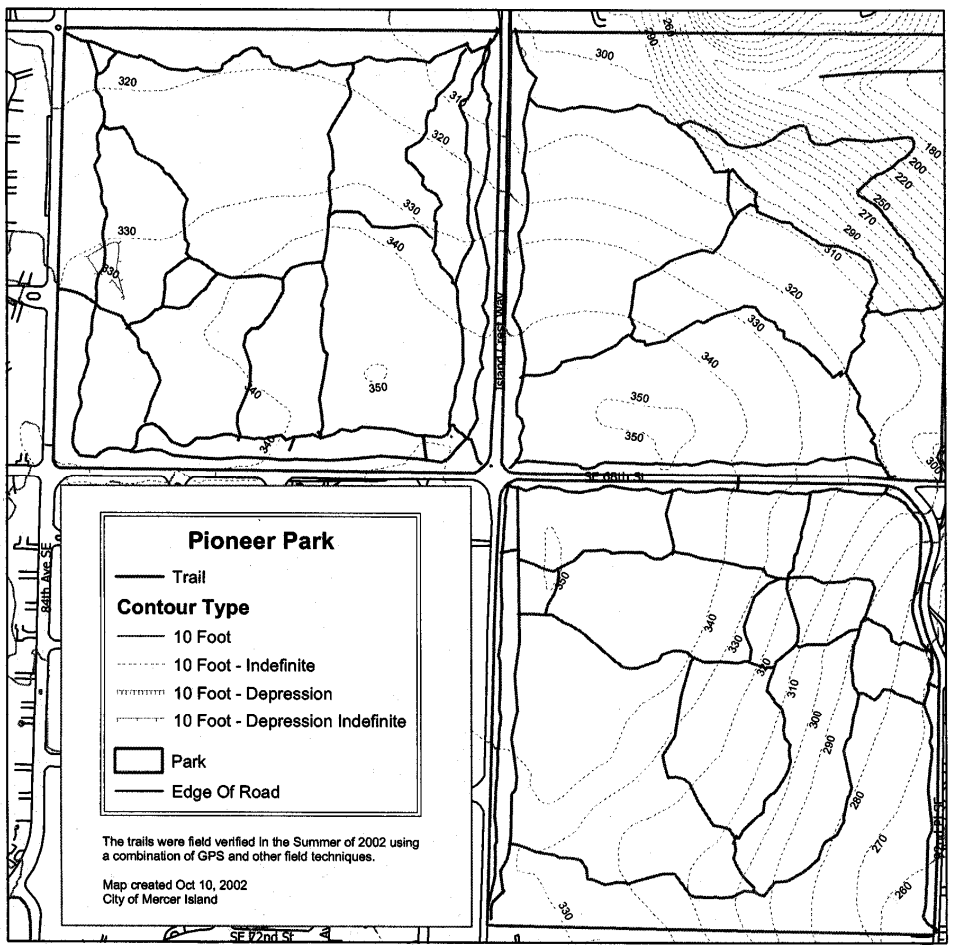
Signs will be located where?_____

Attach Maintenance Plan showing activities, schedule, assignment of responsibility and costs.

For how many seasons?_____ Cost of maintenance_____

Will Parks staff perform any of this work?_____

Who will evaluate the project?_____ At what intervals?_____



23. Appendix M: Pioneer Park and Engstrom Open Space Fire Management Plan

Updated and adopted by the Open Space Conservancy Trust Board, April 21, 2022

23.1 Introduction

Pioneer Park and Engstrom Open Space are susceptible to forest fires of natural and human origin. The risk can be partially managed by planning for an occurrence and intervening to mitigate risk factors before such an occurrence. This plan does both within the constraint of preserving the native forest on Trust properties and using the resources currently available to the City of Mercer Island. The goal of this plan is to guide City departments to better protect Pioneer Park, Engstrom Open Space, and the surrounding neighborhood from fire. It begins by assessing current resources and proposing certain goals for fire management, then describes actions for mitigation of risk factors and improving response to fire occurrences.

23.2 Definitions

- **Automatic Aid:** Recourses that are pre-determined and automatically dispatched for incidents outside of their jurisdictional boundaries.
- **Brush Unit:** Any light, mobile vehicular unit with limited pumping and water capacity.
- **Handline:** Hose lines that are less than 2.5" in diameter used for fire extinguishment.
- **Mutual Aid:** Pre-determined resources that are mutually used across jurisdictional boundaries.
- **Incident Command:** A standardized on-scene emergency management concept specifically designed to allow its users to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries.
- **Incident Commander:** An individual who is properly trained and currently assigned to the overall supervision of an incident.
- **Inter-mix Areas:** The area undergoing a transition from agricultural and forest uses to urban uses.
- **Structure Engine:** A fire apparatus designed to carry tools, supplies, water, and pump capable responding to and mitigating structure fires.
- **Supply Line:** Larger diameter hoses designed to supply large amounts of water to/from pumps to smaller fire suppression hose lines.
- **WUIC**: Wildland Urban Interface Code.

23.3 Resource Assessment

Firefighting Resources

The Mercer Island Fire Department (MIFD) would be the first response to fire occurrence. MIFD has seven firefighters stationed on the island at any one time. Three are located at Fire Station 92, which is located on the south side of SE 68th St, across from Pioneer Park's NW Quadrant.

The remaining firefighters are located at Fire Station 91, located approximately 3 miles north of Pioneer Park. Either station might respond to a fire based on the battalion's availability. The Incident Commander would make the decisions about fighting a fire based on the situation.

Washington State Department of Labor and Industries allows firefighters in structural protective clothing to work a maximum of one hour on a wildfire (WAC 296-305). First response by on-duty staff could be followed by calling out for mutual aid from adjacent jurisdictions. If required, off-duty staff could be called to report for duty as the Incident Commander deems necessary, and dependent on the duration of the incident.

Mutual aid agreements with other jurisdictions allow MIFD to request fire units from other fire departments. Bellevue, Kirkland, Woodinville, Redmond, Seattle and Eastside Fire and Rescue have resources that would be useful for wildland fire fighting; these Departments have firefighters who are wildland firefighting certified ("Red Card") to fight this type of fire, and who would respond under a mutual aid request. These resources would likely be needed depending on the extent of a fire.

Washington State Department of Natural Resources (DNR) also has the capability to fight wildland fires. They may be called in, if necessary, when local and mutual aid resources are exhausted. DNR offers many resources most fire departments do not have, such as inmate crews, wildland engines, and experienced overhead (aerial) support.

Hydrants and Hose Access

Pioneer Park and Engstrom Open Space have fire hydrants along the perimeter roads. Other boundaries also have hydrants available through private property. Hose that is normally used in structural firefighting is too bulky and cumbersome to be used in wildland firefighting, but can be used to maintain and support the supply of water to smaller handlines. MIFD has 600 feet of wildland hose (single jacket, lightweight) specific to wildland firefighting available and 1000 feet of 4" traditional structure hydrant supply line for hydrant hook-up on each of its units.

However, topography and trail access reduce the actual distance that water can be conveyed into the park by fire hose. Realistically, 500 feet is the maximum distance that water can be reliably conveyed into the park using conventional tactics. While it is possible to extend the 500 feet further, additional resources and personnel would be needed. Figure 1 illustrates that center of each quadrant and some parts of the ravine in the Northeast quadrant are more than 500 feet from an available hydrant, leaving significant areas of the park without access to water in case of a fire. During these situations other tactical options should be considered such as hand crews and helicopter operations.

Figure 1: Map showing hydrant locations and coverage in Pioneer Park and Engstrom Open Space.

23.4 Goals and Priorities

Common fire mitigation strategies used in dry forests, such as thinning or understory clearing, do little to mitigate fire risk in the dense, fuel-rich forests of western Washington[1]. In naturally high-biomass ecosystems like Pioneer Park and Engstrom Open Space, the most effective approaches to mitigating fire risk are to 1) minimize ignition sources, 2) quickly detect and suppress fires that do occur, 3) maintain a healthy, biodiverse ecosystem that can be resilient in

1. Joshua S. Halofsky et al., "The Nature of the Beast: Examining Climate Adaptation Options in Forests with Stand-Replacing Fire Regimes," Ecosphere 9, no. 3 (March 2018): e02140, https://doi.org/10.1002/ecs2.2140.;

Matt Provencher, "Wildfires in Western Washington: Less Frequent, but No Less Dangerous," Forest Stewardship Notes (Washington State University Extension; Washington State Department of Natural Resources, February 1, 2021), https://foreststewardshipnotes.wordpress.com/2021/02/01/wildfires-in-western-washington-less-frequent-but-no-less-dangerous/.

the face of disturbance, and 4) maintain defensible buffers around structures and buildings.[2] The goals of the Pioneer Park Forest Management Plan (PPFMP) are directed toward maintaining a healthy, biodiverse native forest with vegetated buffers and abundant downed wood for habitat and tree regeneration. The goals outline in the PPFMP are generally in line with expert recommendations. However, they also suggest that additional effort is needed to reduce ladder fuels and dense, dead vegetation where park boundaries overlap with a neighbor's defensible space.

Prescriptions for wildland fire response should include the early identification, as well as early request and allocation of resources. The size and location of the hydrant system surrounding Trust properties, as well as the immediate availability of a highly-trained, well-equipped firefighting staff, allow for rapid suppression of fires when they do arise, making these forests distinct from typical wildland fire situations.

The priorities for MIFD response in any situation are (in priority order) life, property, and incident stabilization. Protecting lives and adjacent homes would be the overriding concern of the Incident Commander in a forest fire situation. A large fire in the park could burn sizable portions of the park before it could be brought under control. There is also the risk of fire extending outside the park boundaries leading to a potential conflagration. Additional risk is assumed if a fire in the park reaches the crowns of a cluster of trees, particularly in warm, dry weather, in which case, providing a defensive line of fire crews to protect fire from reaching homes on the park perimeter would be a top priority. While uncommon in suburban/urban intermix areas, it should be a consideration of the fire response crews and pre-incident planning. Early identification and early resource allocation in imperative.

23.5 Evaluation

Pioneer Park and Engstrom Open Space are susceptible to fire primarily from human behavior. Historical incidents of campfires and fireworks use in the park are concerns. The forest is particularly prone to drought during dry years because the soils are well drained. Woody debris and organic "duff" are abundant in the park, creating fuel in dry seasons. Houses back up to the park, with minimal distances between structures and stands of dense vegetation. The interior of the park is not accessible to fire vehicles because the trails are too narrow for large fire apparatus to traverse.

However, the size of the park and the cooler, moister climate of western Washington reduce risk in comparison to eastern Washington forest landscapes. The quadrants are surrounded by a network of fire hydrants that can supply water to the park perimeter and significant portions of the interior. Fire Station 92 is located across the street from the park. The staff of the MIFD is

[2]Halofsky et al., "The Nature of the Beast".;

Brian Harvey, Daniel Donato, and Joshua Halofsky, "Fighting Wildfires in Western WA Requires Different Approaches | Crosscut," crosscut.com, July 14, 2021, https://crosscut.com/opinion/2021/07/fighting-wildfires-western-wa-requires-different-approaches.;

Provencher, "Wildfires in Western Washington".

highly trained and experienced in incident response. Furthermore, mutual aid agreements with other cities and the availability of DNR crews would enable the City to respond and initiate mitigation and control measures and provide specialized capabilities as conditions warrant.

Limitations in response include the difficulty of conveying water to the center portion of a quadrant, difficult terrain in certain areas of the park, and limited firefighting resources. For certain hydrants, vegetation poses a barrier to ready trail access, while other hydrants have no trails that lead into the park. City firefighters have not received training specific to the situation in Pioneer Park and Engstrom Open Space. These limitations are certainly addressable (See section 23.6 *Action Items*).

In most fire scenarios within the wooded areas, MIFD will likely lay hose lines into the interior of the park and wait for the fire to reach their location. One advantage here is that the park trail system provides reasonable access, except in the NE corner of the NE quadrant, where the terrain is untenable.

	Safety Factors	Risk Factors
Fire Occurrence	• Well-developed trail system • Extensive fire hydrant network around park perimeter • Nearby location of Fire Station 92 • Trained and coordinated firefighters • Mutual aid agreements with other cities • Availability of DNR resources • Incident Management protocols for all possible fire scenarios (NIMS)	• Narrow trail widths • Some hydrant locations are not close to trail access points • Lack of water conveyance to the interior of the park • Lack of firefighter training specific to Trust properties • Limited *initial* firefighting resources • Hilly terrain and shrubby understory vegetation in certain quadrants reduces ability to lay hose lines close to the seat of a fire
Fire Mitigation	• Street buffers • Low summer temperatures • Winter rainfall • Low summer wind speeds • Small land area • Cooler, covered canopy • Moisture of ground materials	• Seasonal low rainfall • Well-drained, drought-prone soils • Woody debris and “duff” (ground fuel load) • Campfire activity • Fireworks use in the park • Minimal backyard buffers • Lack of supervision

Figure 2: Case-specific factors in Fire Occurrence and Fire Mitigation at Pioneer Park and Engstrom Open Space

23.6 Vegetation Management Plan

The Pioneer Park Forest Management Plan outlines the City's approach to maintaining a healthy, resilient forested ecosystem. Strategies described in the plan include preserving existing canopy, aiding natural regeneration by planting habitat- and climate- adapted species, and removing invasive plants to improve biodiversity and prevent overcrowding.

In addition to improving the health and resiliency of forests throughout the park, City staff will work with participating neighbors to cooperatively develop a plan for managing park boundaries that meets forest management and fire management goals. City staff will recommend ways the forest edge can be managed to establish a defensible space in areas where Trust property is within 30 feet of a home or structure[3]. Site-specific recommendations will be developed in accordance with resources and input from King Conservation District and King County Department of Natural Resources and Parks. Some examples of these recommendations are to 1) remove dense patches of dead vegetation, 2) ensure any dead trees that are leaning against structures or other trees are felled and in full contact with the ground, 3) prune overhanging branches to create a 6-10 foot buffer between any structures and the canopy.

23.7 Action Items

Fire Occurrence

1. MIFD will offer training for pertinent to the Pioneer Park and Engstrom Open Space situation. The DNR Western Washington Interagency Training Committee provides standard training on wildfire situations.
2. MIFD will familiarize staff with Pioneer Park and Engstrom Open Space and evaluate its existing equipment for anticipated incidents in the park.
3. MIFD will develop a list of desirable basic firefighting hand tools to be stored in fire caches at Stations 91 and 92.
4. Both departments will further research the availability of DNR for fire response and determine what conditions may warrant their involvement.
5. MIFD will work with other local jurisdictions to ensure the establishment and maintenance of Automatic Aid and Mutual Aid agreements.
6. MIFD will provide annual refresher training to fire crews on initial wildland fire response.

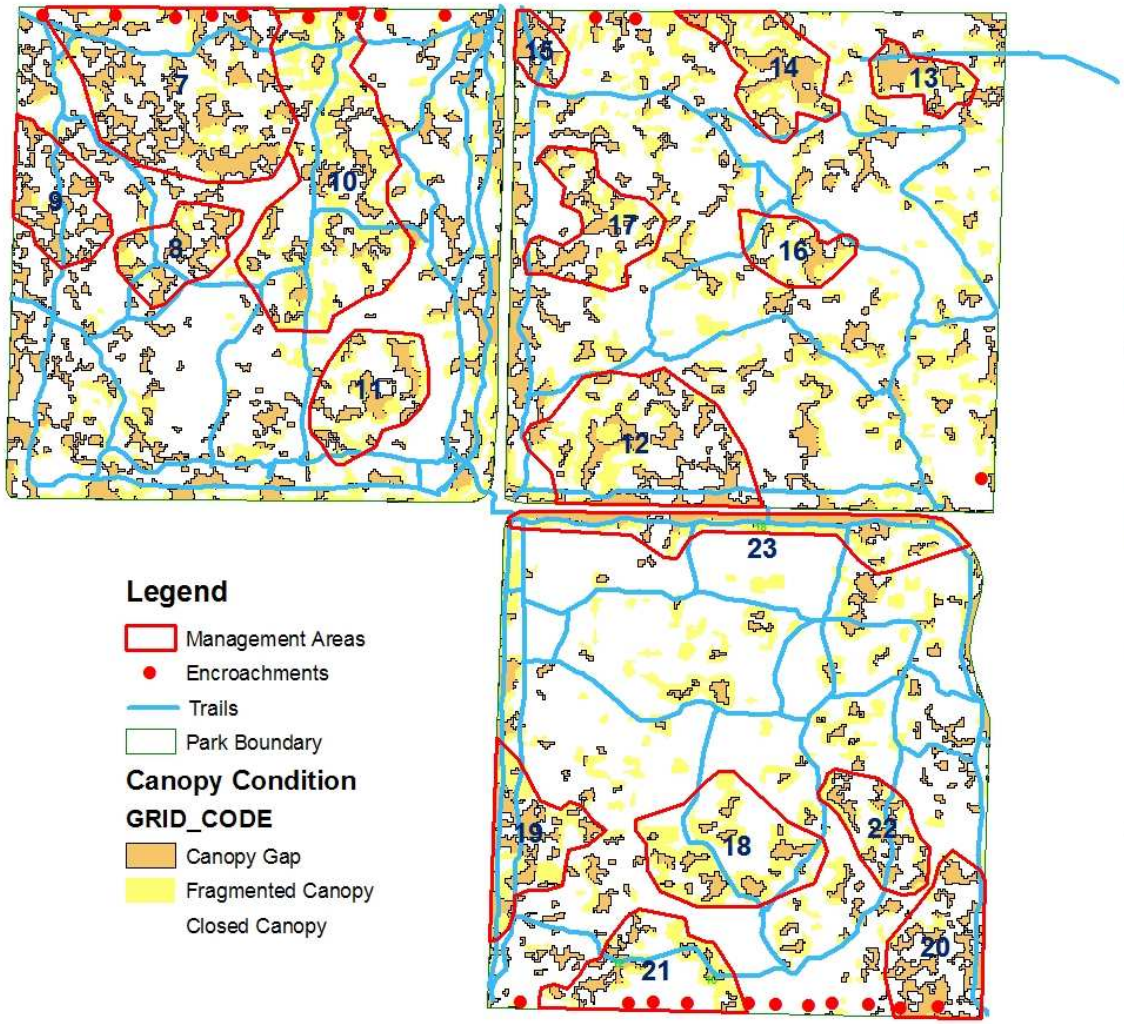
Forest Fire Mitigation

1. Parks staff will conduct an educational campaign about fire-wise landscaping with adjacent property owners using existing educational materials.
2. Parks staff will work with interested park neighbors to establish a defensible space and improve habitat value along the residential perimeter of the park.

[3] King County Department of Natural Resources and Parks, "Be Firewise: Create the First Line of Defense," n.d., https://your.kingcounty.gov/dnrp/library/water-and-land/forestry/forestfire/FirewiseBrochure-rev.pdf.

3. Parks staff will patrol remote locations of the park during summer months to identify and address potential human-cause ignition sources.

24. Appendix N: Forest Management Projects



Pioneer Park Forest Management: Canopy Condition and Management Areas

Management areas have been identified based on the presence of canopy gaps, fragmented canopy and vegetation condition within those areas. Priorities are outlined in the associated spreadsheet.

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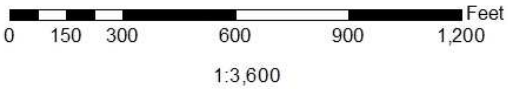

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Project	project type	Acres	Quadrant	priority	Goal	Total cost	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
1	controlling ivy in trees, laurel and holly	113	all	1	control invasive plants in non-project areas	$50,000					5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
2	public education	113	all	1	raise awareness of public about park environment	$20,000					2000	4000	4000	4000				2000	2000	2000
3	neighbor partnerships	3	all	1	recruit park stewards from adjoining neighbors	$10,000				7000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
4	wildlife habitat assessment	113	all	2	inventory wildlife habitat and determine needs	$3,000												3000		
5	tree risk management	113	all	1	prune or remove hazard trees	$20,000				9221	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
6	forest mangement Plan	113	all	1	revise plan with experience and data from projects	$18,000					8000								10000	
7	NW Regen mgmt w/conifer planting	5.36	NW	1	foster native regeneration, plant conifers, control invasives	$59,326					17798	17798	11865	5933	5933					
8	NW Regen mgmt w/conifer planting	1.28	NW	1	foster native regeneration, plant conifers, control invasives	$14,882								4465	4465	2976	1488	1488		
9	NW Regen mgmt w/conifer planting	1.52	NW	1	foster native regeneration, plant conifers, control invasives	$17,524							5257	5257	3505	1752	1752			
10	NW Regen mgmt w/conifer planting	5.54	NW	2	foster native regeneration, plant conifers, control invasives	$61,232										18369	18369	12246	6123	6123
11	NW Regen mgmt w/conifer planting	1.82	NW	1	foster native regeneration, plant conifers, control invasives	$20,762								6228	6228	4152	2076	2076		
12	NE deciduous regen mgmt	3.86	NE	1	encourage deciduous regeneration, control invasives	$43,046		???	???	???	12000	4000	1000							
13	NE ravine mgmt w/planting	0.77	NE	2	install erosion control, replant canopy trees	$9,407												2822	2822	1881
14	NE ravine mgmt w/planting	1.69	NE	1	install erosion control, replant canopy trees	$19,429							5829	5829	3886	1943	1943			

Project	project type	Acres	Quadrant	priority	Goal	Total cost	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
15	NE regen mgmt w/conifer planting	0.46	NE	2	foster native regeneration, plant conifers, control invasives	$5,991			???	???	500	500						1797	1797	1198
16	NE deciduous regen mgmt	0.96	NE	2	encourage deciduous regeneration, control invasives	$11,449												3435	3435	2290
17	NE regen mgmt w/conifer planting	2.35	NE	1	foster native regeneration, plant conifers, control invasives	$26,520		???	???	???	1500									
18	SE deciduous regen mgmt	2.76	SE	2	encourage deciduous regeneration, control invasives	$30,984											9295	9295	6197	3098
19	SE deciduous regen mgmt	1.68	SE	1	encourage deciduous regeneration, control invasives	$19,229	???	???	???	???	1000	1000								
20	SE regen mgmt w/conifer planting	2.02	SE	2	foster native regeneration, plant conifers, control invasives	$23,003									6901	6901	4601	2300	2300	
21	SE deciduous regen mgmt	2.11	SE	1	encourage deciduous regeneration, control invasives	$23,909						7173	7173	4782	2391	2391				
22	SE deciduous regen mgmt	1.27	SE	2	encourage deciduous regeneration, control invasives	$14,859									4458	4458	2972	1486	1486	
23	Utility canopy conversion	2.07	SE	1	remove hazard trees, plant trees that won't grow into powerlines	$23,562						7068	7068	4712	2356	2356				
							20000	60400	50000	50000	50798	49539	50192	49206	48122	53299	50497	49946	44160	24591

25. Appendix O: Restoration Plant List for Pioneer Park

	BOTANICAL NAME	COMMON NAME	LOCATION	EXPOSURE	SPACING
	Abies grandis	Grand Fir	M>U	FSn - Sh	>= 15' o.c.
	Arbutus menziesii	Madrona	U>M	FSn	>=10' o.c.
	Pinus contorta v. contorta	Shore Pine	U>W	FSn	>=10' o.c.
	Pinus monticola	Western White Pine	U>M	FSn	>=15' o.c.
EVERGREEN	Pseudotsuga menziesii	Douglas Fir	M>U	FSn - PSh	>= 15' o.c.
TREES	Thuja plicata	Western Red Cedar	W > U	FSn - Sh	>= 15' o.c.
	Tsuga heterophylla	Western Hemlock	W > U	FSn - Sh	>= 15' o.c.
	Taxus brevifolia	Pacific Yew	W>M	FSn - PSh	>= 10' o.c.
	Alnus rubra	Red Alder	W>U	FSn - PSh	>= 10' o.c.
	Acer circinatum	Vine Maple	W, U	PSh	>= 6' o.c.
BROADLEAF	Acer macrophyllum	Bigleaf Maple	M>U	FSu - PSh	>= 10' o.c.
TREES	Amelanchier alnifolia	Serviceberry	U > W	FSn - PSh	>=6' o.c.
	Arbutus menziesii	Pacific Madrone	U>M	FSn	>=10' o.c.
	Betula papyrifera	Paper Birch	M>W	FSn	>=10' o.c.
	Craetegus douglasii	Pacific Hawthorn	M	FSn	10' o.c.
	Fraxinus latifolia	Oregon Ash	W>U	FSn - PSh	>= 10' o.c.
	Cornus nuttalii	Pacific Dogwood	U.M	FSn – PSh	10’ o.c.
	Prunus emarginata	Bitter Cherry	M>U	FSn	10' o.c.
	Quercus garryana	Oregon Oak	U	Fsn	10' o.c.
	Rhamnus purshiana	Cascara	W>M	FSn - PSh	10' o.c.
	Cornus stolonifera	Red Osier Dogwood	W>M	FSn - PSh	4' o.c.
	Corylus cornuta californica	Hazelnut	U > W	FSn - Sh	>= 6' o.c.
	Gaultheria shallon	Salal	M>U	FSn - Sh	18" o.c.
	Holodiscus discolor	Oceanspray	U>M	FSn	4' o.c.
	Lonicera ciliosa	Creeping Honeysuckle	U	FSn-PSh	4' o.c.
SHRUBS	Lonicera involucrata	Honeysuckle	W>U	FSn-PSh	3' o.c.
	Mahonia aquifolium	Tall Oregon Grape	U	FSn - PSh	4' o.c.
	nervosa	Cascade Oregon Grape	U >M	PSh - Sh	18" o.c.
	Oemlaria ceraciformis	Indian Plum	W>U	PSh - Sh	6' o.c.
	Oplopanax horridum	Devil's Club	W	PSh	4' o.c.
	Pachistima myrsinites	Oregon Box	M>U	PSh - Sh	2' o.c.
	Philadelphus lewisii	Mock Orange	M>U	FSn - Psh	6' o.c.
	Physocarpus capitatus	Pacific Ninebark	W, U	FSn - Psh	8' o.c.
	Rhododendron macrophyllum	Pacific Rhododendron	M>U	PSh	random
	Rosa gymnocarpa	Baldhip Rose	U	FSn-PSh	4' o.c.
	Rosa nutkana	Nootka Rose	M > U	FSn - PSh	5' o.c.
	Rubus parviflorus	Thimbleberry	W>U	FSn - PSh	4' o.c.
	Rubus spectabilis	Salmonberry	W>M	fSn - Sh	4' o.c.
	Salix scouleriana	Scouler's Willow	W>M	FSn	2' o.c.
	Salix hookeriana	Hooker's Willow	W>M	FSn	2' o.c.
	Salix laisandra	Pacific Willow	W	FSn	8' o.c.
	Sambucus racemosa	Red Elderberry	M>W	FSn-PSh	4' o.c.
	Spiraea douglasii	Hardhack	W>U	FSn	3' o.c.
	Symphoricarpos alba	Snowberry	M > U	FSn - PSh	4' o.c.

	Vaccinium ovatum	Evergreen Huckleberry	U>M	FSn - PSh	4' o.c.
SHRUBS	Vaccinium parvifolium	Red Huckleberry	W>M	PSh	4' o.c.
	Viburnum edule	Moosewood	W	FSn - PSh	6' o.c.
	opulus (trilobum)	High Bush Cranberry	W > U	FSn - PSh	6' o.c.
	Adiantum pedatum	Maidenhair Fern	W	Sh	random
	Athyrium filix-femina	Lady Fern	W>M	PSh-Sh	random.
	Blechnum spicant	Deer Fern	U > W	PSh - Sh	random
FERNS	Dryopteris expansa	Wood Fern	U	PSh-Sh	random
	Gymnocarpium dryopteris	Oak Fern	W, U	Sh	18" o.c.
	Polystichum munitum	Sword Fern	W, U	FSn - Sh	3' o.c.
	Achlys triphylla	Vanilla Leaf	W, U	PSh - Sh	12" o.c.
	Aquilegia formosa	Red Columbine	W, U	FSn - PSh	random
HERBACEOUS	Aruncus diocus (sylvester)	Goat's Beard	W	FSn - PSh	random
	Circaea alpina	Enchanter's Nightshade	U, M	PSh-Sh	12" o.c.
	Claytonia siberica	Miner's Lettuce	M,U	FSn-Sh	12" o.c.
PERENNIALS	Dicentra formosa	Western Bleeding Heart	W, U	PSh - Sh	12" o.c.
	Fragaria vesca	Wood Strawberry	U	FSn-PSh	12" o.c.
	Geum macrophyllum	Large-Leaf Avens	U	PSh-Sh	random
	Maianthemum dilatatum	False Lilly-Of-The-Valley	W > U	PSh - Sh	18" o.c.
	Osmorhiza chilensis	Sweet Cicely	U	PSh-Sh	random
	Tellima grandiflora	Fringecup	U	FSn-PSh	random
	Tiarella trifoliata	Foamflower	W>U	FSn - PSh	18" o.c.
	Tolmiea menziesii	Piggyback Plant	W>M	PSh	18" o.c.
	Trientalis borealis latifolia	Starflower	U	PSh	12" o.c.
	Trillium ovatum	Western Wake Robin	U	PSh	random
	Vancouveria hexandra	Inside-Out Flower	M>U	PSh-Sh	12” o.c.
	Carex obnupta	Slough Sedge	A	PSh - Sh	18" o.c.
WETLAND	Lysichitum americanum	Skunk Cabbage	A, W	PSh - Sh	random
	Juncus ensifolius	Dagger Leaf Rush	A, W	FSn - PSh	12" o.c.
	Oenanthe sarmentosa	Water Parsely	W	FSn - PSh	18" o.c.
	Sagittaria latifolia	Arrowhead, Wapato	A, W	FSn - PSh	12" o.c.
	Scirpus microcarpus	Small Fruited Bullrush	W>A	FSn - PSh	18" o.c.
	M=Mesic U = Upland				
	A = Marsh (Aquatic) W = Wetland				
	FSn = Full Sun PSh = Part Shade Sh = Shade				
	o.c. = on center >= greater than or equal				

26. Appendix P: Identified Encroachments in Pioneer Park

Street Number	Street	Type of encroachment
6306	84th Av SE	yard waste
8421	SE 63rd St	lawn, rockery, yard drain, wood pile
8437	SE 63rd St	lawn, shed, landscaping
8445	SE 63rd St	yard waste
8453	SE 63rd St	yard waste
8611	SE 63rd St	lawn, landscaping, yard waste
8621	SE 63rd St	yard waste
8631	SE 63rd St	landscaping, gravel path, wood pile
8651	SE 63rd St	yard waste
8817	SE 63rd St	lawn, landscaping, arbor
8807	SE 63rd St	fence
6250	89th Av SE	yard waste
7190	SE 72nd Pl	shed, fence, lawn, yard waste
8836	SE 72nd Pl	fence
8838	SE 72nd Pl	light on tree
8852	SE 72nd Pl	firewood, debris
8868	SE 72nd Pl	gravel path, bark area
8874	SE 72nd Pl	yard waste, firewood
9100	SE 72nd Pl	compost bin, yard waste
9108	SE 72nd Pl	swing set
9116	SE 72nd Pl	compost bin
9120	SE 72nd Pl	yard waste
7201	92nd Av SE	lawn, doghouse, wood pile, compost bin
9200	SE 68th St	driveway

27. Appendix Q: Trees Suitable for Transmission Line Corridors

Species	**Common Name**	**Height Ft**	**Width Ft**	**Location Relative to Power Lines**
Acer circinatum	Vine maple	20	15	under
Acer glabrum	Rocky Mtn maple	30	20	Side
Amelanchier alnifolia	Serviceberry	15	15	Under
Calocedrus decurrens	Incense cedar	40	15	side
Corylus cornuta	Hazel	15	15	under
Crataegus douglasii	Pacific hawthorn	20	15	Under
Cupressus bakeri	Modoc cypress	30	10	Side
Juniperus scopulorum	Juniper	30	10	Side
Lithocarpus densiflorus	Tanbark oak	20	15	Under
Pinus contorta var contorta	Shore pine	30	20	Side
Rhamnus purshiana	Cascara	30	15	Side
Taxus brevifolia	Pacific yew	20	20	Under

28. Appendix R: 2008 Pioneer Park Forest Health Survey




2008 FOREST HEALTH SURVEY

Pioneer Park, Mercer Island, WA

Prepared by: Benjamin Peterson
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In consultation with: Seattle Urban Nature

PIONEER PARK FOREST HEALTH SURVEY REPORT

EXECUTIVE SUMMARY

Pioneer Park, which covers 114 acres in the south part of Mercer Island, is the largest open space area within the city. The preservation and fostering of forest health of the park is a priority for the City of Mercer Island and the Open Space Conservancy Trust. In 2008, the City of Mercer Island, in conjunction with Seattle Urban Nature (SUN), mapped habitat types and conducted a vegetation inventory in Pioneer Park. The goals of the project were to:

1) provide an inventory of native and invasive species in the park
2) compare the success of previous management efforts
3) create a management plan based on collected data
4) estimate the time and cost necessary to meet the set goals

Four forested habitat types were mapped in the park: conifer forest, conifer/ deciduous mixed forest, riparian forest and landscaped forest. To study these habitats, 56 1/10th acre rectangular vegetation plots were established throughout the forested natural areas of Pioneer Park. Within these plots, information about trees, shrubs, vines, herbaceous plants, snags and downed wood was recorded.

The overall quality of the shrub and herbaceous vegetation throughout the park was found to be in good condition. Native shrubs and herbaceous species outnumbered their non-native invasive counterparts in both species diversity and percent cover. The quality and quantity of dead and downed wood in the park was comparable to other Seattle-area urban forests, and is sufficient to support a variety of wildlife species within the park.

Results of the study also show that there are serious threats and concerns to the ecological integrity of the forests at Pioneer Park. Large populations of regenerating invasive trees (English holly and cherry laurel) cover the forest floor while English ivy, an invasive vine, was found growing on 20% of the native canopy trees. In addition, there are very few naturally regenerating conifer trees, suggesting that without active management, the conifer-dominated canopy may be lost and replaced by canopy gaps and native deciduous trees in the near future.

The current management strategy, adopted from the 2003 Forest Management Plan, involves intensive removal of existing invasive species and native tree planting. While this strategy has been effective, it lacks the flexibility needed to target specific urgent forests health issues. A new management strategy is proposed that allows the flexibility necessary to target a range of issues such as key invasive species eradication and long-term planning for the future structural diversity of the forest. The new management strategy prescribes immediate removal of English ivy from canopy trees, eradication of the invasive plants English holly and cherry laurel, and planting of disease-resistant conifer trees in a two stage approach.

Management using the strategy recommended by this report has been organized into a 20 year plan. The cost of this preferred 20 year plan ($3,580,000) is estimated to be similar to the cost of achieving similar goals using the current strategy ($3,730,000)

established in the 2003 Forest Management Plan. The preferred 20 year plan would substantially increase the likelihood of long-term ecological sustainability by allowing managers to initially focus management priorities on immediate threats affecting forest health. However, current funding ($55,000 per year from CIP for Pioneer Park) and new funding ($77,000 per year from Proposition No. 2 - Levy for Park Operations and Maintenance) is not sufficient to achieve the preferred plan.

Therefore, a restricted budget management strategy was developed that, while based on the preferred 20 year plan, stays within the currently available budget. In order to accommodate this budget, the timing of management activities was changed and some follow-up maintenance reduced. These changes are likely to compromise the effectiveness of the recommendations, as priority activities, such as holly and laurel removal, tree planting, and ivy ring creation will take longer to complete. The budget-restricted plan also requires 25 years of management to achieve comparable levels of forest health set in the original plan (20 years). If additional funding becomes available in future years, priority management activities can be accelerated to rates comparable to the preferred plan.

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1. INTRODUCTION

1.1. Purpose of study

In June 2008, the City of Mercer Island City Council funded a forest health survey in Pioneer Park. This study was proposed in response to several questions posed by the Trustees of the Open Space Conservancy Trust. The primary aim of the forest health study is to assess the feasibility of accomplishing goals set forth in the 2003 Pioneer Park Forest Management Plan (PPFMP) within reasonable funding and time constraints. Specifically, the study was designed to:

1) establish a baseline assessment of native and invasive species cover in the park
2) compare the success of various management efforts
3) estimate the time and cost necessary to meet the set goals

See Appendix A for a complete list of the 2003 PPFMP goals.

1.2. Site location and context

A comprehensive overview of Pioneer Park can be found in the Pioneer Park Forest Management Plan, adopted in 2003.

1.2.1. Area description

Pioneer Park is located in the south end of Mercer Island in King County, Washington, and consists of approximately 114 acres of public land. The park is split into three, nearly equal-sized contiguous units, divided by Island Crest Way and Southeast 68th Street. These units are appropriately referred to as the northwest (NW), northeast (NE), and southeast (SE) quadrants.

Of the total 114 acre area, approximately four acres are considered landscaped forest. These areas, which are primarily composed of mowed grass and large trees, are a transition landscape feature between busy roads and the non-landscaped forest. The remaining 110 acres of the park are non-landscaped forests, managed for native ecosystem function (current management is described in Section 1.4). Parking at Pioneer Park is limited to informal turnouts on roadsides, and a portable latrine, located at the southeast corner of the NW quadrant, serves as the park's only restroom. There are no formal facilities within the park. The park, as a whole, has 6.9 miles of trails (Map 1). The primary use of the park is recreational: walking, running, and horseback riding. Hiking and bicycling are allowed on all the trails, however horseback riding is allowed only on the Horse and Fire Station Trails of the NW quadrant and throughout the SE quadrant, a total of 3.5 miles of trail.

1.2.2. Hydrology

Most of the land at Pioneer Park is relatively dry upland. However, the northeast part of the NE quadrant contains several diverse hydrologic features. A ravine with a small perennial stream enters the NE quadrant at the center of the north border (Map1). The drainage then curves to the east and drains near the park's northeast entrance. The stream enters a culvert as it exits the park. Also in the northeast section of the NE quadrant are several naturally occurring seeps. These outlets of groundwater support populations of unique plant species such as skunk cabbage (*Lysichiton americanus*) and

devils club (*Oplopanax horridus*). The north central part of the NW quadrant contains a region with poorly drained soils, which has resulted in high densities of water-loving shrubs such as salmonberry (*Rubus spectabilis*).

1.2.3. Geology and soils

The soil and topographic features at Pioneer Park owe their development largely to glacial activity within the past 10,000 years. Higher areas and ridges in the topography were left after glaciers gouged troughs and deposited sediment. The elevation drops 45m (150') from the rim of the adjacent upland area in the park's NE quadrant to the bottom of the ravine. Slopes in the ravine area of the NE quadrant can exceed 30 degrees.

The soils of Pioneer Park, as the result of glacial activity, are sandy and gravely. However, some areas of the park have a relatively shallow, cemented substratum which prevents soil drainage and results in areas of wet soil. Other areas, which do not have this drainage barrier, have relatively dry soils as a result of its coarse texture. A more detailed description of the soils at Pioneer Park can be found in the "Soil -The Park's Foundation" section of "Pioneer Park: A Natural History" (Mercer Island Parks and Recreation Department, 1990).

1.3. Site use history

The first documented management of the land which is now occupied by Pioneer Park was in the late 1800s when the area was logged (Gellantly, 1989). Since the logging activities of the late 1800s and early 1900s, no large-scale alterations have been made to this land. The land was held privately until 1931, when it was willed to the University of Washington. The park was then bought by the newly incorporated City of Mercer Island in 1964, following passage of a bond. Despite several attempts to turn parts of the park into a golf course, Pioneer Park has remained intact since becoming a park. The construction of a formal trail system is the only major change to the park since its creation. In 1992, the City of Mercer Island chartered the Open Space Conservancy Trust to oversee the preservation of Pioneer Park and ensure that all uses of and improvements to the park "shall not change its character or impair any of its ecological, scenic, aesthetic, or natural attributes" (Mercer Island Open Space Conservancy Trust & City of Mercer Island Parks and Recreation Department, 2003).

1.4. Current vegetation management practices

Starting in 1997, the City of Mercer Island began various restoration projects within Pioneer Park. The 2003 Pioneer Park Forest Management Plan outlined a preferred management plan, the "Purely Native" scenario, which focused on "aggressive control of invasive, non-native plants" and "dispersed planting of evergreen and deciduous overstory species". What has been adopted since is a strategy that incorporates the complete weed removal aspects of that plan with a more intensive planting regime than the plan stated. Today, these activities continue, with sections of the park receiving varying levels of treatment. For the purposes of this survey, these activities have been split into three main groups: *control, selective treatment,* and *comprehensive treatment*.

Control areas are those that have not received any organized effort to eradicate invasive plants or plant trees and shrubs. Areas that have received *selective* treatment are those in which one or more specific type of restoration effort has taken place. *Selective*

treatments may include tree planting, Himalayan blackberry (*Rubus armeniacus*) removal, Himalayan blackberry knockdown, creation of English ivy (*Hedera helix*) rings, holly (*Ilex aquifolium*) and cherry laurel (*Prunus laurocerasus*) removal or ivy removal. While *selective* treatment is not considered a viable, complete strategy for creating a healthy forest on its own, *selective* treatment methods can yield effective results as part of a larger management strategy. In this paper, *selective* treatment areas are used to assess the effectiveness of a given treatment in the continuum from *control* areas to *comprehensive* areas. *Comprehensive* treatment includes both removal of all non-native species **and** planting of native conifer trees. A condensed description of *comprehensive* removal is described below. For a thorough description of management activities, can be found in Appendix F.

The removal of non-native species includes:

- Himalayan blackberry– roots dug up from the forest floor, and biomass piled and left to compost on site,
- English ivy– roots dug up, and biomass piled and left to compost **and** ivy growing on trees severed at base and removed from tree trunk to approximately four feet high,
- Other non-native, invasive small shrubs and herbaceous plants - roots dug up, and biomass piled and left to compost or removed from site
- Cherry laurel, English holly and other non-native, invasive shrubs and small trees – stems girdled and treated with glyphosate herbicide

Follow-up weed removal is done at *comprehensive* treatment sites for two years. This work, which uses the methods described above, is completed at least once during the late spring or summer.

Following initial removal, *comprehensive* treatment areas are inter-planted with native trees and shrubs. The density of the plantings varies from 3’ spacing for shrubs to 8’ to 15’ spacing for trees. Shrub species vary, but tree species consist mostly of native conifers.

2. STUDY METHODOLOGY

Methods used in this study were adapted from established methodologies created by Seattle Urban Nature (Seattle, WA). Execution of this study has been done in close coordination and consultation with Seattle Urban Nature. This organization has preformed similar vegetation studies using these forest survey methodologies throughout the greater Seattle area. Many of following methodology descriptions in this section represent direct references from these reports.

2.1. Habitat and treatment delineation

At the onset of this study, Pioneer Park was split into zones reflecting the composition of the forest canopy, associated understory species, and topography. With the aid of aerial orthoimagery and topography maps, the boundaries between zones were delineated and ground-truthed in the field. This information was then used to create a GIS base layer representing the spatial arrangement of habitat types throughout the park. The resulting habitat types identified were conifer forest, mixed conifer-deciduous forest, riparian forest, and landscaped forest. Map 1 shows the delineation of the four forest habitat types at the park and Table 1 shows the corresponding acreage of each habitat type.

Map 1. Locations of habitat zones delineated in Pioneer Park, Mercer Island, WA

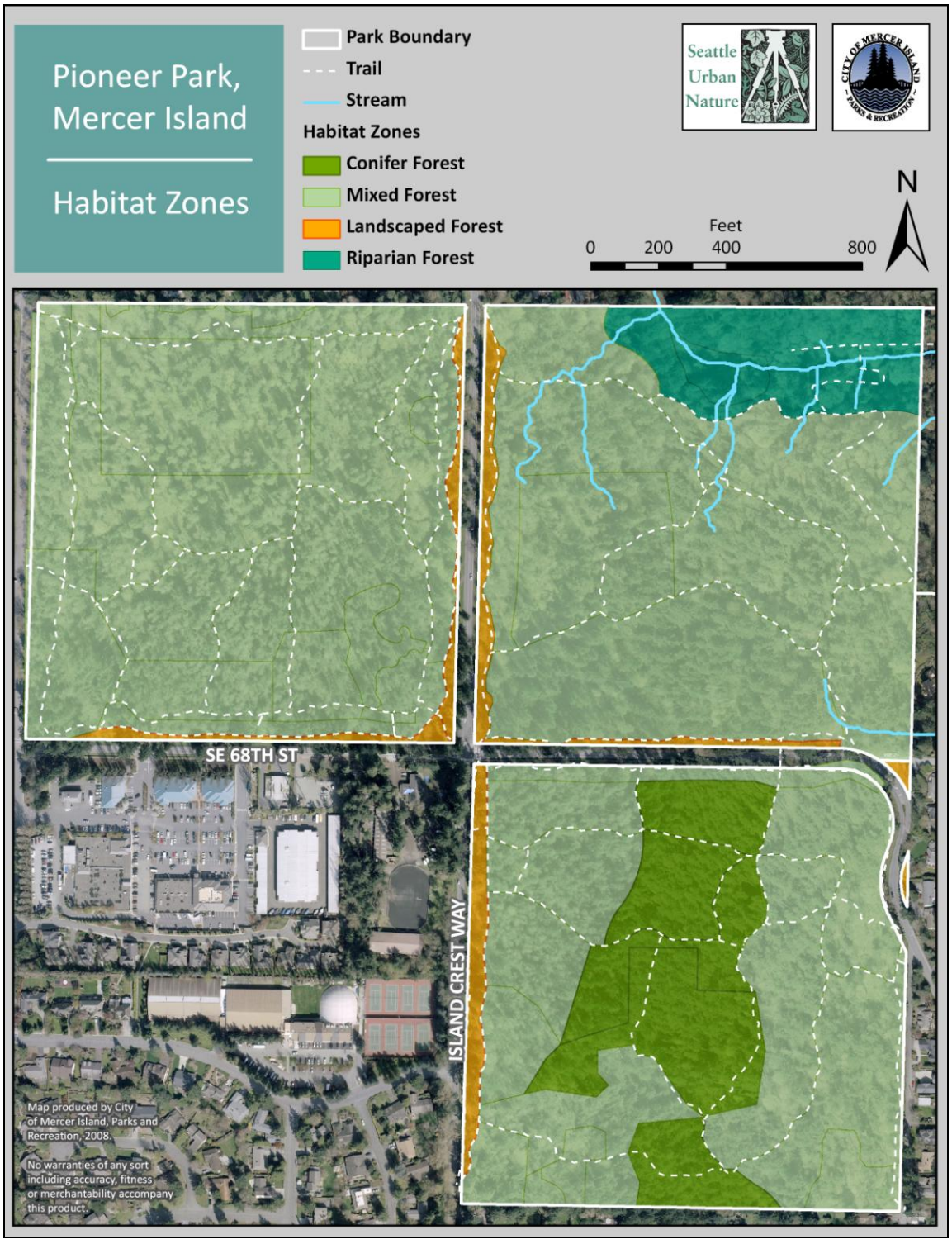


Table 1. Total acreage of each forest habitat type in Pioneer Park, Mercer Island, WA

Forest Habitat Type	Area (acres)	Percent of total area	Number of plots sampled
Conifer Forest	28.0	24.4	6
Mixed Conifer/ Deciduous Forest	71.2	62.4	47
Riparian	10.8	9.5	3
Landscaped Forest	4.2	3.7	0
Total Park	114.2	100	56

Previously established treatment areas were mapped using a GPS unit, from which a GIS layer was created. Three treatment types were incorporated into the map: *comprehensive, selective,* and *control*. Map 2 shows the delineation of the three treatment types at the park and Table 2 shows the corresponding acreage of each treatment.

2.2. Sampling intensity

With the aim of sampling five percent of the park, 56 one-tenth acre plots were surveyed during the summer of 2008. The total coverage of these plots is 5.6 acres, or 5.1% of the non-landscaped areas of the park (110 acres). Areas of the park designated as 'landscaped forest', generally found near the roadways, were not included in the survey (Map 1).

2.3. Transect layout

Plots were distributed proportionately among all habitat types and randomly located within a particular habitat. Plots were also situated to correspond to management treatment locations (Map 2). Of the total 56 plots, six were located in conifer forest, 47 in mixed conifer/deciduous forest and three in riparian forest.

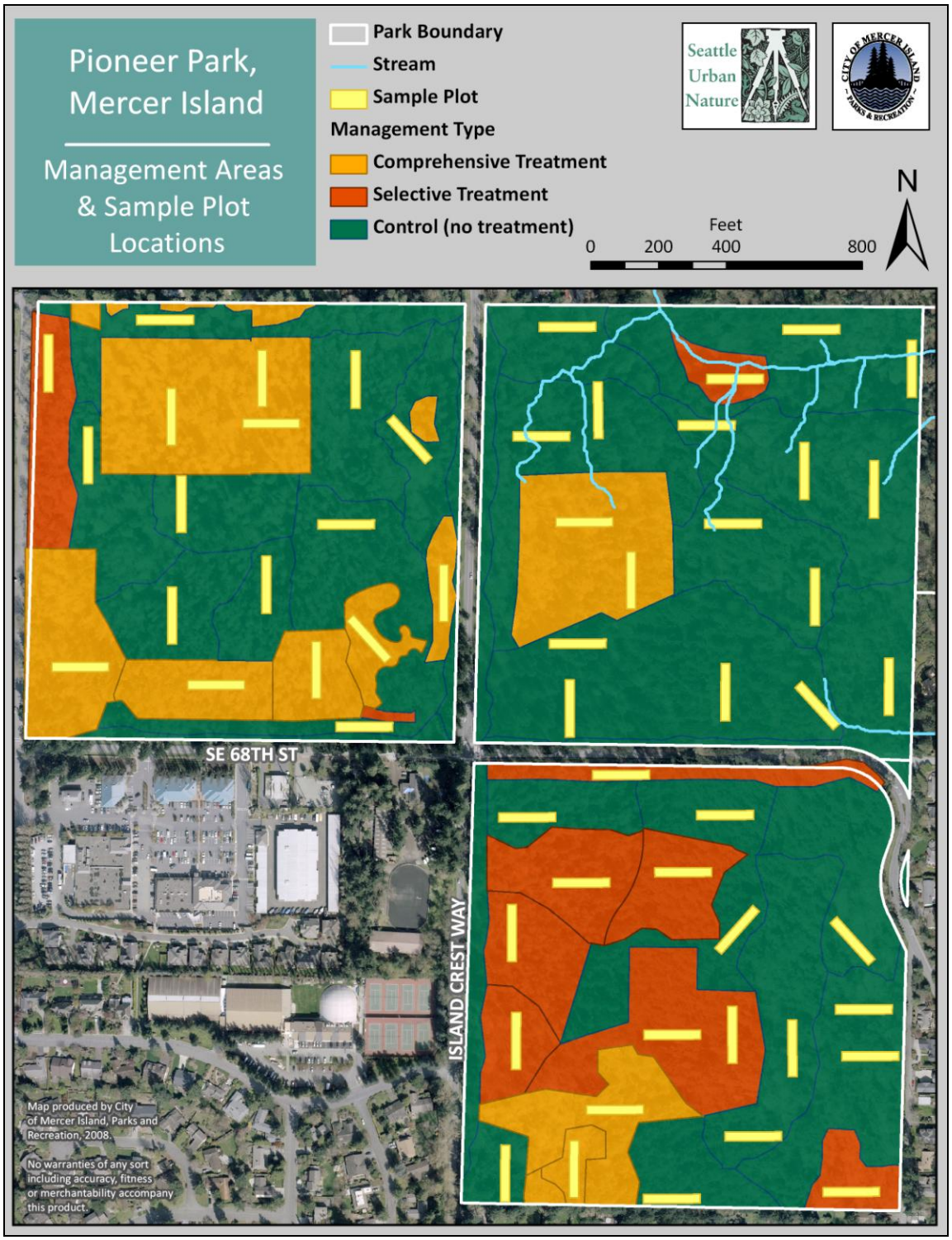
The plots are rectangular and measure 26.2 feet (8 meters) wide and 164 feet (50 meters) long. These dimensions cover an area of approximately 0.1 acre, which has been a standard measure in recent vegetation management plans in the Seattle area (Jones and Stokes, 2002; Sheldon Associates, Inc., 2003; Seattle Urban Nature, 2006).

Long rectangular plots provide more accurate sampling of the naturally occurring variation that occurs within clumped distributions of plant species, thereby producing more accurate estimates than round or equal-sided plots, particularly in regard to

Table 2. Current total acreage of each management practice in Pioneer Park, Mercer Island, WA

Management Type	Area (acres)	Percent of total area	Number of plots sampled
Control	75.0	65.7	34
Selective	16.7	14.6	10
Comprehensive	22.5	19.7	12
Total Park	114.2	100	56

Map 2. Management areas and 2008 sample plot locations, Pioneer Park, Mercer Island, WA



density-related measurements (Elzinga *et al*, 1998).

The majority of sampling plots in Pioneer Park are oriented along a north/south or east/west axis. If orientation along these axes did not allow the plot to be fully included in a particular habitat type or management unit, the plot was modified to a northwest/southeast or northeast/southwest orientation that would allow the sample to stay within the habitat/management boundary.

The origin of each plot was marked with a 1" x 1" x 4' wooden stake (Stake A) and a 12" rebar stake with a metal, numbered tag, each of which were driven one foot into the ground. Plots were laid out as shown in Figure 1. GPS point locations were recorded at Stakes A and C. Plot bearings and GPS points are listed in Appendix G.

2.4. Assessment procedures

Two general categories of attributes, tree density and vegetation cover, were recorded at each plot. Average slope and aspect were also recorded for each plot.

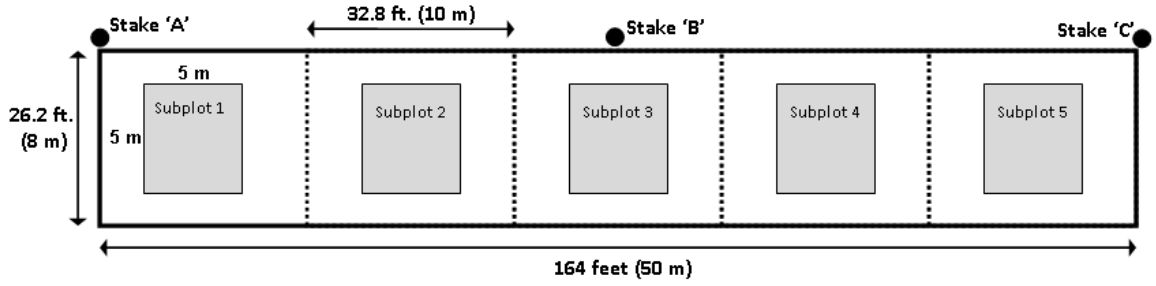
2.4.1. Tree density

All trees with trunks originating within the one-tenth acre plot were identified and counted, including non-native tree species. Trees on the edge of the plot were included only if more than half of the rooted trunk occurred in the plot. Height and diameter at breast height (DBH; measured at 4.5 feet above ground) were recorded for each tree. In addition, trees were assessed for colonization by English ivy. For trees less than 4.5 feet in height, average stem diameter was recorded to the nearest 0.5 inch.

Tree density was considered a key measure in this survey, as it allows for the analysis of several aspects of functionality, including tree regeneration, forest structure, conifer to deciduous ratios and the presence and frequency of exotic tree species.

Snags and coarse woody debris (CWD) greater than five inches in diameter, consisting of downed logs and stumps, were measured and placed into one of three decay classes: I, II or III. Decay class I indicates a branch or trunk that has recently died and is still firm, and frequently has intact bark and branches. Decay class III indicates wood that is in an advanced state of decay, with crumbling wood and extensive epiphytes, and usually has no remaining bark or branches. Decay class II provides an intermediate designation which characterizes wood between these two extremes. CWD dimensions were used to calculate estimates of downed wood volume per acre.

Figure 1. Layout of sampling plots in Pioneer Park, Mercer Island, WA



2.4.2. Vegetation cover

All plant species occurring in or overhanging the sample plot boundaries were identified and percent cover visually estimated for each species. Estimations of vegetation cover were made by dividing the sample plot into five equally-sized quadrats (10 m x 8 m). A 5 meter by 5 meter subplot was randomly placed within each quadrat (see Figure 1), and percent cover of each species was visually estimated for each subplot. The total area covered by the subplots represents 31% of the entire sample plot (400 m^2). Estimates from the five subplots were combined to derive an estimate of cover for the entire sample plot. Species present in trace amounts were given a minimum value of 0.1% cover, which allows for a comprehensive floristic survey of each plot location.

2.5. Data collection and management

Data collection was conducted by two ecologists at the City of Mercer Island, with training and assistance from staff ecologists at Seattle Urban Nature. Data was recorded using a Compaq iPAQ PDA. Information from the PDA was transferred to a Microsoft Access Database, and analyzed using Microsoft Excel. Maps were produced using ESRI ArcMap version 9.2.

3. RESULTS AND FINDINGS

This section contains a summary and analysis of the vegetation and dead wood that occurs in Pioneer Park. These attributes of the forest are divided into six main sections: overstory tree composition and structure (Section 3.2), regenerating tree composition and structure (Section 3.3), shrub composition and diversity (Section 3.4), herb, vine and grass composition and diversity (Section 3.5), snags (Section 3.6), and coarse woody debris (Section 3.7).

3.1. Park-wide vegetation trends

3.1.1. Species distribution

A total of 118 plant species were found in Pioneer Park during the 2008 survey (Appendices B through E). This list includes 26 tree species (15 native, 10 non-native, 1 undetermined); 29 shrub species (19 native, 9 non-native, 1 undetermined); and 63 herbaceous, grass, and vine species (30 native, 24 non-native, 9 undetermined). Occurring throughout the park are a few noteworthy invasive, non-native species. These species include the tree English holly (King County Noxious Weed of Concern, 2008), the shrubs Himalayan blackberry (King County Noxious Weed of Concern, 2008) and cherry laurel (King County Noxious Weed of Concern, 2008), the vine English ivy (King County Non-Designated Noxious Weed, 2008), and the herbaceous yellow archangel (*Lamiastrum galeobdolon*) (King County Non-Designated Noxious Weed, 2008).

3.1.2. Vegetation by habitat types

Three forest types were identified at Pioneer Park based on canopy density of conifer and deciduous trees, as well as proximity to water courses and topography. Both conifer forests and mixed conifer/deciduous forests occur in flat to moderate topography, with conifer forests distinguished by a higher ratio of conifer to deciduous trees. The conifer forest areas also tend to have understory species that are shorter in stature and more tolerant of dry conditions than those of the mixed forest. The riparian forests have an

overstory and understory similar to the mixed conifer/deciduous forest, but occur near watercourses. These areas are often dominated by plants associated with water, and tend to have steeper topography. Landscaped forests include areas of managed vegetation, often with mown grass, on the street edge of the park. No study plots were located in the landscaped forest areas.

Detailed descriptions of vegetation differences between habitat types can be found in Sections 3.2 through 3.5.

3.1.3. Vegetation by management treatments

In general, vegetation varied between the three management treatment categories: *control, selective,* and *comprehensive.* Areas under *comprehensive* treatment result in far fewer invasive non-native regenerating trees, shrubs, and herbaceous plants. Additionally, the *comprehensive* treatment areas have a much higher density of regenerating conifer trees compared to the other treatments. *Selective* treatment areas differ from *control* areas by having slightly fewer non-native regenerating trees. However, *selective* treatment areas do not have appreciably different levels of non-native invasive shrubs, herbaceous plants or regenerating conifer trees compared to the *control* areas.

3.2. Overstory tree composition and structure

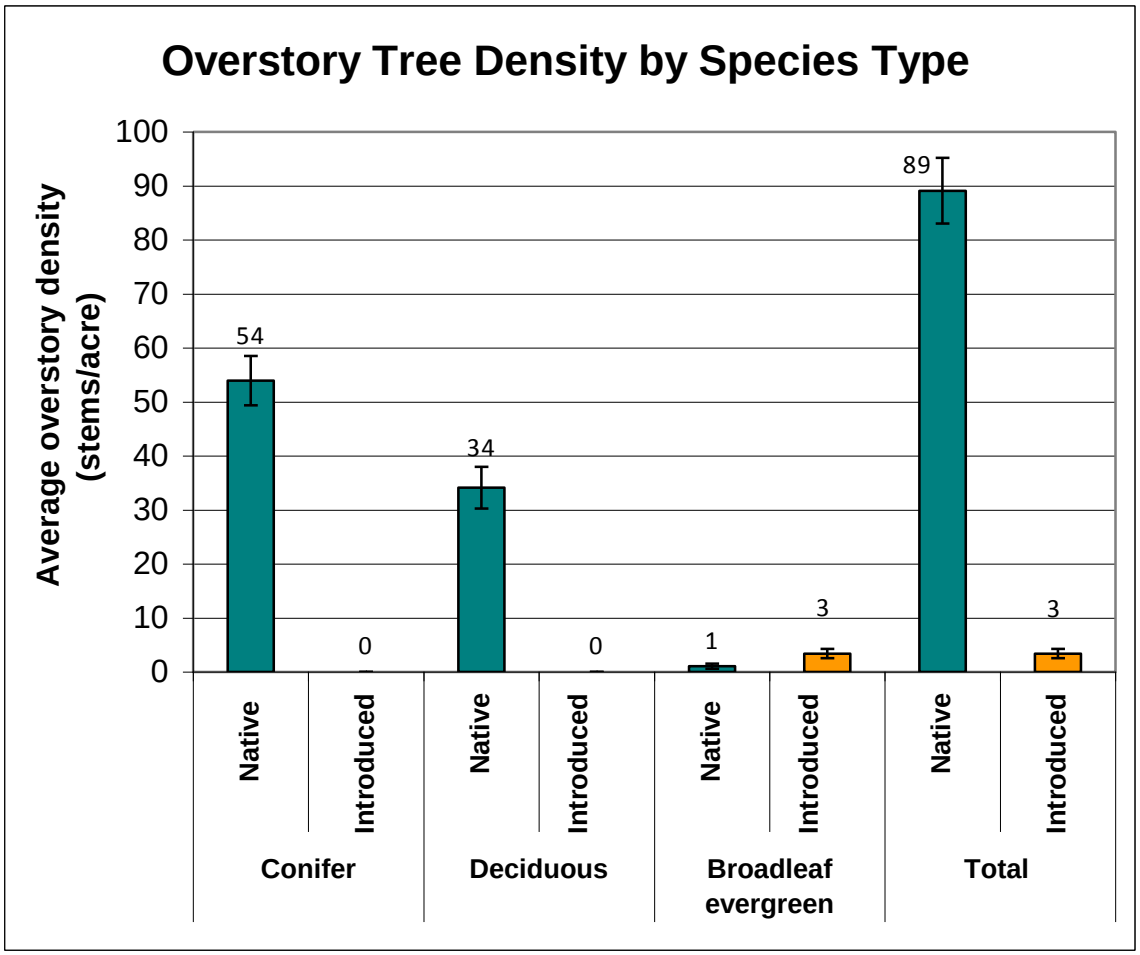
3.2.1. Summary

In this study, trees over 5 inches DBH were considered in the analysis of overstory tree composition and structure. In all habitat types identified in Pioneer Park the dominant overstory tree type is the native conifer, which makes up 58.3% of all overstory trees. Native deciduous trees are the second most common tree type, and account for 36.8% of large trees. Both native and introduced broadleaf evergreen trees make up smaller portions of the overstory tree composition (1.2% and 3.7%, respectively) (Figure 2). An "overstory composition by treatment" section is not included due to the fact that treatments do not affect overstory composition.

Douglas-fir (*Pseudotsuga menziesii*) is the most common conifer species, found in 84% of plots, while western hemlock is found in 45% of plots. Big leaf maple and red alder are found in 57% of sample plots. Other species found regularly as large trees include western red cedar (*Thuja plicata*), madrone (*Arbutus menziesii*) and English holly (Appendix B).

English holly, the only non-native tree which met overstory tree criteria, accounts for only 3.7% of the total density (Figure 2), but was found in 25% of sample plots. Despite its proportionally low density of 3 stems/acre, the presence of large English holly trees is a concern. This species is a prolific seeder, and these mature trees are largely responsible for the continued and constant growth of new English holly plants. The effects of the high seeding rate can be seen in the composition of regenerating trees in Pioneer Park, the vast majority of which are English holly (see Section 3.3).

Figure 2. Density of overstory trees by species type, Pioneer Park, Mercer Island, WA. Bars represent ±1 standard error.



Forest development in the Puget Sound area

The development of Puget Sound area lowland forests following disturbance such as logging or fire is thought to be a three-step process in terms of overstory tree composition. Fast growing native deciduous trees, such as big leaf maple and red alder, become established in areas of mature forest that have been cleared by such disturbances. Following, and concurrent with, the 70-150 year life-cycle of these deciduous trees, native conifers become established in the forest. Of the native conifers, the most dominant in younger forests (<250 yrs old) is Douglas-fir, known for growing relatively fast in open areas (Franklin *et al*, 2002). Growing slowly and steadily in the shade created by Douglas-fir are western hemlock (*Tsuga heterophylla*) and western red cedar, both of which have the ability to eventually surpass Douglas-fir in height and dominate a mature old-growth forest (Franklin *et al*, 2002).

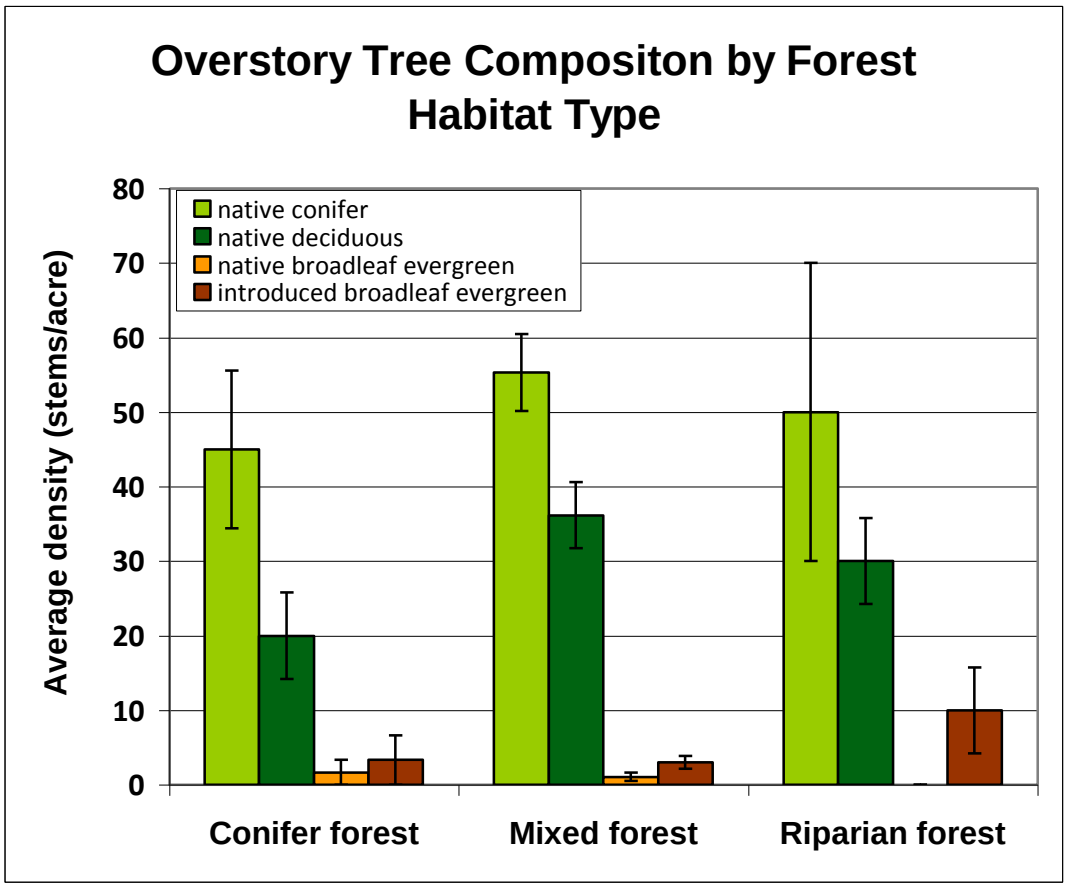
Overstory tree composition varies by forest type (Table 3, Figure 3). Mixed conifer-deciduous forests and riparian forests have a lower ratio of conifer to deciduous (1.53:1 and 1.67:1 respectively) than the conifer forest category (2.25:1). The ratios of conifer to deciduous trees in the overstory in mixed and riparian forests are very similar.

Table 3. Conifer and deciduous overstory tree densities in habitat types of Pioneer Park, Mercer Island, WA

Forest Habitat Type	Native conifer tree density (stems/acre)	Native deciduous tree density (stems/acre)	Ratio of conifer to deciduous trees
Conifer	45	20	2.25
Mixed conifer / deciduous	55.3	36.2	1.53
Riparian	50	30	1.67

The relatively high proportion of large native conifers suggests that the forest may be progressing past the deciduous-dominated stage of forest development. However, the abundance of Douglas-fir in overstory trees (42%), compared to that of western hemlock (12%) and western red cedar (4%), indicates that the forest overstory is still developing and has not yet reached maturity (Appendix B).

Figure 3. Composition of overstory trees by forest habitat type, Pioneer Park, Mercer Island, WA. Bars represent ±1 standard error.



3.2.2. Overstory tree density

Overall, Pioneer Park has an average of 93 overstory trees per acre. Table 4 shows values for forested natural areas in the Seattle area which have a similar history of disturbance within the past 100 years. Because previous assessments of Pioneer Park have classified its forest as a Western Hemlock Forest (Mercer Island Parks and Recreation Department, 1990), results from Pioneer Park are also compared to those of a typical Pacific Northwest western hemlock old-growth forest (Table 4).

Table 4 demonstrates that the overall density of the forest in Pioneer Park is similar to densities of other regional urban parks and suburban natural areas. However, it is much lower than that of an old-growth forest of comparable composition, which suggests that the forest is less productive, possibly due to past logging, a lack of continuous conifer regeneration, and/or the fungal pathogen laminated root rot (see Section 3.2.4).

3.2.3. Structure

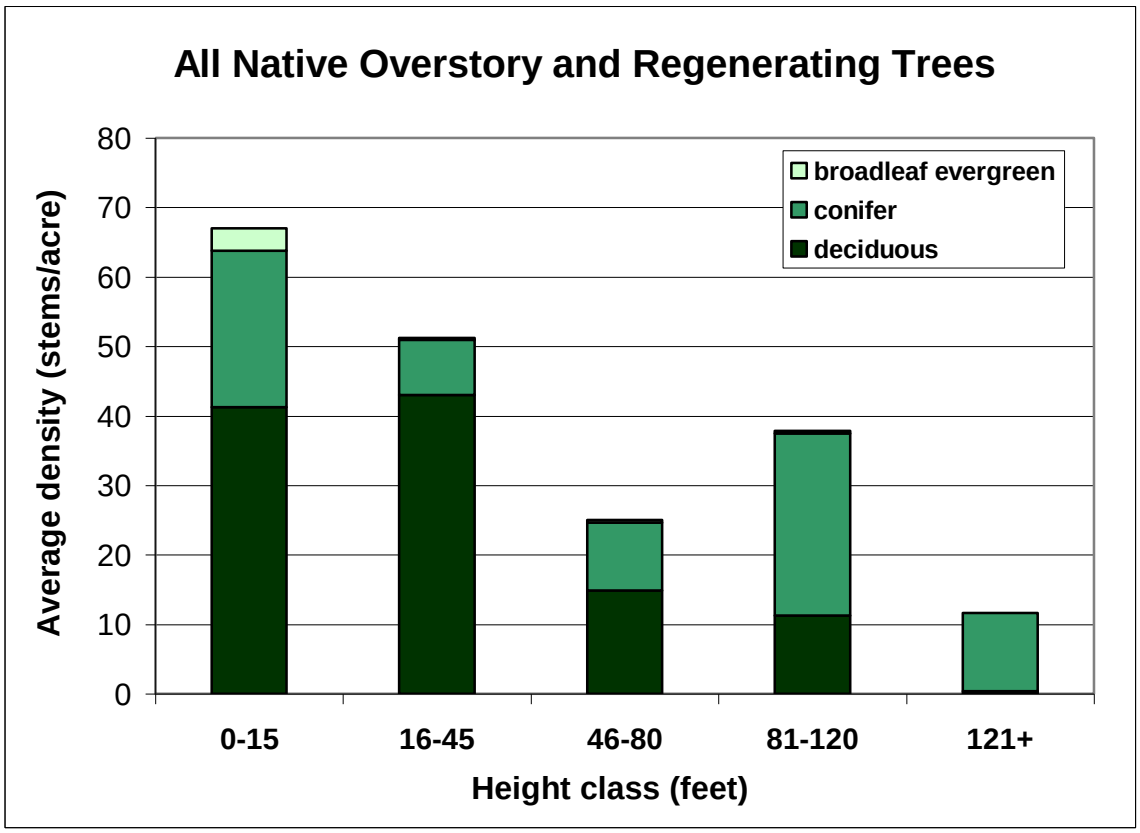
The forest canopy of Pioneer Park has a relatively high structural diversity as a result of variation in tree species and height. The distribution of trees in height classes lends insight into how structurally diverse the canopy is and which species are emerging into the canopy. At Pioneer Park, the majority of native trees in the lower (0'-15' and 16'-45') height classes are native deciduous trees (Figure 4), the majority of which are big leaf maple and red alder. The mid-strata height category of 46'-80' contains an approximately even mix of native conifer and native deciduous trees. The canopy overstory height classes (81'-120' and 121'+) are dominated by native conifer trees, the majority of which is Douglas-fir. The large group of conifer trees in the 81' to 121'+

Table 4. Comparison of overstory tree density and composition at study sites in Seattle-area urban forests

Study site	Years since disturbance (approx.)	Overstory tree density (stems/acre)	Density of native conifer (% of total)	Percent Douglas-fir of total density
Shadow Lake, King Co., WA* (SUN, 2008c)	70-90 years	125	86 (69%)	23%
Boeing Creek, Shoreline, WA* (SUN, 2008a)	110 years	114	81 (71%)	21%
Deadhorse Canyon, Seattle, WA* (SUN, 2005)	110 years	88	15 (17%)	2%
Hamlin Park, Shoreline, WA* (SUN, 2008b)	100 years	113	40 (35%)	14%
Old-growth western hemlock forest, Cascade Range ** (Franklin *et al*, 1981)	250 years	156	-	32%
Pioneer Park, Mercer Island, WA	110 years	93	54 (58%)	42%

* Study sites sampled and analyzed by Seattle Urban Nature (SUN) using methods comparable to those of the Pioneer Park Forest Health Survey. Values reported are those of **mixed conifer/deciduous forests**.
Values reported are those of **conifer forests.

Figure 4. Average density of tree heights across all plots, Pioneer Park, Mercer Island, WA



height classes likely became established following the last logging of the area around 1915. Introduced canopy tree species were not addressed in these diameter and height comparisons because it is assumed that these species will be removed in the future and therefore not contribute to the forest structure.

3.2.4. Disease

As the forest in Pioneer Park continues to develop, it also faces the effects of laminated root rot (*Phellinus weirii*). While there are several fungal diseases that currently affect overstory trees in Pioneer Park, laminated root rot is the most active and destructive. This naturally-occurring fungus causes the roots of healthy, mature Douglas-fir and western hemlock to decay, resulting in treefall and death within 5-20 years (Mercer Island Open Space Conservancy Trust & City of Mercer Island Parks and Recreation Department, 2003). The fungus, which occurs in all three quadrants of Pioneer Park, spreads from tree to tree via root contact, and can survive in large stumps for over 50 years. The result of laminated root rot is a matrix of gaps in the forest, which reach 2.5 acres in size. While gaps and forest heterogeneity are considered good for forest structure and wildlife habitat, these openings can create prime sites for growth of invasive shrubs such as Himalayan blackberry. Additionally, trees infected with laminated root rot can be a safety hazard due to their tendency to fail while still appearing relatively healthy. For more information on tree diseases in Pioneer Park see Appendix E (pp.55-84) in the 2003 Pioneer Park Forest Management Plan.

3.3. Regenerating tree composition and structure

3.3.1 Summary

In this study, trees with a DBH of 5 inches or less are considered to be regenerating trees. In the 56 plots sampled in Pioneer Park, 24 species of regenerating tree were identified (Appendix C). The average density of regenerating trees was 1038 stems/acre. The majority of these trees were English holly, which was found in 86% of the plots and averaged 899 stems/acre (Figures 5 and 6). Native tree species only contributed 10% of the regenerating tree density, with 104 stems/acre. Of these native trees, big-leaf maple is the most common, found in 77% of the plots and contributing 46.9% of the native regenerating tree density (Figure 7). Native conifer regeneration is low, with an average of 23.8 stems/acre (2.3% of the total regeneration and 20.7% of native tree regeneration).

Comparisons made with other Puget Sound urban forested areas show that forest regeneration in Pioneer Park faces many challenges (Table 5). English holly density is much higher than in other regional urban parks and suburban natural areas, while native conifer regeneration is very low. Although the density of introduced deciduous species, such as European mountain ash (*Sorbus aucuparia*), is not as high as that of Hamlin Park in Shoreline, these trees are regenerating faster than native conifers and may pose a future threat to the forest structure. Native deciduous trees are regenerating well

Figure 5. Mean density of regenerating trees across all plots, Pioneer Park, Mercer Island, WA

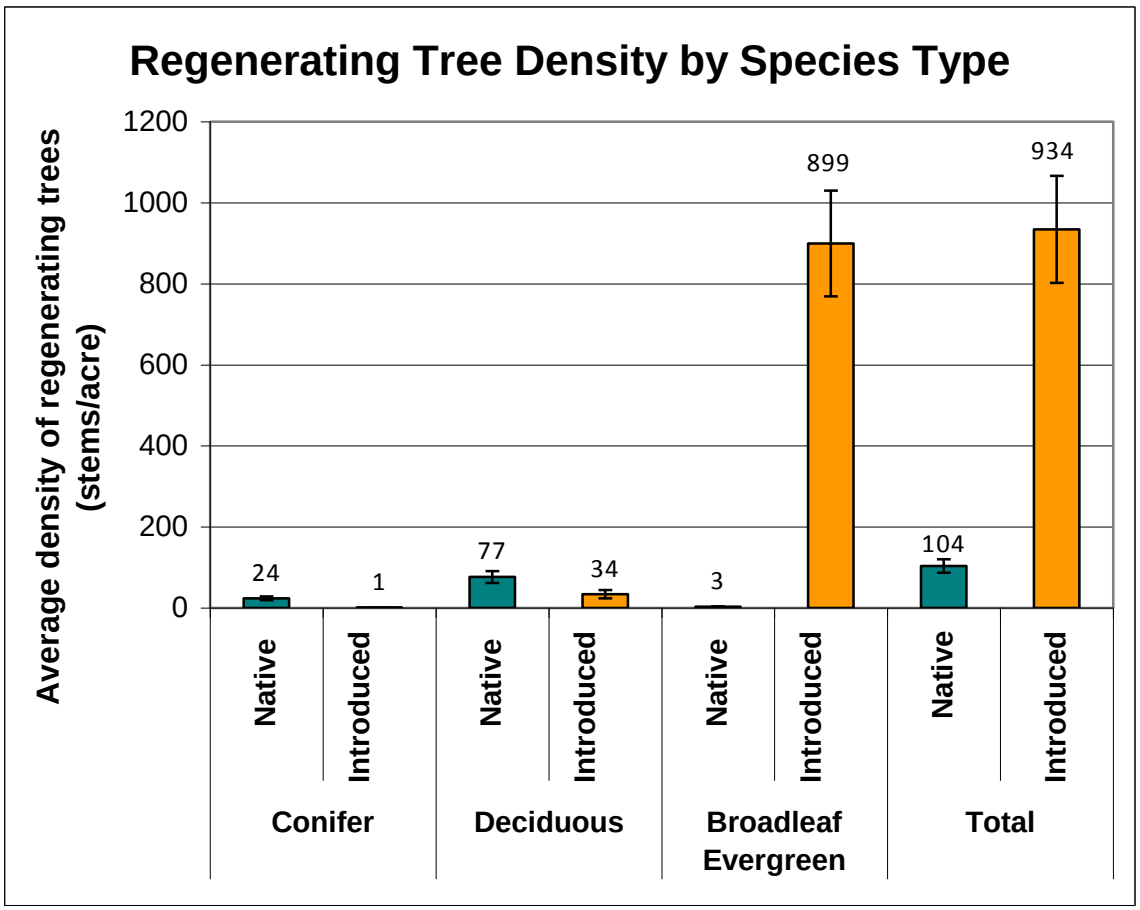


Figure 6. Regenerating tree composition by species type, Pioneer Park, Mercer Island, WA

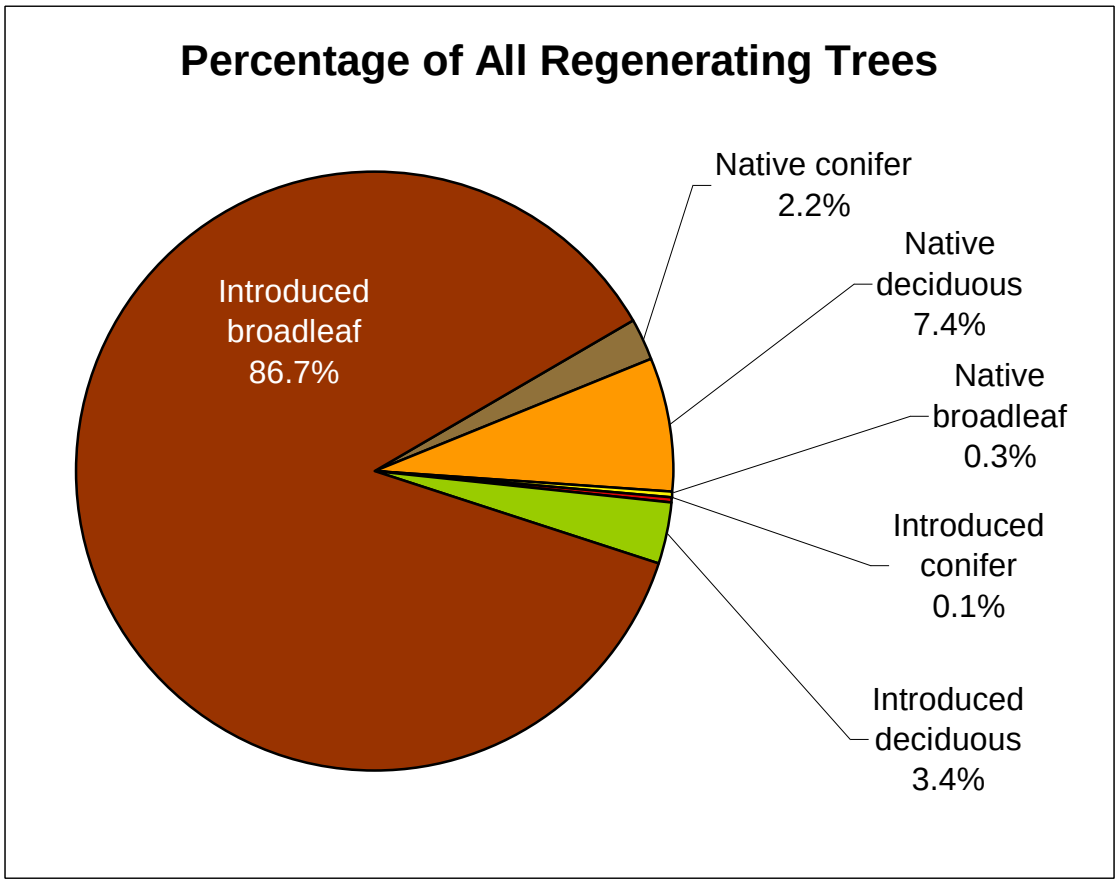
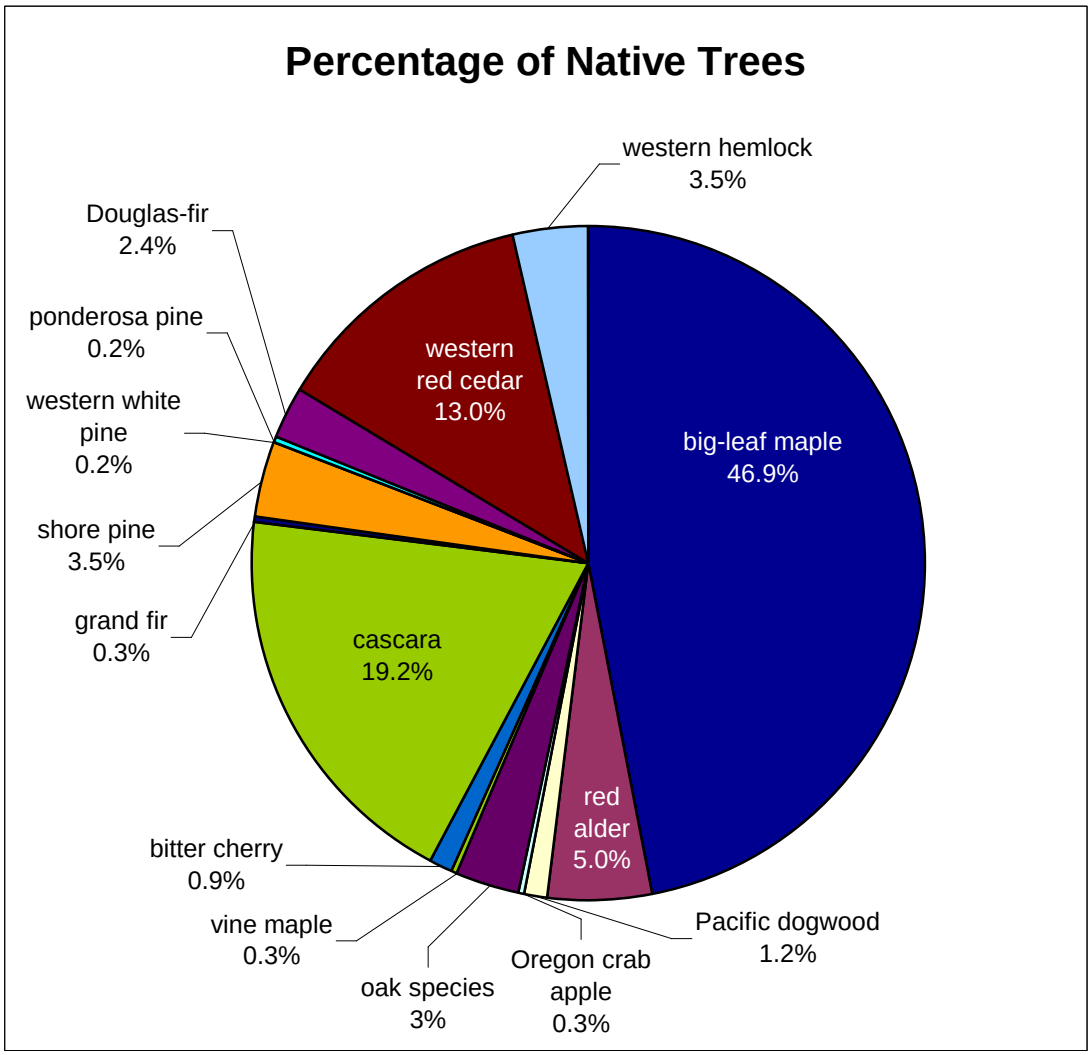


Table 5. Comparison of regenerating tree densities at study sites in Seattle-area urban forests

Area	Native conifer (stems/ acre)	Native deciduous (stems/ acre)	Introduced deciduous (stems/ acre)	Introduced broadleaf evergreen (stems/acre)
Boeing Creek, Shoreline, WA* (SUN, 2008a)	120	53	50	151
Hamlin Park, Shoreline, WA* (SUN, 2008b)	143	11	294	789
Deadhorse Canyon, Seattle, WA* (SUN, 2005)	61	39	13	243
South Woods, Shoreline, WA* (SUN, 2007)	57	99	136	3646
Pioneer Park, Mercer Island, WA	**24**	77	34	899

* Study sites sampled and analyzed by Seattle Urban Nature (SUN) using methods comparable to those of the Pioneer Park Forest Health Survey.

Figure 7. Native regenerating tree composition by species, Pioneer Park, Mercer Island, WA

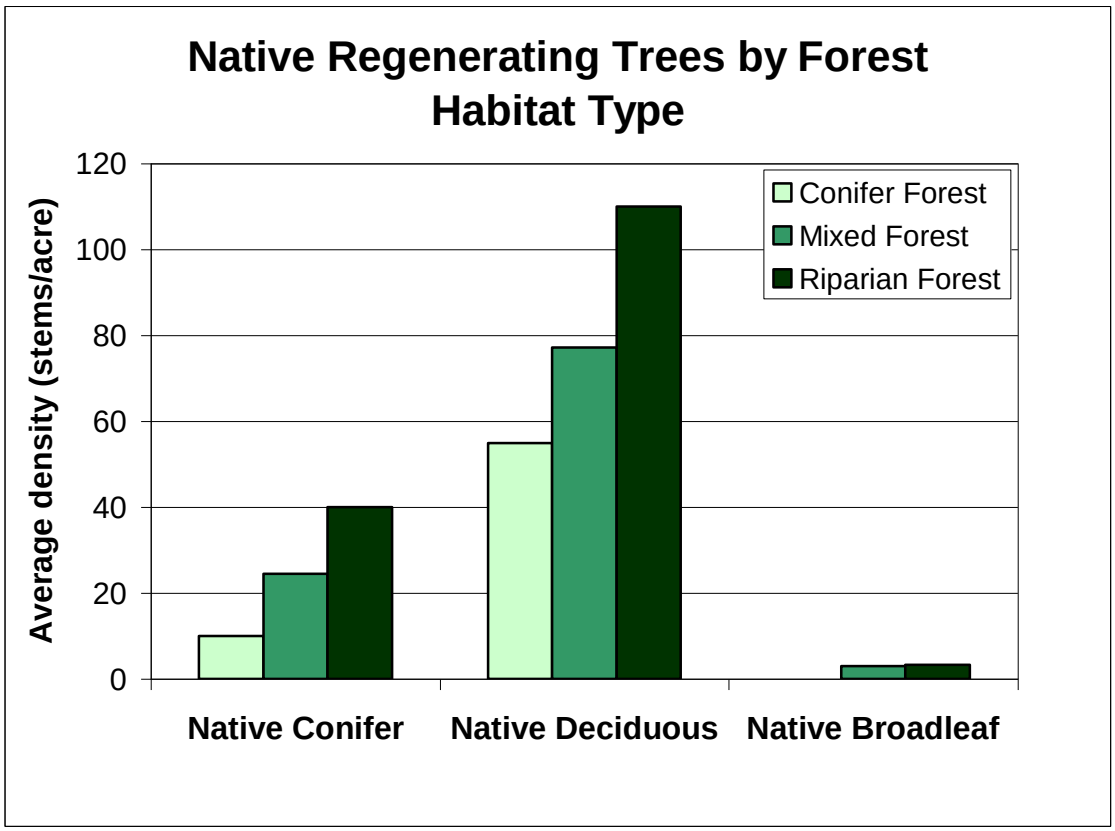


overall. However, in order to maintain the current overstory ratio of conifer to deciduous trees, native conifers should be present at three times the density of deciduous trees (Table 4).

3.3.2 Regenerating tree composition by habitat

The density of regenerating trees vary by habitat type. Conifer forest areas have the lowest densities of all categories of regenerating native trees, ten native conifer stems/acre and 55 native deciduous stems/acre (Figure 8). The mixed forest areas have a moderate amount of regenerating native trees, 25 native conifer stems/acre, 77 native deciduous stems/acre, and 3 native broadleaf stems/acre. The riparian forests have the greatest density of native regenerating trees, 40 stems/acre of native conifer, 110 stems/acre of native deciduous, and 3 stems/acre of native broadleaf trees. The exceedingly low density of regenerating native conifer and other trees in conifer forests are of particular note. The particularly low density of regenerating trees in the conifer forest stands may be the result of few seed producing canopy trees in the area that have the ability to grow in the shade of Douglas-fir.

Figure 8. Density of native regenerating trees by forest habitat type, Pioneer Park, Mercer Island, WA



3.3.3 Regenerating tree composition by treatment

Both *selective* and *comprehensive* treatments appear to decrease the density of non-native regenerating trees. Introduced broadleaf tree density shows a marked decrease in both treatment types, from 112 stems/acre in *control* plots to 91 stems/acre in areas with *selective* treatment and 55 stems/acre with *comprehensive* treatment (Figure 9). Introduced deciduous tree density also varies by treatment: density in *control* plots averaged 5 stems/acre while *selective* and *comprehensive* areas contained only 2 and 0.1 stems/acre, respectively (Figure 9).

Because the current regeneration of trees will determine the makeup of the future overstory, the extremely low density of native conifers is of particular concern. Tree-planting efforts over the past six years have been successful in increasing the density of native coniferous trees (Figure 10). However, with an average of 45 regenerating conifers per acre, planted areas are still relatively sparse. The composition between planted and unplanted areas also differs (Figure 11). Planted areas have a higher number of species, due to a focus on diversifying the suite of young conifer species to include those that are less susceptible to laminated root rot. A look at regenerating conifers in unplanted areas, however, shows that there is some natural western red cedar recruitment.

Figure 9. Density of all regenerating trees by treatment type, Pioneer Park, Mercer Island, WA. Bars represent ±1 standard error.

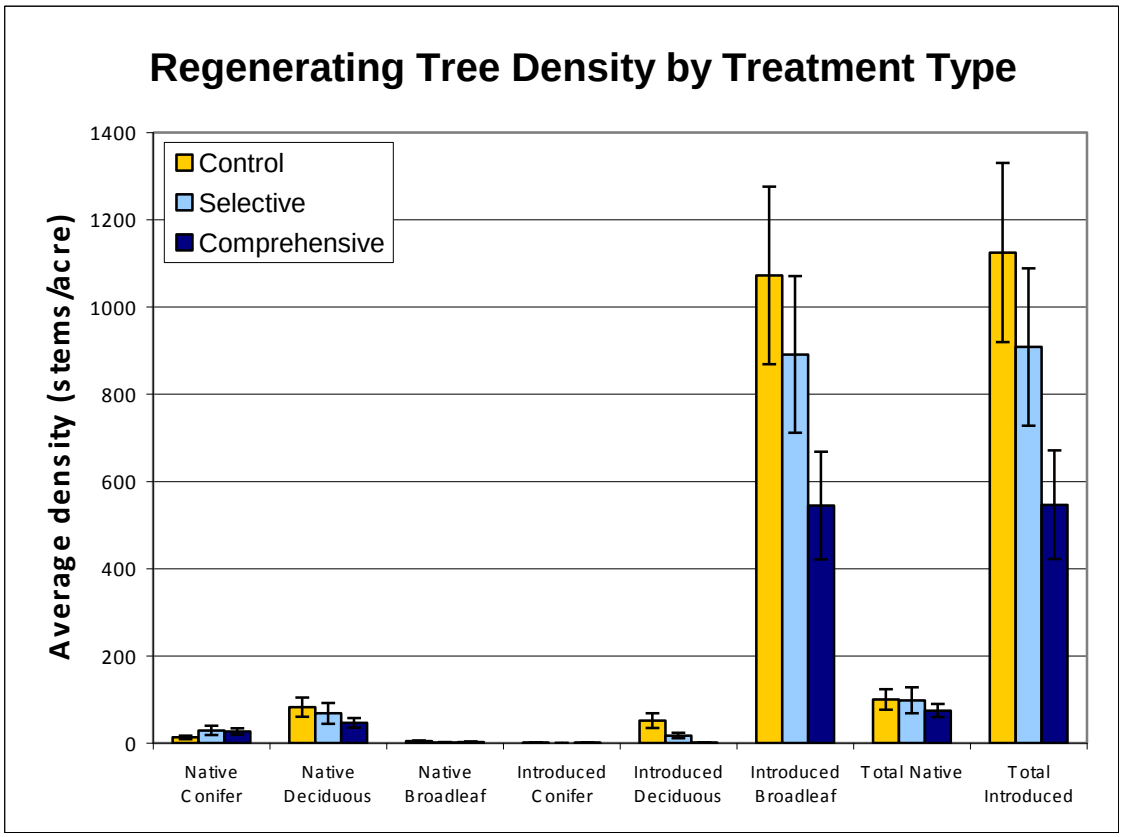


Figure 10. Density of regenerating conifer trees in planted and unplanted areas, Pioneer Park, Mercer Island, WA. Bars represent ±1 standard error.

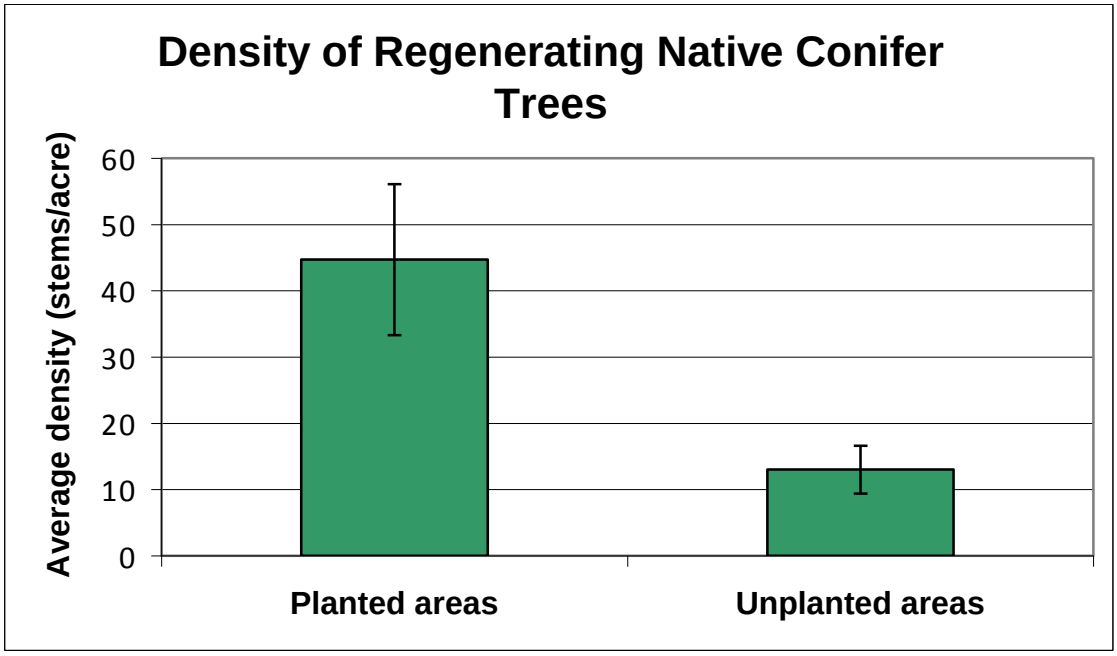
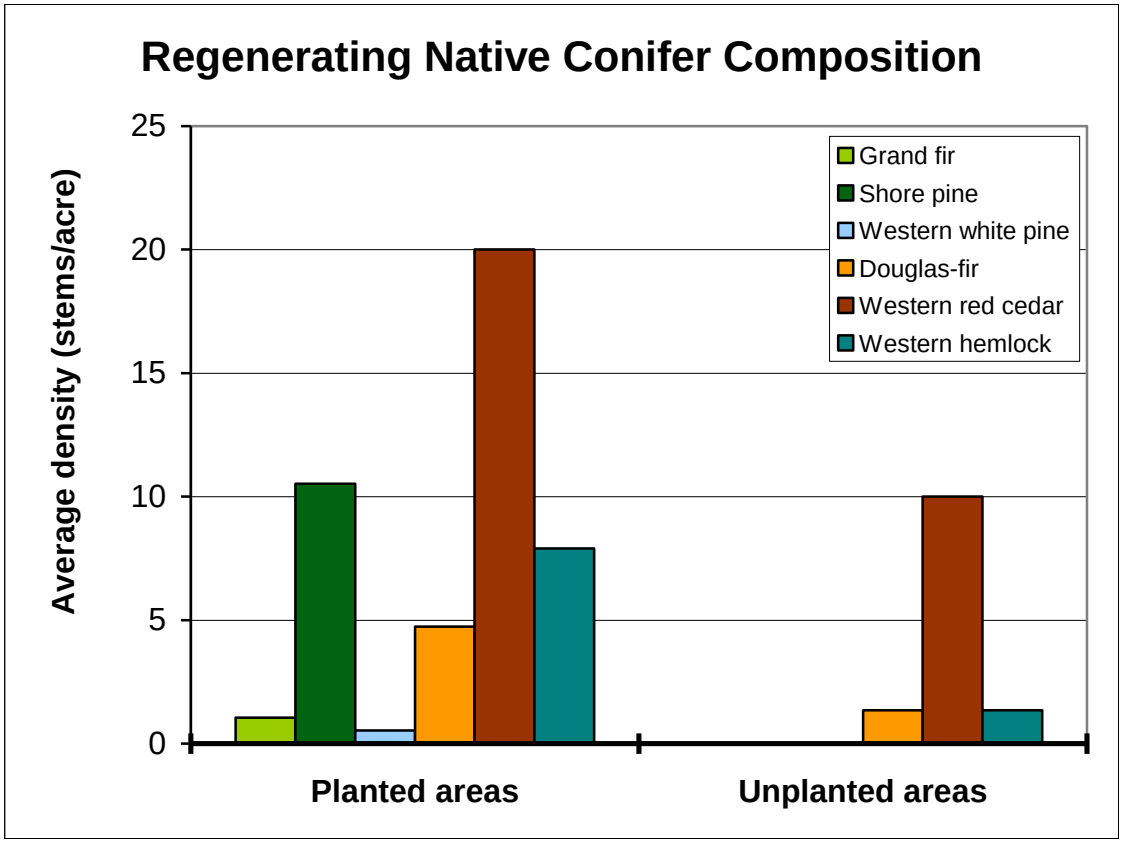


Figure 11. Composition of native conifer regeneration, Pioneer Park, Mercer Island, WA



3.4. Shrub composition and diversity

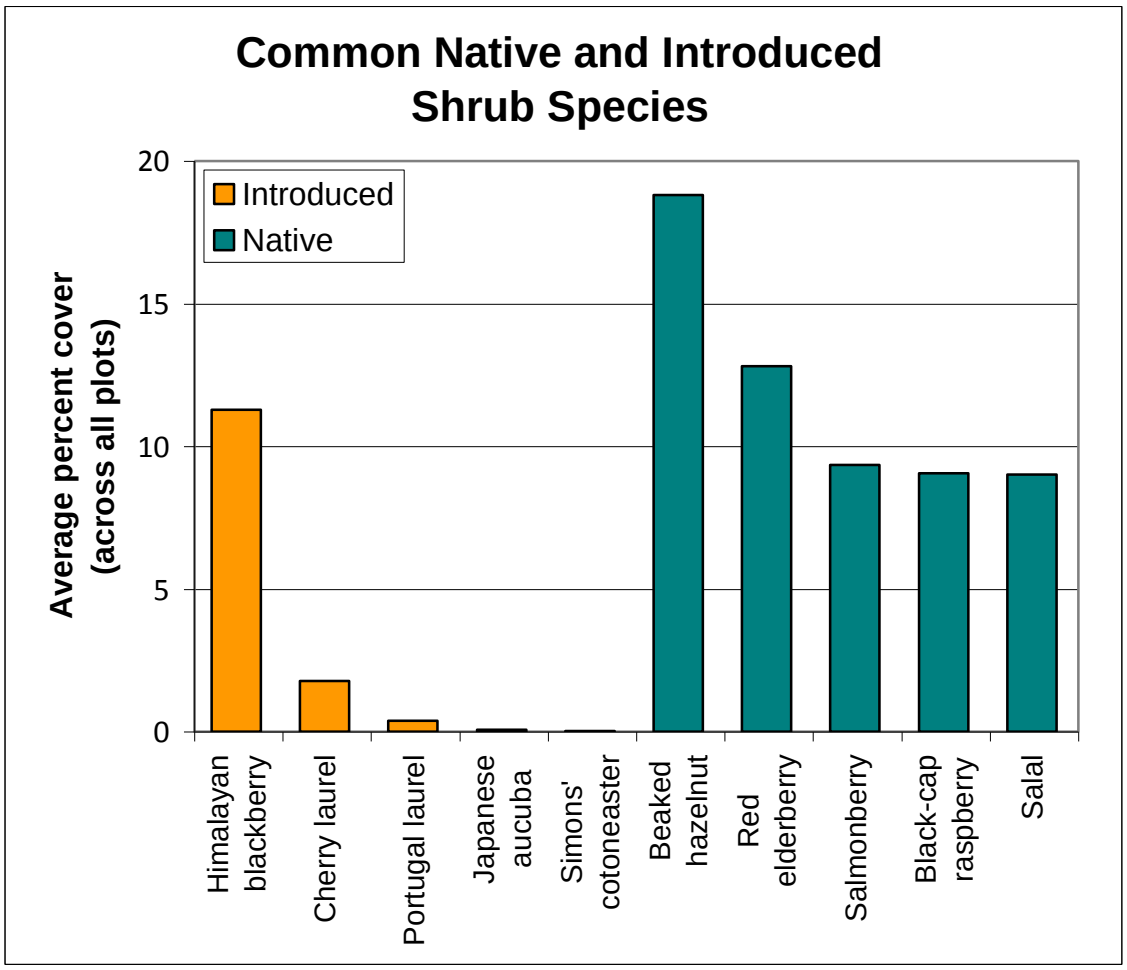
3.4.1. Summary

Twenty-nine species of shrubs were found across the 56 plots sampled in Pioneer Park. Of these, nine are identified as non-native (13.6% cumulative cover), 19 as native (81.6%) and one unidentified shrub. The most commonly found native shrubs, low Oregon grape (*Mahonia nervosa*) and red elderberry (*Sambucus racemosa*), were found in 96% and 93% of the plots, respectively. The shrubs with the highest average cover across all the plots are beaked hazelnut (*Corylus cornuta*) (18.8%) and red elderberry (12.8%) (Figure 12). Himalayan blackberry is the most common introduced plant, found in 76.8% of the plots, with an average cover of 11.3% across all plots (and 14.7% average cover in the plots where it was found).

3.4.2. Shrubs by habitat type

Dominant shrub species and density vary by forest type. The wetter riparian forest areas are dominated by the moisture-loving salmonberry (18.1%) and also include a relatively large (5.7%) cover of the wet-soil indicator plant devils club (Table 6). The mixed forest area has a drier mix of shrubs of moderate cover which include beaked

Figure 12. Mean cover of most common shrubs across all plots, Pioneer Park, Mercer Island, WA



hazelnut (18.6%), red elderberry (14.2%), and Himalayan blackberry (11.1%). The conifer forest areas, with the driest soils at Pioneer Park, had a high cover of the shrub species beaked hazelnut (29.5%), trailing blackberry (*Rubus ursinus*) (23.5%) and salal (*Gaultheria shallon*) (23.4%).

Table 6. Four most common shrubs in each habitat type, Pioneer Park, Mercer Island, WA

Forest habitat type	Conifer Forest	Mixed Forest	Riparian Forest
1st most common shrub (% cover)	Beaked hazelnut (29.5%)	Beaked hazelnut (18.6%)	Salmonberry (18.1%)
	Trailing blackberry (23.5%)	Red elderberry (14.2%)	Red elderberry (7.7%)
	Salal (23.4%)	*Himalayan blackberry (11.1%)	*Himalayan blackberry (7.1%)
4th most common shrub (% cover)	*Himalayan blackberry (14.9%)	Salmonberry (9.9%)	Devils club (5.7%)

***** Invasive, non-native species

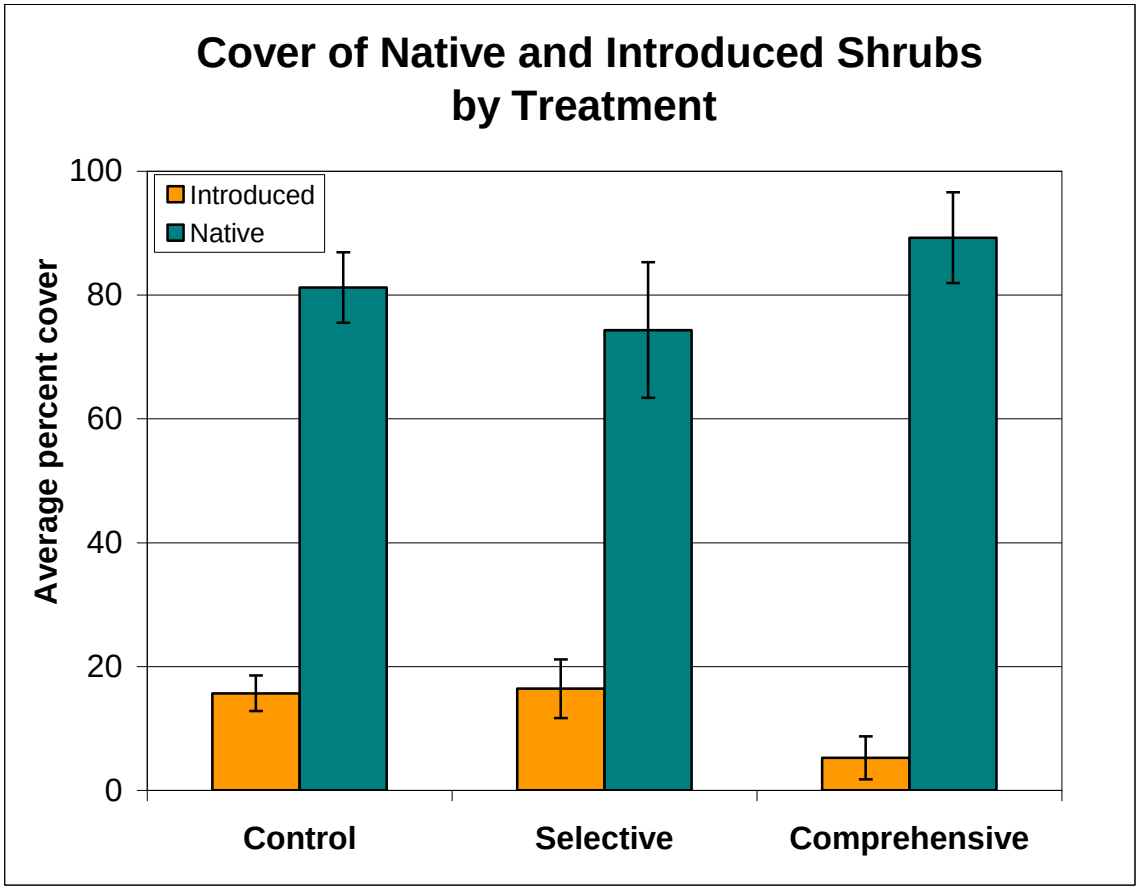
3.4.3. Shrub cover by treatment

In general, native shrubs are far more dominant than introduced shrubs in Pioneer Park. Overall, native shrubs have an average cover of 81.6%, while introduced shrubs cover only 13.6%. Introduced shrub cover is similar in *control* (15.6%) and *selective* (16.4%) treatment areas, but lower in areas with *comprehensive* treatment (5.2%) (Figure 13). Native shrub cover is slightly higher in *comprehensive* treatment areas than either *selective* treatment or *control* areas. Himalayan blackberry, the most prevalent non-native shrub, has an overall cover of 12.7% in *control* areas and 13.9% in *selective* treatment areas, while areas that received *comprehensive* weed removal have only 5.2% cover of Himalayan blackberry.

While Himalayan blackberry is the dominant invasive shrub in Pioneer Park, several others were found in the survey plots. Although they do not currently dominate the forest understory, they have the potential to spread rapidly and compete with native vegetation if left unchecked. Cherry laurel, a large tree-like shrub, was found in 43% of the plots, indicating that it is already widespread and is likely impacting the growth of native shrubs and trees. Spurge laurel (*Daphne laureola*), cutleaf blackberry (*Rubus laciniatus*) and one-seed hawthorn (*Crataegus monogyna*) are also present in the park and may become problems in the future.

A complete list of shrubs and coverage can be found in Appendix D.

Figure 13. Mean cover of introduced and native shrubs by treatment type, Pioneer Park, Mercer Island, WA



3.5. Herb, vine and grass composition and diversity

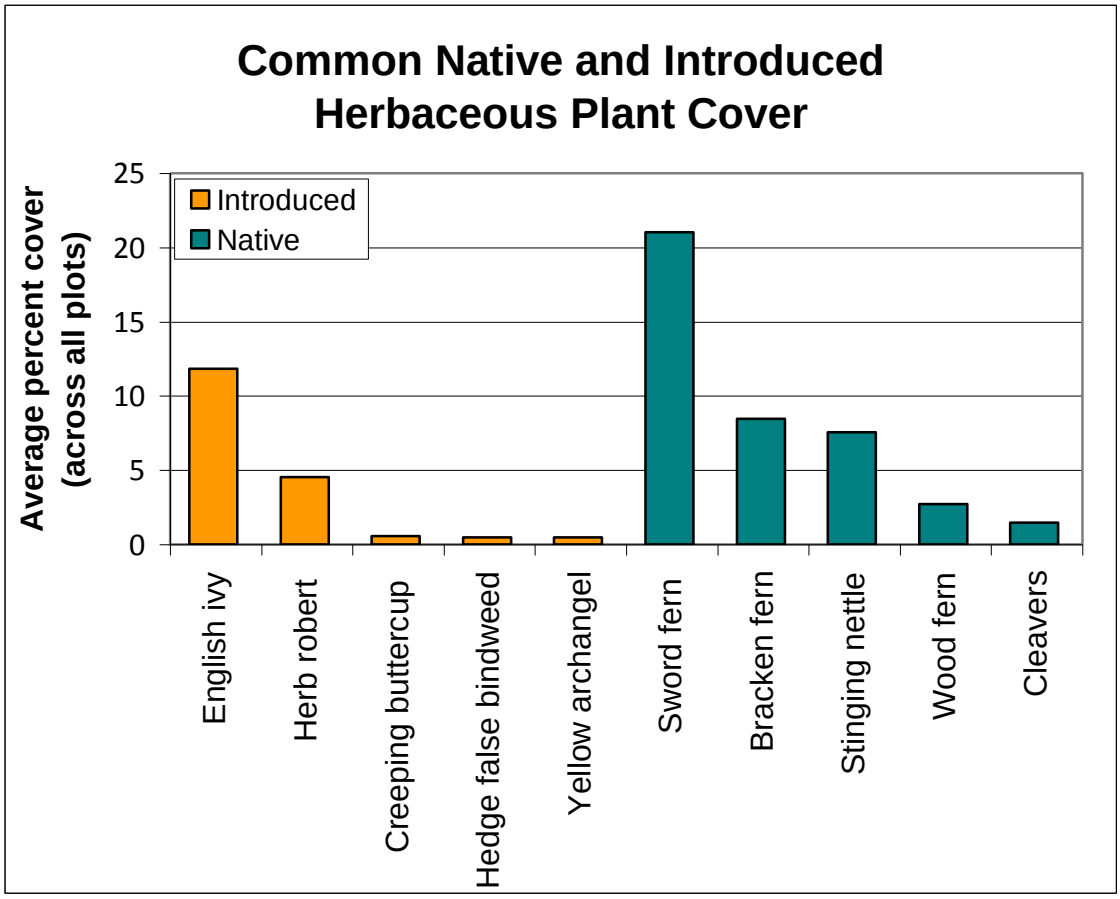
3.5.1. Summary

A total of 63 herbaceous species were found in the sample plots at Pioneer Park. Of these, 30 species are native (44.4% cumulative cover), 24 are non-native (19.1%) and nine are of unknown origin. The invasive species English ivy, as well as the native sword fern (*Polystichum munitum*), are present in every sample plot. Herb Robert (*Geranium robertianum*), a Class B Non-designated Noxious Weed in King County, is present in 94.6% of plots, with an average cover of 4.5% across all plots (Figure 14). Also found throughout the park are wood fern (*Dryopteris expansa*) and bracken fern (*Pteridium aquilinum*), each of which are present in 84% of the plots.

Several other native herbaceous species of interest were also found in the sample plots. Pacific trillium (*Trillium ovatum*), a well-known lily species, was found in 68% of the plots, while vanilla leaf (*Achlys triphylla*), a less common wildflower, was found in 40% of plots. Youth-on-age (*Tolmiea menziesii*) and foam flower (*Tiarella trifoliata*) were also found in over 5% of plots. Wild ginger (*Asarum caudatum*), which has been recorded in previous surveys of Pioneer Park vegetation, was not found in any of the sample plots.

A complete list of herbaceous species and percent coverage can be found in Appendix E.

Figure 14. Mean cover of most common herbaceous species across all plots, Pioneer Park, Mercer Island, WA



3.5.2. Herbaceous species across habitat types

At 105% cover, the riparian forest areas has the greatest total herbaceous matter. This high percent cover reflects the overlap between many individual species, and is the result of wetter conditions that allow for the growth many herbaceous plants. The most common herbaceous species in the riparian forest areas are sword fern (45% cover), lady fern (11%), stinging nettle (Urtica dioica) (10%), and English ivy (9%).

The mixed forest areas, with an average of 65% cover, have a moderate amount of total herbaceous cover. These areas typically have drier soils than the riparian forest areas. The most common herbaceous species in the mixed forest areas are sword fern (21% cover), English ivy (13%), stinging nettle (8%), and bracken fern (8%). Conifer forest areas have an average of 38% total herbaceous cover, the lowest of the three habitat types. These areas generally have the most well drained/dry soils, which create a more stressed environment for herbaceous species. The most common herbaceous species in the conifer forest areas are bracken fern (15% cover), sword fern (11%), English ivy (7%), and herb Robert (3%).

3.5.3. Herbaceous species across treatment types

In comparing treatment effects on herbaceous cover, *comprehensive* treatment areas have a higher ratio of native to introduced species coverage than both the *control* and *selective* treatment areas (Figure 15). Cover of the five most common introduced species were compared by treatment type (Figure 16). English ivy and herb Robert are more prevalent in both the *control* and *selective* treatment areas than the *comprehensive* areas. Additionally, the other three most prevalent herbaceous species (creeping buttercup (*Ranunculus repens*), hedge false bindweed (*Calystegia sepium*), and yellow archangel) are not found in *comprehensive* treatment areas at all. This absence may be attributable to the effectiveness of *comprehensive* weed removal, or may indicate that these weeds were never found in these plots.

Figure 15. Mean cover of introduced and native herbaceous plants by treatment type, Pioneer Park, Mercer Island, WA

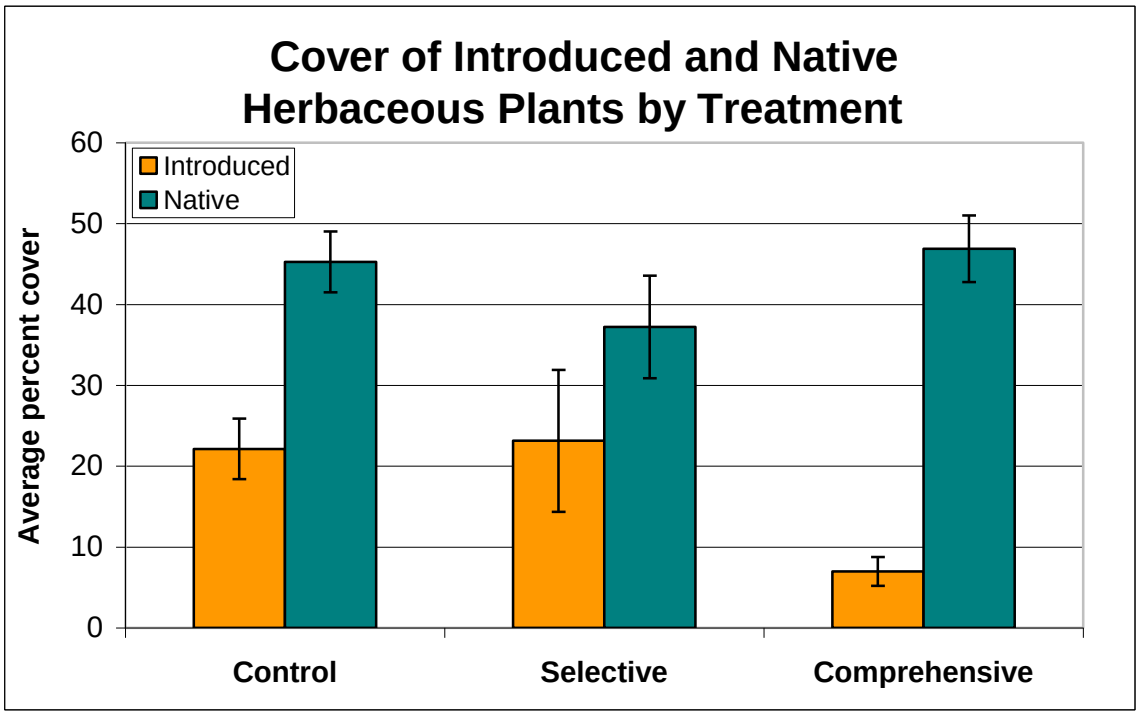


Figure 16. Mean cover of most common invasive herbaceous species by treatment type, Pioneer Park, Mercer Island, WA

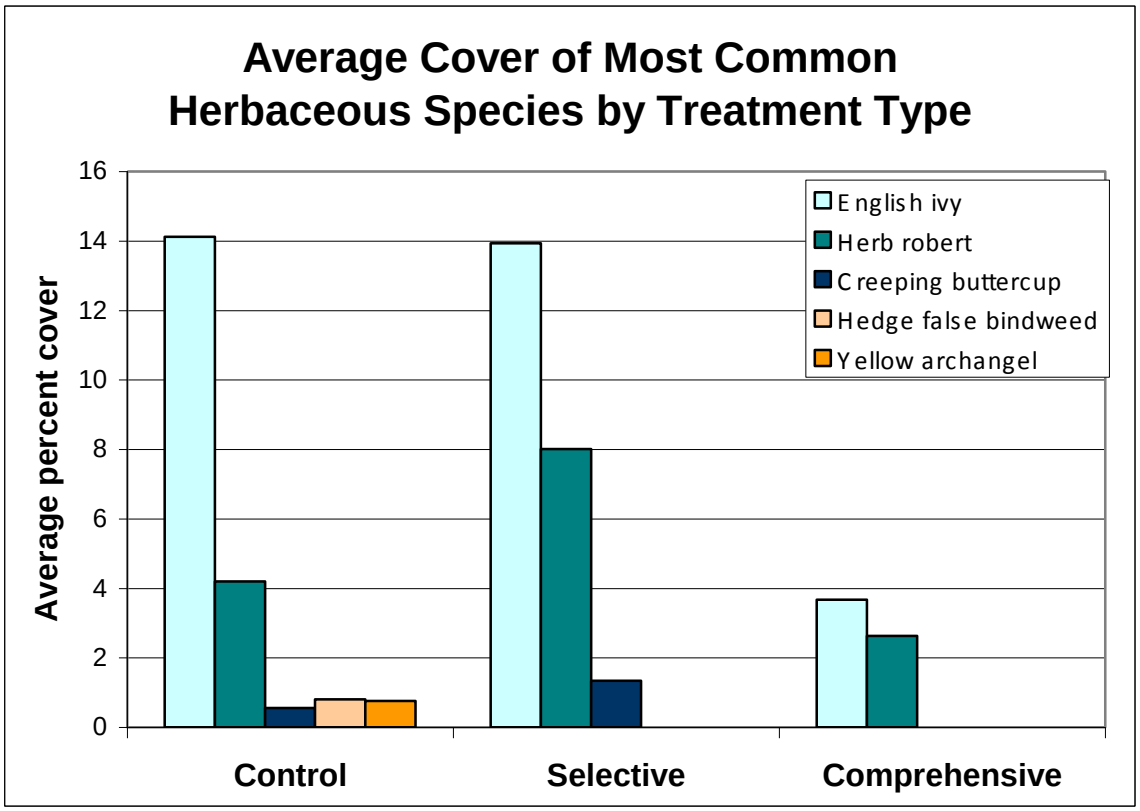
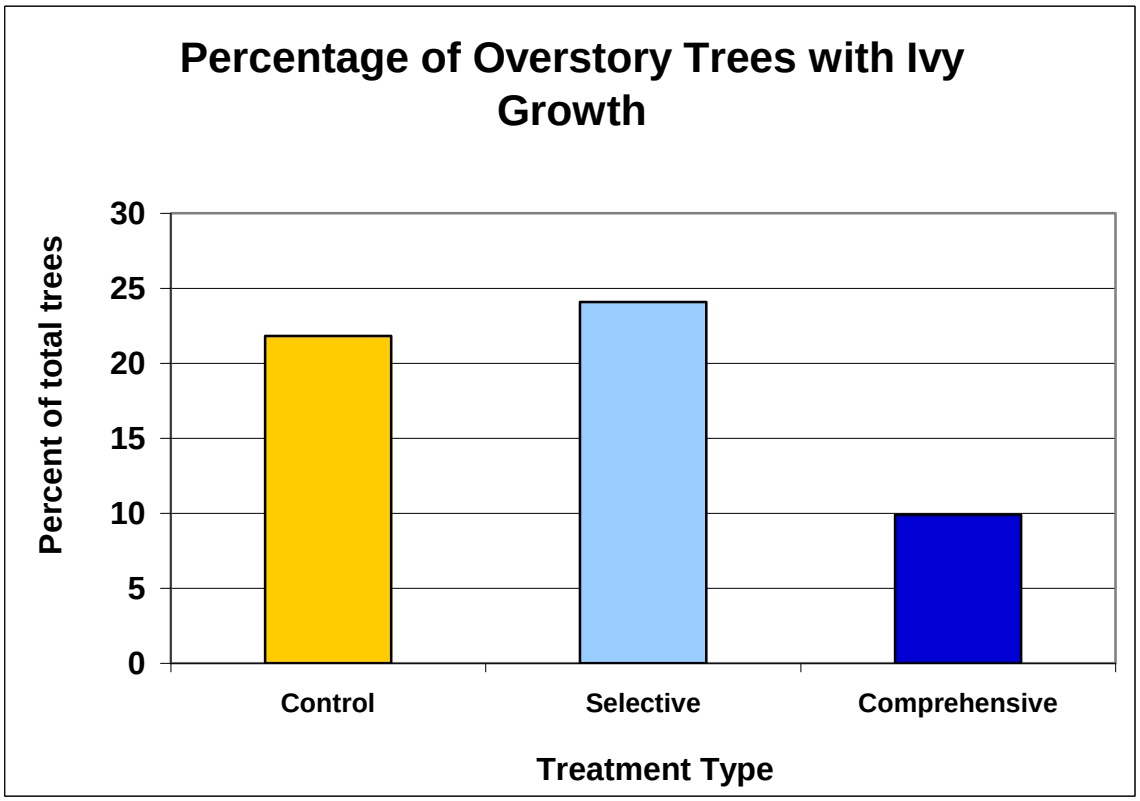


Figure 17. Percent of overstory trees with ivy growth, by treatment type, Pioneer Park, Mercer Island, WA



3.5.4. Ivy growth on overstory trees

While English ivy is a generally a low growing herbaceous plant, it has the ability to climb high in the canopy on mature trees. This growth of English ivy leads to stress, diminished growth, and eventually death of trees due to its weight and competition for light and water. Additionally, English ivy does not produce seed as a ground cover but does produce seed as it reaches into tree crowns. The presence of ivy in the canopy of trees leads to even more ivy in the park due to the production of seeds. Areas that received the *comprehensive* treatment had a greatly reduced percent of overstory trees with ivy growth (10%) as opposed to the *control* (22%) and *selective* (24%) treatments (Figure 17).

3.6. Snags

3.6.1. Background

Standing dead wood is an important component of all forests. These snags provide habitat for wildlife, insects, fungi and plants, and store nutrients, which are slowly released into the forest floor. In the Pacific Northwest, sixty-nine species of animals commonly use cavities carved out of these tree remnants (Boyland and Bunnell, 2002), and the presence of snags is particularly essential for populations of cavity nesting birds. In addition, birds use these pieces of wood as perches and as sources of insects for food.

3.6.2. Summary

Overall, Pioneer Park contains a healthy amount and quality of standing dead wood. Pieces of wood considered snags in this study were at least 5 inches DBH and at least 6 feet tall. Snags were found in 43 of the 56 plots (77%), with an average density of 20.2 snags/acre. The average height of a snag in Pioneer Park is 30 ft tall, with 24.8% of snags (5 snags/acre) taller than 40 ft (Figure 18). The diameters of snags range from 5-35 inches, and 3.2 snags per acre (15% of snags) are larger than 20 inches in diameter (Figure 19). Snags in Pioneer Park were found in all stages of decay, although most snags were categorized as Decay Class II.

Figure 18. Average snag density and height class by decay class, Pioneer Park, Mercer Island, WA

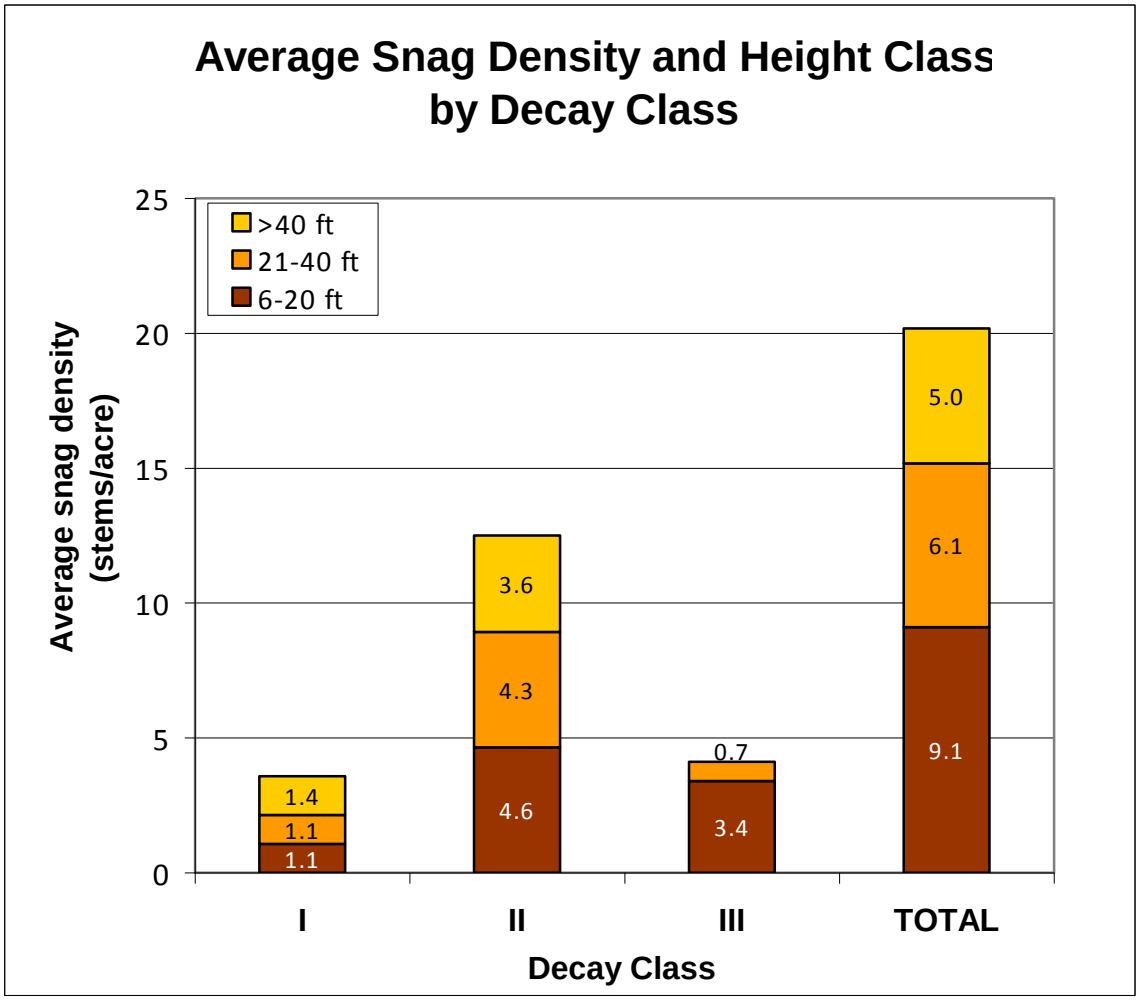
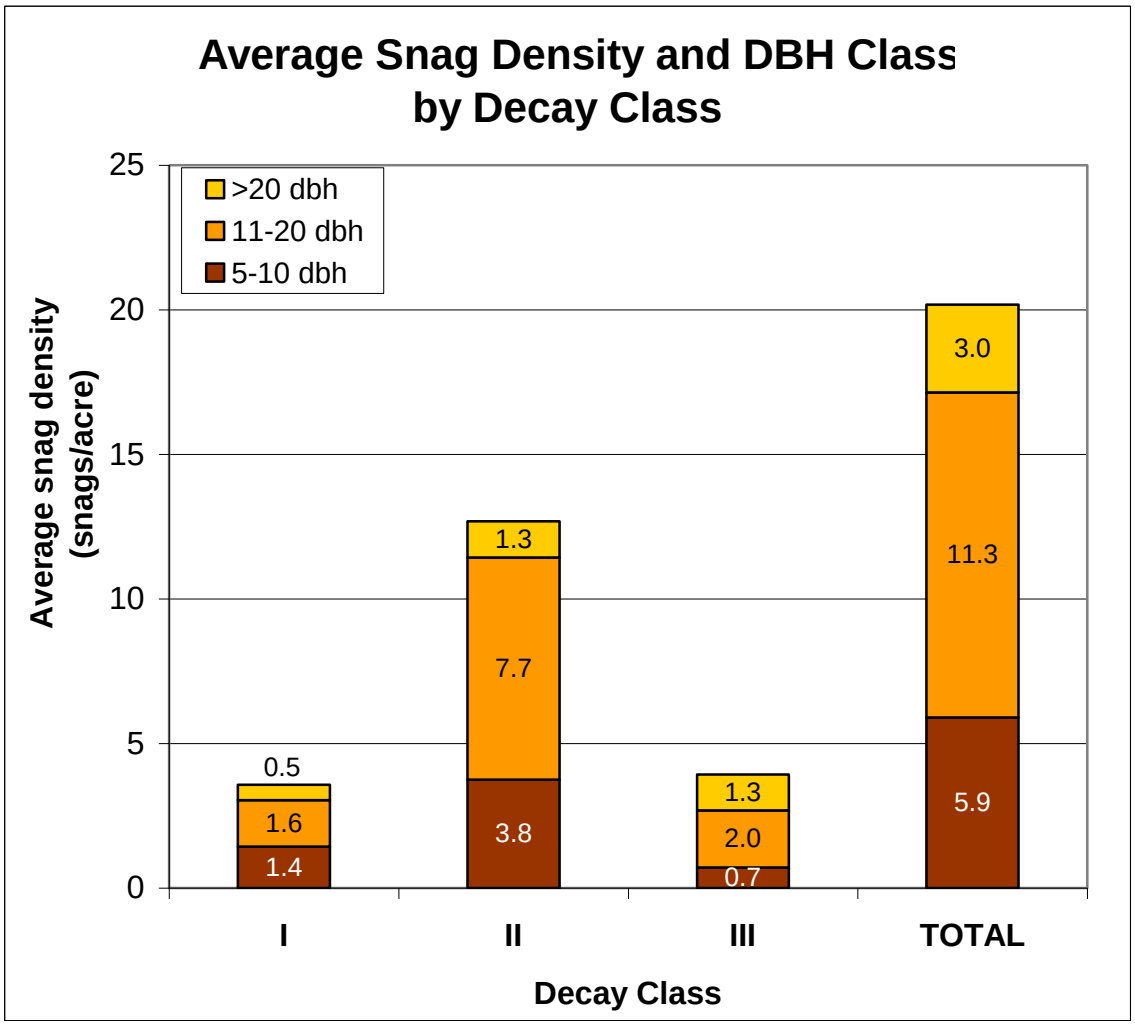


Figure 19. Average snag density and DBH class by decay class, Pioneer Park, Mercer Island, WA



The snags found in this study have a great deal of variation in size, decay and height. This type of diversity is extremely important for the support of all species that rely on certain conditions of standing dead wood. Boyland and Bunnell (2002) suggest that in order to sustain populations of cavity nesting birds, forests in the Pacific Northwest should contain at least 0.8-1.2 snags/acre larger than 20 inch DBH, and 4-8 snags/acre smaller than 20 inch DBH. Pioneer Park easily meets both of these criteria. Boyland and Bunnell (2002) also assert the importance of snags that are wide (to accommodate an adult and several young birds) and tall (to minimize interference by predators). In Pioneer Park, snags above 40 ft. tall average only 15.8 inches in diameter, and only three snags were found that exceeded 20 inches in diameter.

Table 7 shows how characteristics of snags in Pioneer Park compare to those of other urban forested areas in the Seattle area. The overall density and the average diameter of snags in Pioneer Park are slightly lower than other areas, while the average height is similar.

Table 7. Comparison of snag characteristics in Seattle-area urban forests (conifer-deciduous mixed forest type)

Area	Snag density (snags/acre)	Average height (ft.)	Average diameter (in.)	Snags over 20 in. diameter (snags/acre)
Shadow Lake, King Co., WA* (SUN, 2008c)	32	27	13.1	3
Boeing Creek, Shoreline, WA* (SUN, 2008a)	21	40	18.5	6
Deadhorse Canyon, Seattle, WA* (SUN, 2005)	14	24	21	3
Hamlin Park, Shoreline, WA* (SUN, 2008b)	65	36	9.6	0
Pioneer Park, Mercer Island, WA	20	30	12.9	3

* Study sites sampled and analyzed by Seattle Urban Nature (SUN) using methods comparable to those of the Pioneer Park Forest Health Survey.

3.7. Coarse woody debris

3.7.1. Background

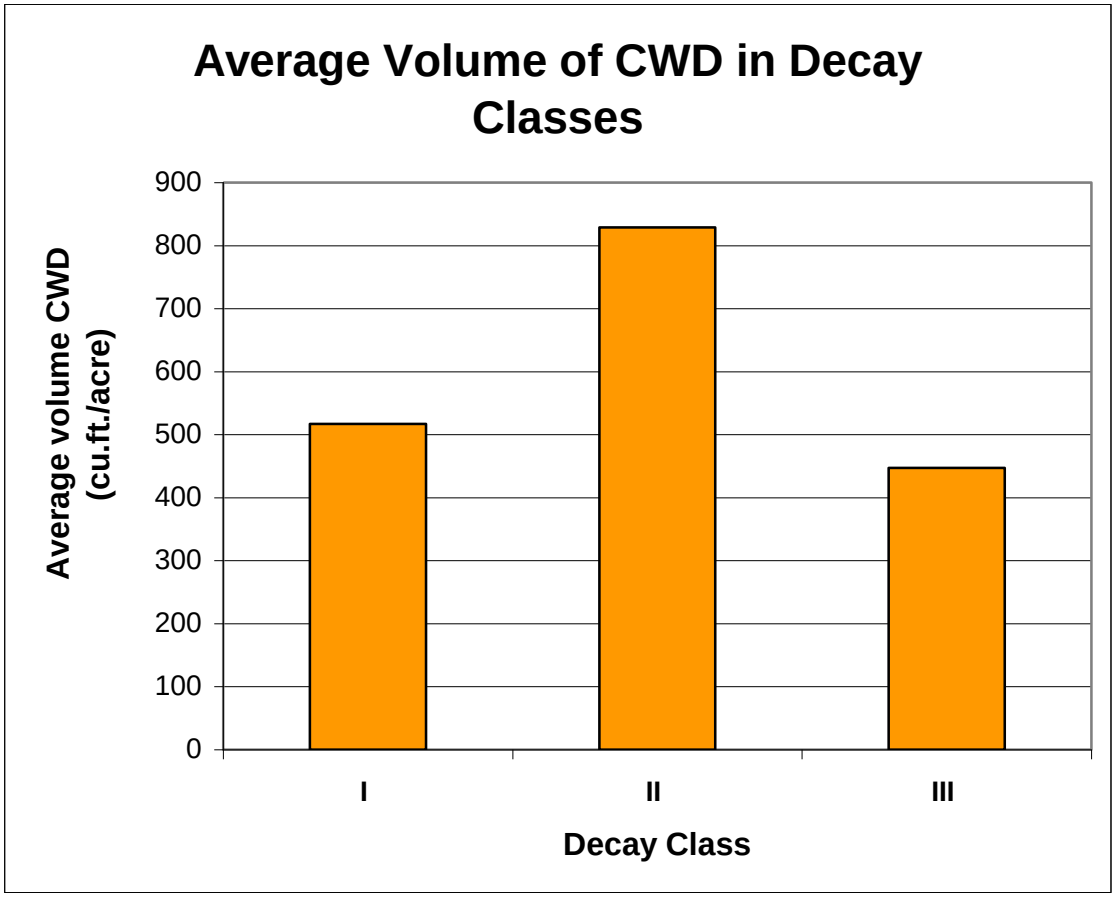
Coarse woody debris has become a focus of forest health and management over the last decade, as its benefits and services have been recognized. The importance of CWD in Pacific Northwest forests is difficult to overestimate, given its role in the lifecycles of forest flora and fauna.

Decaying pieces of wood in the forest often serve as 'nurse logs', areas where shade-tolerant conifers can more easily regenerate, due to the nutrient-rich, moist substrate, and reduced competition with other vegetation (Franklin *et al*, 1981; Stevens, 1997). Tree regeneration is often higher on coarse woody debris than in surrounding soil areas, and these saplings often have a higher growth rate (Franklin *et al*, 1981). For these reasons, the process of habitat renewal can be faster in areas where coarse woody debris has been left in place (Stevens, 1997).

Because decaying wood absorbs and retains water, CWD often serves as a sought-after microhabitat for animals during dry periods. These pieces of wood provide sites for burrows, nests and dens, as well as travel corridors through dense understory vegetation, for a variety of small mammals (Stevens, 1997). They also provide protection and moisture for amphibians, and habitat for arthropods and decomposers.

These logs also contribute to the health of the ecosystem indirectly: CWD contains pools of nutrients that are slowly released into the forest floor and made available to vegetation. Large pieces of wood serve as long-term storage for large amounts of carbon.

Figure 20. Volume of CWD per acre, by decay class, Pioneer Park, Mercer Island, WA



3.7.2. Summary of coarse woody debris results

Coarse woody debris on the forest floor was only considered in this study if it had a diameter of 6 inches or greater. CWD was found in all but one study plot at an average density of 127 pieces per acre. The average piece of CWD has a length of 15.5 feet and a diameter of 12.1 inches. Coarse woody debris was found in all stages of decay, and almost half of the volume of wood was classified as Decay Class II (Figure 20). A healthy forest, such as this, will have a good proportion of its CWD in each decay class.

The average volume of CWD in the park, 1793 ft^3 per acre, is midway between values for other similar parks in the area (Table 8). Values for unmanaged forests of similar age in the Pacific Northwest range from 1325 to 2359 ft^3 per acre, with a mean of 1774 ft^3 per acre (Spies and Franklin, 1991). Although the volume of downed wood needed to create a 'healthy' forest is difficult to calculate, the proximity of values in Pioneer Park to those of unmanaged forests indicates that this park currently contains an adequate amount of CWD to support local wildlife.

Table 8. Comparison of CWD characteristics in Seattle-area urban forests (mixed conifer-deciduous forest type)

Area	Average number of pieces per acre	Average volume (ft^3/acre)	Average diameter (in.)
Shadow Lake, King County, WA* (SUN, 2008c)	130	2774	11.8
Boeing Creek, Shoreline, WA* (SUN, 2008a)	-	1022	11
Deadhorse Canyon, Seattle, WA* (SUN, 2005)	-	2390	16.5
Hamlin Park, Shoreline, WA* (SUN, 2008b)	128	611	7.8
Pioneer Park, Mercer Island, WA	127	1793	12.1

* Study sites sampled and analyzed by Seattle Urban Nature (SUN) using methods comparable to those of the Pioneer Park Forest Health Survey.

4. MANAGEMENT RECOMMENDATIONS

The recommended management strategies that have been developed for this park are a product of study results and professional experience with similar restoration efforts. These recommendations differ from those of the 2004 City of Mercer Island Open Space Vegetation Plan. The 2004 plan, which guides open space vegetation management in all Mercer Island parks except Pioneer Park, suggests that weed removal priorities should be directed towards the removal of small outlier populations (nascent foci) of a given weed before focusing on larger, dense patches. Due to the healthy cover of native shrubs throughout Pioneer Park, it is not expected that large areas of the park will be invaded by outlying populations of non-native shrubs and herbaceous plants in the years before these weeds are addressed in the new management plan. Therefore the nascent foci strategy will not be used in this plan and instead a complete removal strategy will be employed.

4.1. Review of Management Practices, 2003 – 2008

The goal of the strategy set forth in the 2003 Forest Management Plan is to attain a "healthy forest" using passive, natural regeneration whenever possible. This strategy includes one round of tree planting consisting of primarily native conifer trees. The tree planting occurs throughout the park only as needed, including forest gaps and areas with sparse natural regeneration of any native trees (either conifer or deciduous).

To reach the point of requiring only light annual maintenance, an area must undergo a three year cycle of treatment which includes three years of intensive weed removal and tree planting, where needed, in the first year. This management, referred to as *comprehensive* treatment, prioritizes treatment by area. Treatment in one or more areas of the park is begun before another area is addressed. Generally, areas not receiving *comprehensive* treatment either remain untreated until they can receive *comprehensive* treatment, or receive a small amount of treatment (*selective*), such as tree planting or blackberry brush-cutting.

An advantage of this methodology is that once an area has gone through a complete three-year cycle of treatment, it is considered "finished" and only requires annual maintenance. Unfortunately, it delays focus on particularly troublesome park-wide issues, such as English ivy on large trees and low conifer regeneration, which will affect the health of Pioneer Park's forests for years (Appendix H).

4.2. Overview of 2008 Forest Health Plan

The 2008 Forest Health Plan has the goal of attaining a healthy and sustainable forest based on the findings of the 2008 FHS study. The methodology of this plan is outlined in Sections 4.3 though 4.5.

The strategy prioritizes specific issues throughout the park that will have the greatest impact on the future structure of the forest. Treatment of an entire forest health issue occurs throughout the park before treatment of the next most pressing issue. This gives managers the ability to prioritize management activities based on ecological need, and adjust timing of particular tasks in accordance to available funding levels. As proposed, the workload and cost of this plan has been distributed relatively evenly over the next twenty years (see Section 4.3).

4.3. Continuation of *comprehensive* treatment

The areas currently undergoing *comprehensive* treatment have received a significant investment of both time and money over the past seven years. For this reason, it is our recommendation that invasive removal and other maintenance activities in the 17.1 acres receiving *comprehensive* treatment continue through the three-year schedule of maintenance. Once these three years of intensive management are completed, lower-intensity yearly maintenance should continue to aid the growth of new trees. This maintenance is expected to be required for approximately 20 years.

4.4. Management of large woody debris

Because dead and decaying wood plays a vital role in the regeneration of trees and the preservation of plant and animal diversity of Pioneer Park, CWD and snags should be kept in place whenever possible. In addition, wood from living trees or snags that are cut due to safety concerns should be left within the park. Special efforts should be made to retain tall, large diameter snags.

4.5. New management strategy (in order of priority)

4.5.1. Short-term objectives

1) Remove English holly and cherry laurel

English holly is the most common tree found in Pioneer Park (Map 3). Its ability to form dense thickets and grow in virtually any environment makes this species a major competitor of native vegetation for light, nutrients and water. If possible, a given area should be swept clean of all English holly, regardless of size, by herbicide treatment. Larger plants (with a diameter of one inch or more) should be frilled at a height of one foot and treated with 100% concentration glyphosate applied immediately to the fresh wound of the tree. Smaller trees and seedlings (all specimens with a diameter less than one inch) of English holly should

Map 3. Regenerating English holly density in Pioneer Park, Mercer Island, WA

be cut at a height of one foot and receive an immediate 100% concentration glyphosate application on the cut stem.

Because it is spread easily by seed and will continue to invade new areas, the control of mature specimens of English holly is the highest priority. If time or budgets do not allow for removal/treatment of all sizes of English holly, older specimens, with a diameter of one inch or more, should be removed first as they are more likely to contribute new propagules to the environment.

The same control measures should be used for cherry laurel.

2) Plant conifers and maintain

Over the next 100 years the composition of the forest canopy in Pioneer Park will continually change, due in part to forest diseases. A relatively high percent of existing overstory Douglas-fir will become infected with laminated root rot (LRR) and fall to the forest floor. In order to prevent the rapid colonization of these new forest gaps by native deciduous trees or invasive tree species, it is important that young conifers be planted early. At Pioneer Park, native conifers suitable for planting in LRR gaps include the LRR-resistant western red cedar and the LRR-tolerant shore pine (*Pinus contorta* var. *contorta*) and western white pine (*Pinus monticola*). While Douglas-fir and western hemlock will not be actively removed, planting these species is not encouraged due to their susceptibility to LRR. With widespread planting of LRR -resistant and -tolerant conifer species, the historic conifer tree character of Pioneer Park will be preserved, while the naturally-occurring laminated root rot fungus persists in the forest.

Based on densities found in comparable mature forests (Table 4), the desired stem density for overstory trees in Pioneer Park is approximately 150 trees/acre. The structure of this forest is ideally a multi-aged conifer stand, with a small percentage of native deciduous trees. Because Pioneer Park currently supports a robust population of young deciduous trees, planting efforts should focus primarily on the aforementioned conifer species.

Given the target density, regenerating conifers should be planted at a density of 200 to 400 trees/acre (Sound Native Plants, 2006), depending on site quality. This initial planting density will ensure good survival while allowing for natural attrition and thinning. However, in order to achieve a forest stand that contains trees of varying ages, we recommend that tree planting be completed in two phases:

- Phase 1 (short term): Plant at approximately 200 trees/acre density, including existing regenerating conifers.

- Phase 2 (long term, 20-30 years later): Plant at approximately 110 trees/acre density, *excluding* existing regenerating conifers (see section 4.3.3)

Overplanting to account for natural mortality will save time and cost of future planting. However, if mortality rates are lower than expected, future thinning may be required. Thinning forest understory plantings requires additional expense, and the removal of young, healthy trees may cause public concern. (K. Moller, Seattle Parks Urban Forester, Personal communication, 7 October, 2008).

Although trees planted at Pioneer Park should primarily consist of conifer species, these plantings may be supplemented and diversified by adding under-represented native broadleaf species that are well-suited to particular habitat types. In the conifer forest habitats, the addition of cascara, pacific dogwood and madrone will diversify the overstory canopy. Mixed forest areas will benefit from the addition of young madrone trees, and riparian forest habitats should also receive several broadleaf species, such as bitter cherry (*Prunus emarginata*), cascara (*Frangula purshiana*), Oregon ash (*Fraxinus latifolia*), pacific dogwood (*Cornus nuttallii*), and paper birch (*Betula papyrifera*). The planting of these non-dominant native broadleaf trees should be limited to 10% of any given planting to ensure that the desired conifer species thrive.

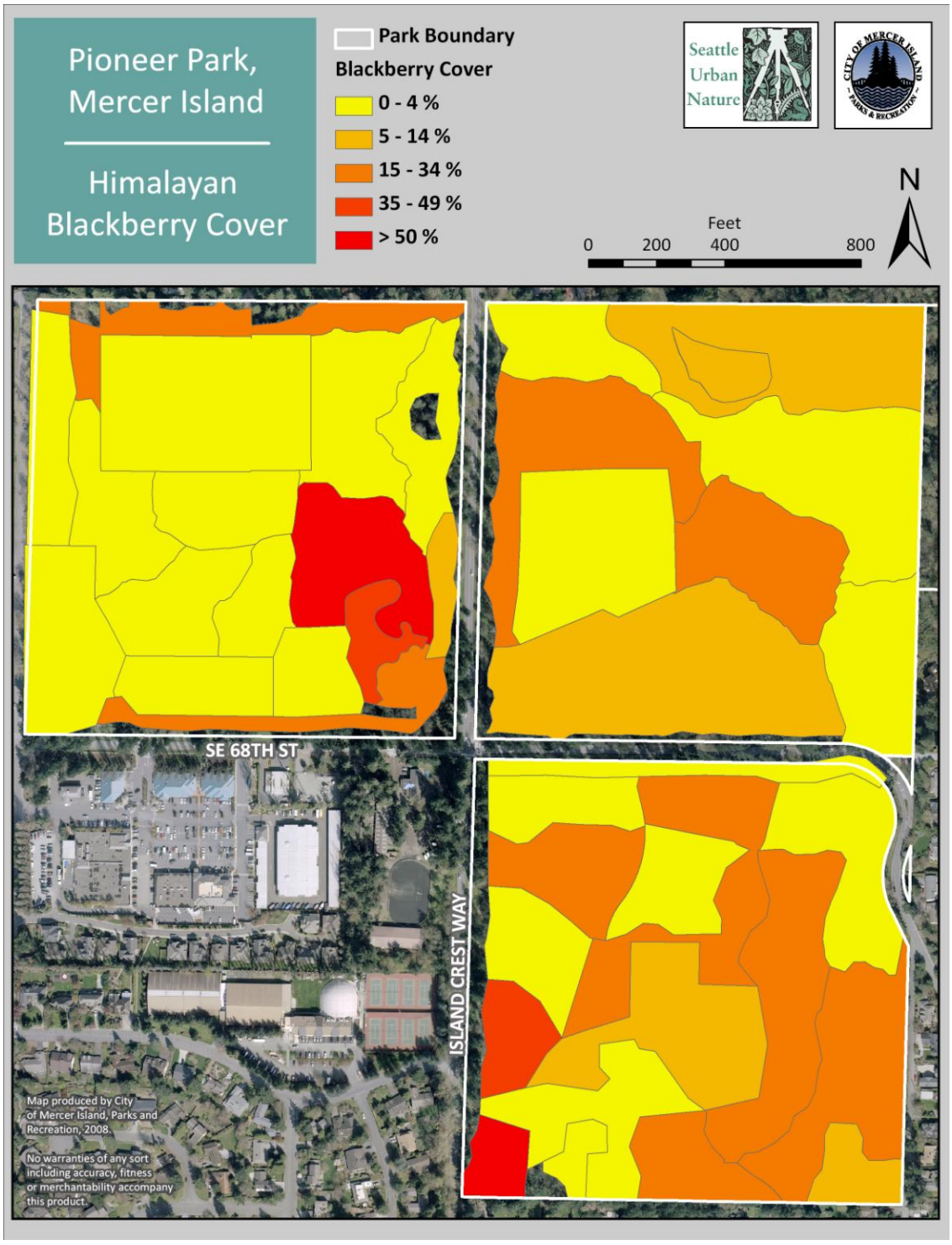
Himalayan blackberry control

In preparation for planting, vegetation will be cleared to allow light to reach the newly planted trees. This vegetation clearing will include removal or cutting back of both invasive species (such as English ivy and Himalayan blackberry) and native species (such as sword fern and low Oregon grape). This clearing should be completed no more than four weeks before planting to ensure that the vegetation has not grown back.

In areas such as forest gaps, where dense patches of Himalayan blackberry dominate, the area will need to be cleared of all canes by brush cutting or "knock down". This process involves cutting all blackberry canes in the area to a height of one foot using mechanized equipment and allowing the cut material to decompose on site. This relatively quick method of clearing these areas does not remove the root material but, rather, over time exhausts the plant's underground resources by restricting photosynthesis. It also may allow native vegetation surrounding the Himalayan blackberry to expand.

Priority Himalayan blackberry removal areas are indicated in Map 4. Overall, complete elimination of Himalayan blackberry is a lower priority than the treatment of English holly, cherry laurel, and English ivy because, unlike these species, growth of blackberry can be suppressed with increased shade. As portions of the forest become shadier following the planting of conifer trees, density and spread of Himalayan blackberry will be kept at a minimum.

Map 4. Himalayan blackberry cover in Pioneer Park, Mercer Island, WA



New trees should be planted in the fall or early winter only, to allow for adequate rooting before the dry months of the year. We recommend 2-gallon planting stock, as these trees generally have developed root systems, and are tall enough to be re-located for maintenance (if flagged). If possible, planting stock should be obtained from a local seed source.

Maintenance should be performed on trees once per summer, for two years following planting. This maintenance will include the removal of all vegetation within a 5 foot diameter of each tree. Removing these plants, and their roots, will reduce the competition for light, water and soil nutrients. Because these trees will not be irrigated, the reduction of competition is especially important to the survival of these saplings.

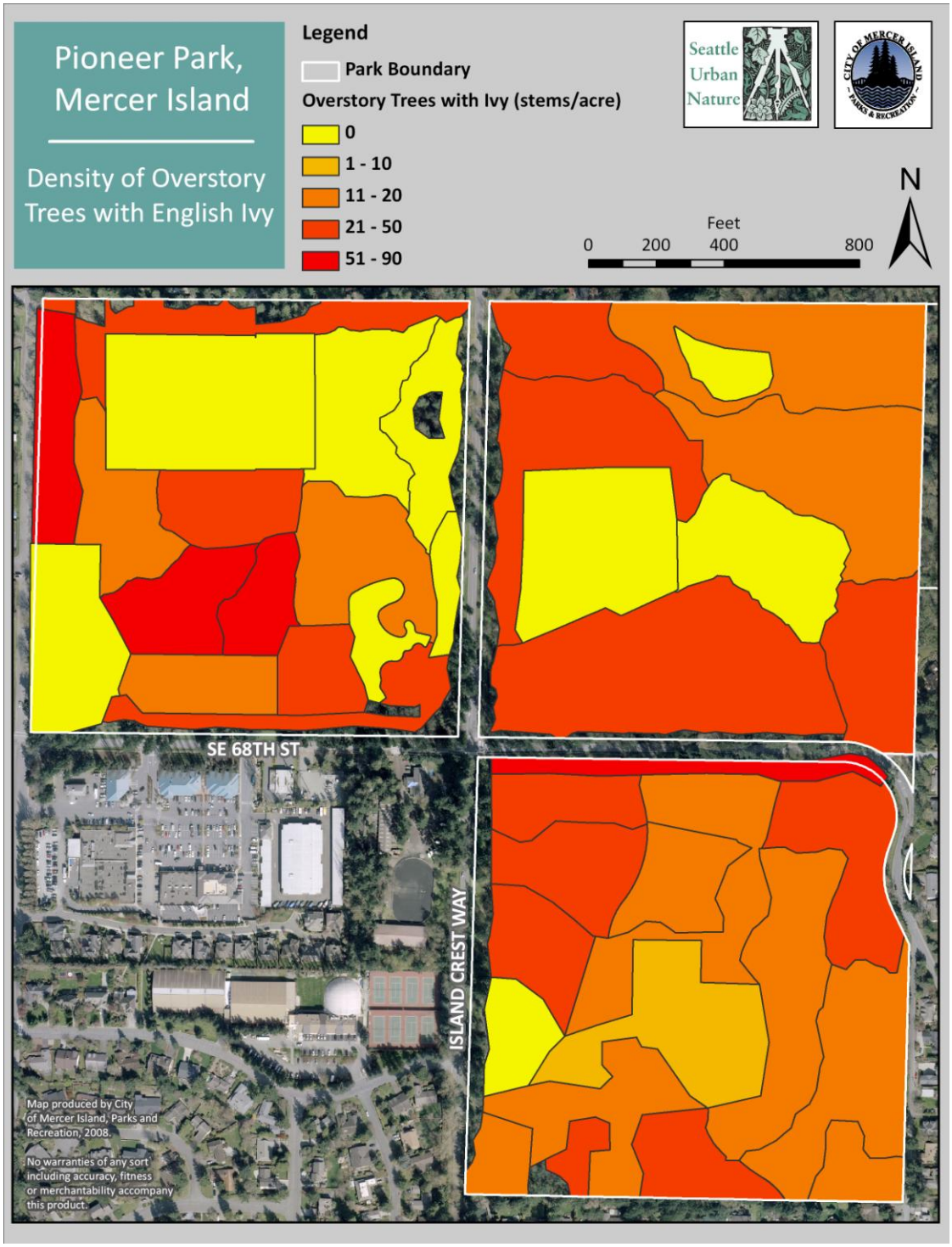
While the shrub component of the forest is very important, the planting of shrubs is not a priority for several reasons. First, there already exists a good diversity and density of native shrubs (Figure 12). Second, the future knockdown and removal of Himalayan blackberry may open space in the forest into which native shrubs will continue to move, given ongoing maintenance.

3) Remove English ivy from trees

The removal of English ivy from trees is a critical step in improving the health of Pioneer Park. On very small trees the entire mass of ivy is removed from the plant. On large trees, where ivy has grown high into the tree, the stems of ivy are severed at approximately four feet from the ground. In both cases, the ivy stems and root mass are cleared within a three foot ring around the base of the tree. This technique, known as creating “ivy rings”, causes the ivy on large trees to dry out and slowly die. Although the ivy dies relatively quickly, it can take up to 20 years for the dead ivy biomass to fall out of the tree. The creation of ivy rings greatly reduces the weight and shading on the tree canopy, and decreases the competition for soil resources, within weeks.

Because English ivy is evergreen, ivy ring creation can be performed any time of the year. Areas of Pioneer Park with a high density of ivy-covered trees should be given first priority in control (Map 5).

Map 5. Density of overstory trees with English ivy growth in Pioneer Park, Mercer Island, WA



4.5.2. Mid-term objectives

1) Remove herbaceous weeds from forest floor

This goal targets aggressive non-native groundcover species such as English ivy, yellow archangel, hedge false bindweed, and herb Robert. In areas where these species occur in dense monocultures, control using a foliar-application of glyphosate herbicide at the manufacturer's recommended concentration is advised. In areas near existing native plants, young conifer trees, or watercourses, manual removal is recommended. Pulled plant material can be left on site in large piles atop tree branches, elevating the pile several inches above the ground, which will promote degradation. Follow-up removal of these plants will occur once every three years.

2) Monitor and remove new invasions

Pioneer Park is currently home to several invasive species which require significant economic resources for management and pose immediate threats to the ecological health of the forest. Other invasive plants, such as yellow archangel and cherry laurel, have the potential to greatly increase their presence in the park. However, there are many other invasive species found in the Pacific Northwest which have not yet become problems in the park. Such species include Scotch broom (*Cytisus scoparius*), knotweed (*Polygonum cuspidatum*), garlic mustard (*Alliaria petiolata*), and reed canarygrass (*Phalaris arundinacea*). Preventing invasions by these species is the most effective and resource-efficient method of controlling these plants. Therefore, a systematic monitoring program of the areas that are likely to host such invasions is strongly recommended. This monitoring should be done every-other year in late spring, when the greatest numbers of plants are growing concurrently. The three general locations in the park where plant invasions are likely to occur are at the park boundaries with private residences, along the stream corridor, and alongside trails.

Boundary search
Many of the non-native species that become a problem in public wildland parks are plants that have spread from horticultural plantings on adjacent properties. Because four edges of Pioneer Park directly border private residential property, these boundaries must be monitored for potential invasive plants. Each year, a search of the boundary between Pioneer Park and private properties should be made to identify new species. This search should cover a 50' wide swath from the park boundary line inward. The important boundaries for this search are the north edge of the NW quadrant, the north and east edges of the NE quadrant, and the south edge of the SE quadrant. Monitors should carry a GPS unit to record the location of new invasions, and hand tools and bags, used to remove small invasive populations, if time permits. Larger population of newly discovered invasive plants should be eliminated from park property as soon as possible.

Stream corridor search
Stream corridors provide a unique opportunity for new non-native plant invasions. Plants can move as seeds and vegetative material, making their way into the park by flowing downstream. Invasive, non-native water-loving plants such as

knotweed, reed canarygrass, and bittersweet nightshade (*Solanum dulcamara*) are uniquely adapted to wet areas and are especially difficult to remove once established. In monitoring the stream corridor, a 100' wide search (50' on each side of the stream) is recommended.

Trail edge search
New plant invasions often occur along trail edges because these areas of the park receive the most use by park visitors. Invasive plant seeds can enter the park through attachment to clothing, shoes, pet hair, pet paws, and horse waste. A regular survey of all park trails is recommended to monitor for potential new plant invasions. Because trail corridors are observed more often than the park's streams or boundaries, it is only necessary to monitor a 10' swath on either side of the trail.

3) Permanent survey plot monitoring

Permanent survey plots, first established for the 2008 Forest Health Survey, will be revisited every ten years. This monitoring will use the same sampling techniques described in Section 2 of this report. With each data collection, new information will be available regarding existing forest conditions, effectiveness of treatments, and trends in vegetation over time. Ideally, this survey will be conducted in the same season in which the initial study was conducted (early June through August) so that data are comparable. Plots can be located using maps from the original survey as well as geographic coordinates (Appendix G).

4.5.3. Long-term objectives

1) Second phase conifer planting

The second phase of conifer planting will take place 20-25 years after the implementation of this plan. As in the first phase of planting, most trees will be LRR-resistant conifer species, with a small proportion of native broadleaf species. Trees will be planted at a density of 100 stems/acre, filling in the spaces between existing trees and replacing previous planted trees that have not survived.

Similar maintenance should be performed on these newly planted trees, to ensure a high percentage of survivorship and the creation of a healthy multi-aged stand.

4.6. Budget-restricted management alternative

An alternative management strategy was developed that, while based on the 2008 Forest Health Plan, stays within Mercer Island Parks' annual budget for work at Pioneer Park ($132,000). In order to accommodate this budget, the timing of management activities was changed and some follow-up maintenance reduced. These changes are likely to compromise the effectiveness of the recommendations, as priority activities, such as holly and laurel removal, tree planting, and ivy ring creation will take longer to complete. The budget-restricted plan also requires 25 years of management to achieve comparable levels of forest health set in the original plan (20 years).

4.6.1 Specific modifications to 2008 Forest Health Plan

In the modified plan, initial holly and laurel treatment is spread over six years rather than five, and follow-up treatment of holly and laurel occurs every six years rather than every five. Initial tree planting occurs over 13 years rather than five years, and only one round of annual maintenance occurs on the planted trees rather than the two years recommended in the original plan. Ivy ring creation begins in the fifth year of the project in the budget-restricted plan, rather than the first year, and stretches the activity over ten years rather than five years. Two cycles of ivy ring maintenance occurs in the modified plan rather than three cycles.

Ground ivy treatment occurs seven years later in the budget-restricted plan and is spread out over six years rather than five. Additionally, there is one fewer cycle of ground ivy maintenance in this revised plan. Four rounds of boundary search and destroy are included in this plan (once every four years, starting at year 11) compared to eight rounds (every other year, starting at year 6) in the 2008 Forest Health Plan. The second phase of tree planting takes place over 11 years rather than five years.

4.7. Cost estimates

Three condensed budgets are presented in the appendices. Appendix I estimates the cost of implementation for the 2008 Forest Health Plan, the details of which are presented in Sections 4.2 through 4.5. This plan is projected to cost approximately $3.58 million over the next 20 years. For comparison purposes, Appendix J presents the costs expected for continuation of the 2003 Forest Management Plan, with a total cost of approximately $3.73 over 20 years. The budget-restricted version of the 2008 Forest Health Plan costs is presented in Appendix K. This budget and the corresponding management schedule are revised to limit annual spending on Pioneer Park management to approximately $132,000, the current amount allocated to these activities, and costs are projected over the next 25 years. All strategies include the completion of management activities in the current *comprehensive* treatment areas (Sections 1.4 and 2.1).

Costs are calculated based on unit costs of contracted work within Mercer Island Parks between 2006 and 2008. There are very few estimates of unit costs for annual maintenance once initial weed removal or planting has occurred. Because of this, long term unit costs for maintenance are educated guesses at best. Budgets are projected through 2028 or 2033, depending on the plan, when the forest is expected to have attained a stable, healthy state, requiring minimal further maintenance.

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Appendix A. Pioneer Park Forest Management Plan goals

(From: Mercer Island Open Space Conservancy Trust & City of Mercer Island Parks and Recreation Department, 2003):

1. Pioneer Park will remain a healthy, sustainable native forest

2. The soils of the park are the foundation for all life in the park. Therefore, they will be preserved, along with the living organisms and soil-building processes found there.

3. The forest will consist of plant species native to the Puget Sound basin. Plants native to the coastal northwest, but not endemic to the Puget Sound basin may be used, limited to sites where locally native species cannot perform a landscape function necessary for forest management.

4. Natural regeneration will be the primary mechanism for managing the forest vegetation, since this achieves ecological restoration with lower levels of input and disturbance. Plantings will be used where native regeneration is not sufficient to achieve plan goals.

5. Diversity of structure and composition will be managed. Too much or too little diversity impacts habitat, aesthetics, pest control, and management efficacy. Activities that increase diversity should not introduce excessive randomness to the forest composition.

6. Habitat will be preserved and enhanced to maintain the park's population of native animals, including, but not limited to, mammals, birds, reptiles and invertebrates.

7. The riparian environments within the park will be managed as in Goal 6 and also avoid adverse impact to aquatic habitat downstream from the park.

8. Invasive non-native plants will be controlled to achieve plan goals.

9. Park vegetation will not pose an unreasonable hazard to park users, adjacent streets or neighboring properties.

10. The vegetation in the park will be managed to enhance park users' passive enjoyment of a native forest setting.

11. Members of the Mercer Island community find ways to actively participate in the restoration projects under the leadership of the Open Space Conservancy Trust.

12. The City of Mercer Island will manage the forest under the leadership of the Open Space Conservancy Trust.

Appendix B. Frequency and density of overstory tree species in Pioneer Park

Species	Common Name	Native/ Introduced	Percentage of Plots Found	Average Density (stems/ plot)	Percentage of Native Density	Percentage of Total Density
Acer macrophyllum	big-leaf maple	native	57.1	15	16.9	16.4
Alnus rubra	red alder	native	57.1	15	16.4	15.8
Arbutus menziesii	madrone	native	8.9	1	1.2	1.2
Cornus nuttallii	dogwood	native	7.1	1	1	1
Ilex aquifolium	English holly	introduced	25	3		3.7
Prunus emarginata	bitter cherry	native	3.6	3	3.2	3.1
Pseudotsuga menziesii	Douglas-fir	native	83.9	39	43.7	42.1
Rhamnus purshiana	cascara	native	7.1	1	1	1
Taxus brevifolia	yew	native	1.8	0.2	0.2	0.2
Thuja plicata	western red cedar	native	25	4	4.4	4.2
Tsuga heterophylla	western hemlock	native	44.6	11	12	11.5

Appendix C. Frequency and density of regenerating tree species in Pioneer Park

Species	Common name	Native/ Introduced	Percent of Plots Where Found	Average Density (stems/plot)	Percentage of Native Trees	Percentage of Total Trees
Abies grandis	grand fir	native	1.8	0.04	0.3	<0.1
Acer circinatum	vine maple	native	1.8	0.04	0.3	<0.1
Acer macrophyllum	Big-leaf maple	native	78.6	4.8	46.9	4.7
Acer palmatum	Japanese maple	introduced	1.8	0.02	--	<0.1
Acer saccharinum	silver maple	introduced	1.8	0.07	--	<0.1
Alnus rubra	red alder	native	7.1	0.5	5	0.5
Cornus nuttalii	Pacific dogwood	native	3.6	0.1	1.2	0.1
Ilex aquifolium	English holly	introduced	85.7	89.9	--	86.6
Malus fusca	Oregon crab apple	native	3.6	0.04	0.3	<0.1
Malus sp.	apple	introduced	3.6	0.04	--	<0.1
Pinus contorta	shore pine	native	3.6	0.4	3.5	0.3
Pinus monticola	western white pine	native	1.8	0.02	0.2	<0.1
Pinus ponderossa	ponderosa pine	native	1.8	0.02	0.2	<0.1
Prunus avium	sweet cherry	introduced	9	0.4	--	0.4
Prunus cerasifera	cherry plum	introduced	1.8	0.02	--	<0.1
Prunus emarginata	bitter cherry	native	3.6	0.09	0.9	<0.1
Prunus sp.	plum	introduced	5.4	0.1	--	0.1
Pseudotsuga menziesii	Douglas-fir	native	10.7	0.3	2.4	0.2
Quercus sp.	oak	native	19.6	0.3	3.1	0.3
Rhamnus purshiana	cascara	native	60.7	2	19.2	1.9
Sequoia sempervirens	coast redwood	introduced	7.1	0.1	--	<0.1
Sorbus aucuparia	European mountain ash	introduced	39.3	2.9	--	2.8
Thuja plicata	western red cedar	native	41.1	1.3	13	1.3
Tsuga heterophylla	western hemlock	native	19.6	0.4	3.5	0.3

Appendix D. Frequency and cover of shrub species in Pioneer Park

Species	Common Name	Native/ Introduced	Percent of Plots Where Found	Avg. Cover Where Found	Avg. Cover Across All Plots
Acer circinatum	vine maple	native	5.4	2.5	0.1
Aucuba japonica	Japanese laurel	introduced	3.6	2.0	<0.1
Corylus cornuta	beaked hazelnut	native	83.9	22.4	18.8
Cotoneaster simonsii	Simons' cotoneaster	introduced	3.6	0.9	<0.1
Crataegus monogyna	oneseed hawthorn	introduced	1.8	0.02	<0.1
Daphne laureola	spurgelaurel	introduced [1]	1.8	0.02	<0.1
Gaultheria shallon	salal	native	73.2	12.3	9.0
Holodiscus discolor	oceanspray	native	26.8	6.1	1.6
Lonicera involucrata	twinberry	native	1.8	0.02	<0.1
Mahonia aquifolium	tall Oregon grape	native	3.6	0.1	<0.1
Mahonia nervosa	low Oregon grape	native	96.4	7.1	6.8
Oemeleria cerisformis	Indian plum	native	85.7	6.4	5.5
Oplopanax horridus	devil's club	native	12.5	8.4	1.1
Prunus laurocerasus	cherry laurel	introduced [1]	42.9	4.1	1.8
Prunus lusitanica	Portugal laurel	introduced	8.9	4.2	0.4
Ribes lacustre	prickly currant	native	1.8	2.6	<0.1
Rosa gymnocarpa	baldhip rose	native	10.7	1.6	0.2
Rosa pisocarpa	cluster rose	native	1.8	3.6	<0.1
Rubus armeniacus	Himalayan blackberry	introduced [2]	76.8	14.7	11.3
Rubus laciniatus	cutleaf blackberry	introduced [2]	5.4	0.05	<0.1
Rubus leucodermis	whitebark raspberry	native	76.8	11.8	9.1
Rubus parviflorus	thimbleberry	native	16.1	2.1	0.3
Rubus spectabilis	salmonberry	native	62.5	15.0	9.3
Rubus ursinus	creeping blackberry	native	85.7	5.8	4.9
Sambucus racemosa	red elderberry	native	92.9	13.8	12.8
Symphoricarpos albus	common snowberry	native	1.8	19.2	0.3
Ulmus americana	American elm	introduced	1.8	1.6	<0.1
Unknown shrub	Unknown shrub	--	1.8	4.8	<0.1
Vaccinium parvifolium	red huckleberry	native	75.0	2.0	1.5

[1] Invasive species which are currently listed as Non-Designated Noxious Weeds by the King County Noxious Weed Program (King County, 2008)
[2] Invasive species which are currently listed as Noxious Weeds of Concern by the King County Noxious Weed Program.

Appendix E. Frequency and cover of herb, fern and grass species in Pioneer Park

Species	Common Name	Native/ Introduced	Percent of Plots Where Found	Avg. Cover Where Found	Avg. Cover Across All Plots
Achlys triphylla	vanilla leaf	native	39.3	0.8	0.3
Actaea rubra	red baneberry	native	3.6	0.4	<0.1
Adiantum pedatum	northern maidenhair	native	3.6	1.1	<0.1
Agrostis sp.	bentgrass	-	3.6	2.9	0.1
Aira caryophyllea	silver hairgrass	introduced	1.8	4.2	0.1
Ajuga reptans	common bugle	introduced	1.8	0.1	<0.1
Athyrium filix-femina	common ladyfern	native	19.6	4.5	0.9
Bromus vulgaris	Columbia brome	native	1.8	0.2	<0.1
Calystegia sepium	hedge false bindweed	introduced [2]	3.6	13.6	0.5
Cardimine hirsuta	hairy bittercress	introduced	3.6	0.6	<0.1
Carex sp.	sedge	native	5.4	0.2	<0.1
Circaea alpinum	enchanter's nightshade	native	21.4	0.5	0.1
Cirsium vulgare	bull thistle	introduced [1]	1.8	0.02	<0.1
Claytonia sibirica	Siberian springbeauty	native	23.2	0.3	0.1
Crepis capillaris	smooth hawksbeard	introduced	1.8	0.3	<0.1
Dryopteris expansa	wood fern	native	83.9	3.3	2.7
Epilobium angustifolium	fireweed	native	1.8	0.02	<0.1
Epilobium ciliatum	fringed willowherb	native	16.1	0.4	0.1
Equisetum sp.	horsetail	-	5.4	4.9	0.3
Galium aparine	stickywilly	native	41.1	3.6	1.5
Geranium robertianum	herb robert	introduced [1]	94.6	4.8	4.5
Geum macrophyllum	largeleaf avens	native	12.5	0.1	<0.1
Hedera helix	English ivy	introduced [1]	100.0	11.9	11.9
Hieracium albiflorum	white hawkweed	native	3.6	0.02	<0.1
Hypericum androsaemum	sweet-amber	introduced	1.8	0.4	<0.1
Hypericum sp.	St. Johnswort	-	1.8	0.02	<0.1
Hypochaeris radicata	hairy cat's ear	introduced	1.8	0.02	<0.1
Impatiens capensis	jewelweed	introduced	1.8	1.0	<0.1
Juncus sp.	rush	-	1.8	0.2	<0.1
Lactuca serriola	prickly lettuce	introduced	1.8	0.02	<0.1
Lamiastrum galeobdolon	yellow archangel	introduced [1]	3.6	13.0	0.5
Lapsana communis	common nipplewort	introduced	28.6	1.3	0.4
Lonicera ciliosa	orange honeysuckle	native	17.9	0.2	<0.1
Lunaria annua	annual honesty	introduced	3.6	0.1	<0.1
Luzula parviflora	smallflower woodrush	native	1.8	0.02	<0.1
Lysichiton americanus	American skunkcabbage	native	1.8	4.2	0.1
Maianthemum dilitatum	false lily of the valley	native	1.8	1.2	<0.1
Maianthemum racemosum	feathery false lily of the valley	native	1.8	0.2	<0.1
Mycelis muralis	wall-lettuce	introduced	50.0	0.5	0.3
Osmorhiza berteroi	sweetcicely	native	16.1	0.6	0.1
Plantago major	common plantain	introduced	1.8	7.0	0.1
Poa sp.	bluegrass	-	1.8	0.02	<0.1
Polypodium glycyrrhiza	licorice fern	native	12.5	0.3	<0.1
Polystichum munitum	sword fern	native	100.0	21.0	21.0
Prunella vulgaris	common selfheal	native	1.8	0.2	<0.1
Pteridium aquilinum	western brackenfern	native	83.9	10.1	8.4
Ranunculus repens	creeping buttercup	introduced [2]	10.7	5.4	0.6
Rumex obtusifolius	bitter dock	introduced	3.6	0.1	<0.1
Scirpus microcarpus	panicled bulrush	native	21.4	0.5	0.1
Senecio sylvaticus	woodland ragwort	introduced	1.8	0.02	<0.1
Solanum dulcamara	climbing nightshade	introduced [2]	14.3	0.5	0.1
Sonchus oleraceus	common sowthistle	introduced	1.8	0.4	<0.1

Appendix E (continued)

Species	Common Name	Native/ Introduced	Percent of Plots Where Found	Avg. Cover Where Found	Avg. Cover Across All Plots
Stachys chamissonis	coastal hedgenettle	native	1.8	0.04	<0.1
Stellaria sp.	starwort	-	14.3	0.7	0.1
Taraxacum officinale	common dandelion	introduced	3.6	0.1	<0.1
Tiarella trifoliata	threeleaf foamflower	native	10.7	1.2	0.1
Tolmeia menziesii	youth-on-age	native	5.4	7.6	0.4
Trillium ovatum	Pacific trillium	native	67.9	0.6	0.4
Unknown grass sp.	Unknown grass	-	21.4	0.9	0.2
Unknown herb	Unknown herb	-	5.4	0.1	<0.1
Urtica dioica	stinging nettle	native	80.4	9.4	7.6
Vicia sp.	vetch	-	3.6	0.04	<0.1
Vinca minor	common periwinkle	introduced	1.8	14.6	0.3

[1] Invasive species which are currently listed as Non-Designated Noxious Weeds by the King County Noxious Weed Program (King County, 2008)
[2] Invasive species which are currently listed as Noxious Weeds of Concern by the King County Noxious Weed Program.

Appendix F. Management Guidelines for 2006-2008

Project Activity	Scope	Performance Objectives
1. Comprehensive invasive removal	Within the defined area, selectively remove the roots and tops of all non-native plants, *including* herb Robert (*Geranium robertianum*). Exception is holly and laurel greater than 1" diameter. Avoid damage to all other native vegetation. Pile invasives on cardboard sheets to prevent resprouting. Areas that are greater than 50 square feet (4.6 m^2) in size with no visible native plants may be cleared with hand-held power equipment. With approval from the Park Arborist, glyphosate herbicide with adjuvant may be used on English ivy according to label directions in lieu of hand pulling. Application under direct supervision of licensed pesticide applicator, conforming to all applicable regulations. Provide copies of pesticide application records.	Less than 22 lbs (10 kg) of living invasive plant material remaining per 100 sq ft. In areas of herbicide treatment, dieback of ivy leaves AND greater than 90% of ground area showing failure in ivy regrowth during the following spring. **No** herb Robert (*Geranium robertianum*) to remain.
2. Comprehensive invasive removal, no herbicide	Within the defined area, selectively remove the roots and tops of all non-native plants, *including* herb Robert (*Geranium robertianum*). . Exception is holly and laurel greater than 1" diameter. Avoid damage to all other native vegetation. Pile invasives on cardboard sheets to prevent resprouting. Areas that are greater than 50 square feet (4.6 m^2) in size with no visible native plants may be cleared with hand-held power equipment.	Less than 22 lbs (10 kg) of living invasive plant material remaining per 100 sq ft. **No** herb Robert (*Geranium robertianum*) to remain.
3. Herbicide holly and laurel	Within the defined area: 1. For all standing laurel (*Prunus laurocerasus*) and holly (*Ilex aquifolium*) less than 1" diameter at 6" above ground, cut the tree down to a stump 1 foot high. Cut all branches to lengths 18" or less and compact into piles no larger than 1 cubic yard. Apply glyphosate herbicide at the label-recommended rate to the **freshly cut** stump. 2. For all holly and laurel greater than 1" diameter at 6" above ground, do not cut the tree down, but instead clear branches necessary to access the main trunk(s). Apply glyphosate herbicide by injection at the recommended rate. Application under direct supervision of licensed pesticide applicator, conforming to all applicable regulations. Provide copies of pesticide application records.	Dieback of leaves beginning within 2 months following treatment AND greater than 90% of canopy showing failure to regrow during the following spring.
4. Holly and laurel sprout removal	In the defined area, cut and pile all holly (*Ilex aquifolium*) and laurel (*Prunus laurocerasus*) sprouts at stumps or ground level, wherever the growth point occurs. Piles should be well compacted and be no larger than 1 cubic yard.	Less than 1 foot (0.3 m) live terminal growth of holly or laurel per 100 sq ft
5. Ivy survival rings	Within the defined area, cut ivy vines in all trees at chest height and remove all vegetation from that point on the base of the tree downward, extending out to 3' in all directions from the base of the tree. Grub out surface roots of all invasive plants at the base of the tree.	Tree trunk is fully visible; less than 1.1 lbs (0.5 kg) of living invasive plant material within 3' of the tree.

Project Activity	Scope	Performance Objectives
6. Second year invasive removal	Within the defined area, selectively remove the roots and tops of all non-native plants, including herb Robert (*Geranium robertianum*). Treat holly and laurel as above in Activity #3. Avoid damage to all other native vegetation. Pile new debris on existing old piles. Glyphosate herbicide with adjuvant may be used on English ivy regrowth according to label directions in lieu of hand pulling in areas permitted by MI Parks & Recreation staff member.	Less than 2.2 lbs (1.0 kg) of living invasive plant material remaining per 100 sq ft, including areas of herbicide treatment. **No** herb Robert (*Geranium robertianum*) to remain.
7. Selective herbicide herbaceous weeds	Within the defined area, apply glyphosate herbicide in early summer to herbaceous weeds. Application under direct supervision of licensed pesticide applicator, conforming to all applicable regulations. Provide copies of pesticide application records.	Marker dye used to verify application. Less than 5% of the ground area containing living herbaceous weeds one month following treatment.
8. Third year invasive removal	Within the defined area, selectively remove the roots and tops of all non-native plants, including herb Robert (*Geranium robertianum*). Treat holly and laurel as above in Activity #3. Avoid damage to all other native vegetation. Pile new debris on existing old piles.	Less than 1.1 lbs (0.5 kg) of living invasive plant material remaining per 100 sq ft, including areas of herbicide treatment. **No** herb Robert (*Geranium robertianum*) to remain.
9. Tree planting maintenance	Within the defined area, cut all blackberry growth currently 2' or taller to the ground. Cut back any other vegetation within 4' **around *and* above** tree seedlings. Re-mulch with 1" native leaf litter.	Less than 2oz (54g) living plant material within 4' of any tree seedling. Blackberry height less than 2' everywhere else.
10. Understory planting	Within the defined area, plant provided native tree seedlings to achieve a 15' average spacing between trees (existing and planted). Where appropriate, plant provided native understory shrubs to achieve a 3' average spacing between shrubs (existing and planted).	Stocking density of 200 trees (existing and planted) per acre. Tree planted according to detail (Section 10 below).
11. Holly and laurel stump-cut	Within the defined area, cut all holly (*Ilex aquifolium*) and laurel (*Prunus laurocerasus*) greater than 1" diameter at 6" above ground to 4' tall stump. Scatter debris such that it does not smother native vegetation and lies in ground contact.	
12. Mound planting	Within the defined area, harvest native soil from surrounding area to form planting mounds 7" high with sloped edges extending out 18" in all directions from center. Plant provided native tree and shrub seedlings into created mounds. Mulch mounds with provided mulch.	Plant trees and shrubs with root flares emerging just at soil level at top of mound. Tree and shrub planted according to detail (Section 11 below).
13. Knotweed herbicide injection	Within the defined area, inject knotweed (*Polygonum cuspidatum & Polygonum cuspidatum x sachalinense*) stems 1" or larger with glyphosate herbicide at the label-recommended rate. Apply spray paint marker to each injected stem. Application under direct supervision of licensed pesticide applicator, conforming to all applicable regulations. Provide copies of pesticide application records.	Less than 50% survival rate of injected stems following Spring.

Project Activity	Scope	Performance Objectives
14. Water and weed	Within the defined area, selectively remove the roots and tops of all non-native plants, *including* herb Robert (*Geranium robertianum*). Avoid damage to all other native vegetation. Pile invasives on cardboard sheets to prevent resprouting. Apply water to recently-planted native plants to achieve soil saturation to 8" depth.	Less than 2oz (54g) living plant material within 4' of any tree seedling. Apply water to achieve soil saturation to 8" depth.
15. Sheet mulching	Within defined area, brush cut or mow invasive plants to remove tops. Avoid damage to native vegetation. Cover cleared areas completely with 3/8" (1cm) (typically 2 layers) cardboard, working around existing native plants. Cover cardboard with minimum 4" provided mulch.	No invasive re-growth through mulch for one year.

Appendix G. Plot locations and bearings in Pioneer Park

Park Quadrant	Plot #	Stake at 0 m (A)		Stake at 50 m (C)		Plot bearing
		Latitude	Longitude	Latitude	Longitude	
SE	1	47.538518	-122.216671	47.538567	-122.217311	270
SE	2	47.538940	-122.221046	47.538468	-122.221017	180
SE	3	47.538575	-122.219467	47.538591	-122.218801	90
SE	4	47.539024	-122.218496	47.539074	-122.21780	90
SE	5	47.539274	-122.220126	47.539294	-122.219449	90
SE	6	47.539980	-122.220975	47.539507	-122.220967	180
SE	7	47.539886	-122.219413	47.439928	-122.218743	90
SE	8	47.540127	-122.217186	47.540141	-122.216528	90
SE	9	47.540753	-122.217414	47.540485	-122.216630	135
SE	10	47.540825	-122.218098	47.540525	-122.218589	225
SE	11	47.540850	-122.221039	47.540429	-122.221029	180
SE	12	47.541586	-122.220384	47.541613	-122.221064	270
SE	13	47.540948	-122.220093	47.540950	-122.220748	270
SE	14	47.541891	-122.219451	47.541775	-122.220093	270
NE	15	47.542365	-122.218610	47.542799	-122.218600	0
NE	16	47.542972	-122.220765	47.542960	-122.220076	90
NE	17	47.544014	-122.220648	47.544004	-122.219980	90
NE	18	47.543967	-122.218780	47.543911	-122.218137	90
NE	19	47.544661	-122.221213	47.544614	-122.220546	90
NE	20	47.545585	-122.220888	47.545589	-122.220192	90
NE	21	47.544797	-122.219233	47.544763	-122.218615	90
NE	22	47.545132	-122.218720	47.545108	-122.218127	90
NE	23	47.545594	-122.217533	47.545554	-122.216814	90
NE	24	47.544476	-122.216772	47.544063	-122.216751	180
NE	25	47.542952	-122.216557	47.542517	-122.216543	180
NW	26	47.542248	-122.222587	47.542238	-122.223254	270
NW	27	47.543109	-122.222047	47.543577	-122.222082	0
NW	28	47.543942	-122.222769	47.543931	-122.223440	270
NW	29	47.542698	-122.225916	47.542710	-122.226578	270
NW	30	47.542584	-122.224369	47.542605	-122.225028	270
NW	31	47.543540	-122.224115	47.543105	-122.224100	180
NW	32	47.543275	-122.225227	47.542831	-122.225224	180
NW	33	47.544178	-122.226190	47.544618	-122.226217	180

Appendix G (continued)

Park Quadrant	Plot #	Stake at 0 m (A)		Stake at 50 m (C)		Plot bearing
		Latitude	Longitude	Latitude	Longitude	
NW	34	47.545335	-122.226704	47.544891	-122.226688	180
NW	35	47.544281	-122.225049	47.543839	-122.225063	180
NW	36	47.545541	-122.225843	47.545564	-122.225191	90
NW	37	47.544977	-122.225170	47.544523	-122.225177	180
NW	38	47.545278	-122.223087	47.544827	-122.223066	180
NW	39	47.545287	-122.224177	47.544833	-122.224200	180
NW	40	47.544703	-122.223775	47.544691	-122.224425	270
NW	41	47.544401	-122.222245	47.544713	-122.222706	315
NW	42	47.542830	-122.222666	47.543149	-122.223117	315
NW	43	47.542509	-122.223508	47.542965	-122.223514	0
NE	44	47.543257	-122.219773	47.543723	-122.219772	0
NE	45	47.542265	-122.220515	47.542721	-122.220486	0
NE	46	47.542256	-122.217252	47.542595	-122.217792	315
NE	47	47.543110	-122.217637	47.543568	-122.217641	0
NE	48	47.545506	-122.215902	47.545096	-122.215930	180
NE	49	47.545038	-122.220268	47.544588	-122.220261	180
NE	50	47.544205	-122.217984	47.544610	-122.217911	0
SE	51	47.541583	-122.218226	47.541556	-122.218906	270
SE	52	47.541092	-122.218666	47.541115	-122.219417	270
SE	53	47.540052	-122.218397	47.539589	-122.218364	180
SE	54	47.539644	-122.216387	47.539652	-122.217082	270
SE	55	47.539624	-122.217655	47.540053	-122.217649	0
SE	56	47.538487	-122.220438	47.538944	-122.220419	0

Appendix H. Comparison of management plan strategies

	2003 Forest Management Plan	2008 Forest Health Plan
Location of planted trees	Focused in forest gaps and areas with low regeneration	Throughout entire park
Future forest canopy composition	Mixed conifer and deciduous	Mostly conifer, some deciduous
Future forest structure (conifer)	Two-tiered	Multi-tiered
Ongoing invasive plant searches	No	Yes
Completion of in-progress comprehensive treatment	Yes	Yes
Prioritizes treatment of most ecologically critical issues	No	Yes
Total cost (next 20 years)	$3.73 million	$3.58 million
Flexibility in budgeting	Lower flexibility	High flexibility (Adjust for priorities in management)

Appendix I. Cost analysis for 2008 Forest Health Management Plan

2008 FOREST HEALTH SURVEY PLAN	Acres	Square feet	Average cost per square foot	Years	TOTAL COST
STAFF SALARY					
Partial funding for project manager			$10,000.0000	20	$200,000.00
ALREADY COMPLETED Three years intensive treatment completed					
Annual maintenance	6.6	287496	$0.0350	5	$50,311.80
Annual maintenance	6.6	287496	$0.0250	15	$107,811.00
TWO YEARS COMPLETED					
3rd year removal	9.6	418176	$0.0532	1	$22,246.96
Annual maintenance	9.6	418176	$0.0350	5	$73,180.80
Annual maintenance	9.6	418176	$0.0250	14	$146,361.60
ONE YEAR COMPLETED					
2nd year removal	0.9	39204	$0.0634	1	$2,485.53
3rd year removal	0.9	39204	$0.0532	1	$2,085.65
Annual maintenance	0.9	39204	$0.0350	5	$6,860.70
Annual maintenance	0.9	39204	$0.0250	13	$12,741.30
NOT YET STARTED					
Holly/laurel herbicide treatment	93	4051080	$0.0600	1	$243,064.80
Holly/laurel removal (maintenance)	93	4051080	$0.0600	1	$243,064.80
Holly/laurel removal (maintenance)	93	4051080	$0.0400	2	$324,086.40
Tree planting labor (15' spacing)	93	4051080	$0.0600	1	$243,064.80
Tree cost (15' spacing)	93	4051080	$0.0311	1	$125,988.59
Tree planting maintenance (two years)	93	4051080	$0.0638	2	$516,917.81
Ivy ring creation	93	4051080	$0.0209	1	$84,667.57
Ivy ring maintenance (every 2 years)	93	4051080	$0.0070	3	$85,072.68
Ivy ring maintenance (every 2 years)	18	784080	$0.0070	1	$5,488.56
Ground ivy (and other herbaceous weeds) treatment	93	4051080	$0.0100	1	$40,510.80
Ground ivy (and other herbaceous weeds) 2nd year treatment	93	4051080	$0.0070	1	$28,357.56
Ground ivy (and other herbaceous weeds) maintenance	93	4051080	$0.0050	2	$40,510.80
Ground ivy (and other herbaceous weeds) maintenance	37	1611720	$0.0050	1	$8,058.60
Boundary/stream search and destroy	7.2	313632	$0.1000	8	$250,905.60
Phase 2 tree planting labor (20' spacing)	110	4791600	$0.0500	1	$239,580.00
Phase 2 tree cost (20' spacing)	110	4791600	$0.0200	1	$95,832.00
Tree planting maintenance (two years)	110	4791600	$0.0400	2	$383,328.00
			TOTAL PROJECT COST		**$3,582,584.72**

Appendix J. Cost analysis for 2003 Forest Management Plan

2003 FOREST MANAGEMENT PLAN	Acres	Square feet	Average cost per square foot	Years	TOTAL COST
STAFF SALARY					
Partial funding for project manager			$10,000.00	20	$200,000.00
ALREADY COMPLETED Three years intensive treatment completed					
Annual maintenance	6.6	287496	$0.0350	5	$50,311.80
Annual maintenance	6.6	287496	$0.0250	15	$107,811.00
TWO YEARS COMPLETED					
3rd year removal	9.6	418176	$0.0532	1	$22,246.96
Annual maintenance	9.6	418176	$0.0350	5	$73,180.80
Annual maintenance	9.6	418176	$0.0250	14	$146,361.60
ONE YEAR COMPLETED					
2nd year removal	0.9	39204	$0.0634	1	$2,485.53
3rd year removal	0.9	39204	$0.0532	1	$2,085.65
Annual maintenance	0.9	39204	$0.0350	5	$6,860.70
Annual maintenance	0.9	39204	$0.0250	13	$12,741.30
NOT YET STARTED					
1st year removal	93	4051080	$0.0900	1	$364,597.20
Tree planting labor (15' spacing)	93	4051080	$0.1380	1	$559,049.04
Tree cost (15' spacing)	93	4051080	$0.0311	1	$125,988.59
2nd year removal	93	4051080	$0.0634	1	$256,838.47
3rd year removal	93	4051080	$0.0532	1	$215,517.46
Annual maintenance	93	4051080	$0.0290	13	$1,527,257.16
Annual maintenance	43	1873080	$0.0290	1	$54,319.32
			TOTAL PROJECT COST		**$3,727,652.59**

Appendix K. Cost analysis for Budget Restricted 2008 Forest Health Survey Plan

2008 FOREST HEALTH SURVEY PLAN - BUDGET RESTRICTED	Acres	Square feet	Average cost per square foot	Years	TOTAL COST
STAFF SALARY					
Partial funding for project manager			$10,000.0000	25	$250,000.00
ALREADY COMPLETED Three years intensive treatment completed					
Annual maintenance	6.6	287496	$0.0350	5	$50,311.80
Annual maintenance	6.6	287496	$0.0250	20	$143,748.00
TWO YEARS COMPLETED					
3rd year removal	9.6	418176	$0.0532	1	$22,246.96
Annual maintenance	9.6	418176	$0.0350	5	$73,180.80
Annual maintenance	9.6	418176	$0.0250	19	$198,633.60
ONE YEAR COMPLETED					
2nd year removal	0.9	39204	$0.0634	1	$2,485.53
3rd year removal	0.9	39204	$0.0532	1	$2,085.65
Annual maintenance	0.9	39204	$0.0350	5	$6,860.70
Annual maintenance	0.9	39204	$0.0250	18	$17,641.80
NOT YET STARTED					
Holly/laurel herbicide treatment	93	4051080	$0.0600	1	$243,064.80
Holly/laurel removal maintenance	93	4051080	$0.0600	1	$243,064.80
Holly/laurel removal maintenance	93	4051080	$0.0400	2	$324,086.40
Tree planting labor (15' spacing)	93	4051080	$0.0600	1	$243,064.80
Tree cost (15' spacing)	93	4051080	$0.0311	1	$125,988.59
Tree planting maintenance (one year)	93	4051080	$0.0638	1	$258,458.90
Ivy ring creation	93	4051080	$0.0209	1	$84,667.57
Ivy ring maintenance (every 2 years)	93	4051080	$0.0070	2	$56,715.12
Ground ivy (and other herbaceous weeds) initial treatment	93	4051080	$0.0100	1	$40,510.80
Ground ivy (and other herbaceous weeds) 2nd year treatment	93	4051080	$0.0070	1	$28,357.56
Ground ivy (and other herbaceous weeds) maintenance	93	4051080	$0.0050	1	$20,255.40
Ground ivy (and other herbaceous weeds) maintenance	62	2700720	$0.0050	1	$13,503.60
Boundary/stream search and destroy	7.2	313632	$0.1000	3.75	$117,612.00
Phase 2 tree planting labor (20' spacing)	110	4791600	$0.0500	1	$239,580.00
Phase 2 tree cost (20' spacing)	110	4791600	$0.0200	1	$95,832.00
Tree planting maintenance (one year)	110	4791600	$0.0400	1	$191,664.00
			TOTAL PROJECT COST		$3,093,621.19

29. Appendix S: Forest Health Work Plan

	Values in blue cells = acres	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Undergoing Treatment	Comprehensive - Already completed																									
	Annual maintenance	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
	Comprehensive - Two years completed																									
	3rd year removal	9.6																								
	Annual maintenance		9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6	9.6
	Comprehensive - One year completed																									
	2nd year removal	0.9																								
	3rd year removal		0.9																							
	Annual maintenance			0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Not Yet Treated	Short-term Priority Tasks (2009-2013)																									
	Holly/laurel herbicide treatment	16	15	14	15	15	18																			
	Holly/laurel maintenance (every 6 yrs)							16	15	14	15	15	18	16	15	14	15	15	18	16	15	14	15	15	18	
	Tree planting (trees + labor)	11.5	6	11	6.5	7.5	5.5	8.5	7.5	8	7	5	5	4												
	Tree maintenance (one year)		11.5	6	11	6.5	7.5	5.5	8.5	7.5	8	7	5	5	4											
	Ivy ring creation					9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3											
	Ivy ring maintenance (every 2 years) (two cycles)							9.3	9.3	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	9.3	9.3							
	Medium-term Priority Tasks (2014-2023)																									
	Ground ivy & herbaceous weed herbicide treatment													15.5	15.5	15.5	15.5	15.5	15.5							
	2nd year ground ivy & herbaceous weed herbicide treatment														15.5	15.5	15.5	15.5	15.5	15.5						
	Ground ivy & herbaceous weed maintenance (every 4 years)																		15.5	15.5	15.5	15.5	31	31	15.5	15.5
	Boundary/stream invasive search and destroy (every 4 years)											1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
	Long-term Priority Tasks (2024 and later)																									
	Tree planting (trees + labor)													5	7	12	10	10	10	12	13	12	13	6		
	Tree maintenance (every year)														5	7	12	10	10	10	12	13	12	13	6	