Salmon Creek Ravine Vegetation Inventory and Management Plan

Presented to Dr. Kern Ewing, University of Washington, Dr. Jim Fridley, University of Washington, and Dennis Clark, King County Miller/Walker Creek Basin Steward[1] in partial fulfillment of the requirements for the degree of Masters in Environmental Horticulture

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[1] Dennis Clark was the King County Miller/Walker Creek Basin Steward between July 2007 and April 2011.

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Executive Summary

Salmon Creek Ravine is a large (87.6-ac) forested green space located within the Shorewood Community of Burien, WA. As a large natural area within a highly-developed landscape matrix, the site provides habitat for wildlife as well as numerous quality of life benefits and educational opportunities for people. Salmon Creek Ravine contains three branches of Salmon Creek, which run through a series of ravines and ultimately discharge into Puget Sound a short distance to the southwest. There is no sustainable anadromous fish use in Salmon Creek; however, the creek provides rearing habitat for coho fry outplanted by Trout Unlimited each January. The Shorewood on the Sound Community Club has adopted Salmon Creek Ravine and over the past several years has conducted habitat restoration through removal of invasive plants and installation of native plants.

The purpose of this vegetation management plan is to provide to the City of Burien, the Shorewood on the Sound Community Club, and other stewards guidance in selecting and prioritizing vegetation management tasks within Salmon Creek Ravine in order to facilitate ecological restoration of the lowland forest, wetland, and riparian ecosystems. To support development of the plan, a vegetation assessment was conducted in the summer of 2010. Vegetation in the canopy, understory and groundcover was evaluated and other information, such as the quantity and size of large woody debris, was also recorded.

The vegetation assessment results indicate that Salmon Creek Ravine is dominated by an *A. macrophyllum* (bigleaf maple)-*A. rubra* (red alder)-*R. spectabilis* (salmonberry)- *P. munitum* (sword fern) vegetation community. While the forest community is dominated by deciduous tree species, Salmon Creek Ravine also contains patches of mixed conifer/deciduous, deciduous/madrone and coniferous/madrone forest. Riparian wetland habitat is associated with the creek channels. In total, 56 native species were identified; 11 tree species, 13 species of shrub, 31 groundcover species (including herbaceous species, ferns and woody groundcovers like *Gaultheria shallon* (salal) and *Mahonia nervosa* (dull Oregon grape)) and one vine species.

The primary disturbances identified that could adversely affect Salmon Creek Ravine's native vegetation were invasive plant species and soil erosion. The most abundant invasive species are *Rubus armeniacus* (Himalayan blackberry) and *Hedera helix* (English ivy).[2] Twelve additional invasive species, including *Prunus laurocerasus* (English laurel)*, Ilex aquifolium* (English holly) and *Sorbus aucuparia* (European mountain ash) were also observed scattered throughout the green space. As Salmon Creek Ravine consists of a series of ravines with very steep topography, and as the soils are predominantly loose and sandy, the hillsides are susceptible to erosion. Causes of erosion include the use of steep social trails as well as natural causes such as earthquakes and landslides.

[2] Much of the ivy observed in the park may actual be *Hedera hibernica*; however, it is difficult to tell these species apart and the control methods for *H. hibernica* and *H. helix* are the same.

This plan divides Salmon Creek Ravine into nine management zones. The management zones are intended to provide specific information for vegetation management needs within different areas of the green space. Management recommendations include:

- Controlling invasive plant species,
- Planting native species in areas where invasive plants have been cleared from large areas, and
- Planting conifer trees in the understory to enhance structural diversity.

In addition, trail improvements and re-routing trails in some areas would reduce damage to soils and vegetation from erosion.

The plan also provides guidance for conducting vegetation management and habitat restoration activities. Information on best management practices for controlling the invasive species observed in Salmon Creek Ravine is provided, as well as recommendations for suitable native species that could be planted in different areas of the green space.

Maintaining a healthy and diverse native forest community in Salmon Creek Ravine will ensure that this valuable ecosystem continues to provide benefits for both people and wildlife in the future.

1 Salmon Creek Ravine Background Information

Salmon Creek Ravine is located within the Shorewood Community of Burien, WA. It is approximately 90 acres (ac) in size and contains predominantly second- or third-growth forest. The forest community is dominated by deciduous trees, primarily *Acer macrophyllum* (big leaf maple) and *Alnus rubra* (red alder), although stands of mixed conifer-deciduous and conifer-madrone forest are also present and *Populus trichocarpa* (black cottonwood) grows in ravine-bottom riparian areas. Salmon Creek runs through the ravines of the green space and discharges approximately 900 feet (ft) to the southwest into Puget Sound. Within the boundaries of the green space there are three distinct branches of the creek (the upper branch, middle branch, and lower branch) which join together into a single channel just downstream of the Salmon Creek Ravine boundary before flowing into Puget Sound (Map 1).

The Salmon Creek Ravine was acquired as a public green space by King County in 1990 and was later incorporated into the City of Burien. The City of Burien is the current owner of the green space. Today Salmon Creek Ravine is undeveloped except for the presence of the Southwest Suburban Sewer District wastewater treatment plant (WWTP) located on the southwestern end of the green space, a gravel access road associated with the WWTP that spans roughly southwest to northeast through the northern portion of the green space, and a network of unimproved trails that weave throughout the site (Map 2). In recent years the Shorewood on the Sound Community Club has adopted Salmon Creek Ravine as well as nearby Shorewood Park to conduct habitat restoration through removal of invasive plants and installation of native plants.

The City of Burien has pledged financial assistance and other services to aid the community in their restoration efforts, and King County staff have helped develop a stewardship plan for Salmon Creek Ravine. The purpose of this vegetation management plan is to provide to the City of Burien, the Shorewood on the Sound Community Club, and other stewards guidance in selecting and prioritizing vegetation management tasks within Salmon Creek Ravine that will facilitate the ecological restoration of the lowland forest, wetland, and riparian ecosystems. The following sections present information on the historical and current conditions of Salmon Creek Ravine.

1.1 Historical Vegetation Communities

It is useful to have a sense of the historical vegetation that likely existed in Salmon Creek Ravine prior to logging and other human disturbances. Such information can serve as a reference to help guide ecological restoration activities (Clewell and Aronson 2007). Two documents were relied upon to provide information about the historical composition of riparian forest systems located in the vicinity of Salmon Creek Ravine: *Historical Aquatic Habitats in the Green and Duwamish River Valleys and the Elliott Bay Nearshore, King County, Washington* (Collins and Sheikh 2005); and *Reconstructing the Historical Riverine Landscape of the Puget Lowland* (Collins et al. 2003). Both of these documents used General Land Office tree data from historical surveys of the Duwamish, Green, White, Black and Cedar River valleys to derive historical forest composition information. While these reports provide useful information regarding the historical composition of vegetation communities in large riverine floodplains, they are not entirely applicable to Salmon Creek, which is a much smaller stream system confined to steep ravines rather than spread out over a wide floodplain.

Historically, hardwood tree species including *P. trichocarpa* (black cottonwood) and *A. macrophyllum* (bigleaf maple) dominated riverine riparian habitat in the Duwamish, Green, White, Black and Cedar River valleys (Collins and Sheikh 2005). Conifer species like *Thuja plicata* (western red cedar*), Pseudotsuga menziesii* (Douglas fir) and *Picea sitchensis* (Sitka spruce) were also present but were less abundant. Species common at low elevations included *P. sitchensis*, *Fraxinus latifolia* (Oregon ash), *Salix* spp. (willow spp.) and *Oemleria cerasiformis* (Indian plum). *P. trichocarpa* was common at intermediate elevations. Streamside species common at elevations found within Salmon Creek Ravine (approximately 80-410 ft) included *P. trichocarpa*, *A. macrophyllum*, *A. rubra* (red alder), *T. plicata, P. menziesii* and *Acer circinatum* (vine maple). Of these, *A. rubra* (red alder) was by far the most frequently observed species (Collins et al. 2003).

Although deciduous trees were more abundant than conifers in streamside forests (making up over 80% of the tree species accounts in historical tree survey records), coniferous trees made up the majority of the biomass (Collins et al. 2003). Species such as *T. plicata* (western red cedar) and *P. sitchensis* (Sitka spruce) reached sizes up to 150 inches (in.) (381 cm) and 111 in. (282 cm) in diameter, respectively. Deciduous tree species including *P. trichocarpa* (black cottonwood) and *A. macrophyllum* (bigleaf maple) could also reach large sizes, however. The maximum diameter recorded for *A. macrophyllum* was 72 in. (183 cm), and the maximum diameter for *P. trichocarpa* (black cottonwood) was 80 in. (203 cm). Historical accounts of forest conditions around Salmon Creek Ravine indicate that the forest was dominated by fir and cedar trees (see Section 1.2).

At higher elevations in the Puget Sound region (i.e., above riparian forest corridors and riverine floodplains), *Tsuga heterophylla* (western hemlock) is the potential forest climax species (Collins et al. 2003). Other species common at higher elevations or over a broader range of elevations (from low to high) included *T. plicata* (western red cedar*), P. menziesii* (Douglas fir), *A. macrophyllum* (bigleaf maple), *A. circinatum* (vine maple) and *A. rubra* (red alder) (Collins et al. 2005). In addition to historical records, the existing native plant community within Salmon Creek Ravine can serve as an auto-reference for selecting appropriate plant species for restoration (Clewell and Aronson 2007). The existing native plant community is discussed further in Section 1.4.

1.2 Site History and Past Disturbances

The following site history was obtained from the City of Burien website[3] (2010) and is based on a compilation of several information sources, including many personal accounts from long-time residents of the Burien/Shorewood area. Historically, Salmon Creek was four miles long and it drained the White Center plateau to the east and north. The surrounding forested ravine was dominated by fir and cedar trees. Logging in the Salmon Creek Ravine started in the 1890s; however, the first loggers in the ravine abandoned their efforts after penetrating only one quarter mile up from the mouth of the creek due to difficulties encountered trying to harvest lumber from the ravine's steep, wet slopes. Portions of the original skid roads from these early logging operations are reportedly still present in Salmon Creek Ravine. Later logging efforts in the late 1930s and 1940s managed to clear most of the remaining forest and there was reportedly a small sawmill at the mouth of the creek, possibly in the same location as the

[3] URL: http://www.burienwa.gov/index.aspx?NID=449

present-day WWTP. The mill reportedly burned down along with some of the surrounding forest after just a few years' use.

According to historical records, Salmon Creek was once inhabited by sea-run cutthroat and rainbow trout, and coho, chum, and Chinooksalmon. However, due to the small size and steep topography of the creek it was likely used only occasionally by Chinook. Fish passage was first blocked in the 1940s by a private landowner who placed a rock barrier at the mouth of the creek in an effort to eliminate the smell of decaying fish carcasses after spawning. Fish passage in Salmon Creek is still blocked by several barriers today, including a culvert that passes under Shorewood Drive, and channelization on a residential lot located near the mouth of the creek (Unknown Author 1994).

In the late 1980s a residential subdivision was planned for the Salmon Creek Ravine. Part of the site was reportedly cleared using heavy machinery; however, the project developers realized that the site was too steep and saturated to be developed. The surrounding community was interested in protecting the ravine and creek as a green space. In 1990, the ravine was purchased by King County as the first property held under the Washington State Open Spaces Initiative. The green space was later included in the City of Burien.

In 2001, a new creek channel referred to locally as "Earthquake Creek" was formed by the Nisqually earthquake, which caused a landslide in the ravine. The new creek reportedly tripled the volume of Salmon Creek (City of Burien 2010). Material from the landslide also covered a portion of one of the lower pedestrian trails formerly used by site visitors.

1.3 Current Site Conditions

The following subsections describe the current conditions of Salmon Creek Ravine including soils, topography, hydrology and surface water features, existing vegetation communities, fish and wildlife use of the park, human use of the green space and surrounding land uses. The information provided is based on readily available information sources.

1.3.1 Geology, Soils and Topography

The geology of Salmon Creek Ravine consists of glacial advance outwash deposits overlying lacustrine clay deposits (Booth et al. 2004). The glacial outwash deposits descend from the surrounding upland plain of the White Center plateau to the Puget Sound (City of Burien 2010). These deposits consist primarily of sand and gravel. Deposits of older glacial lacustrine clay are present beneath the outwash sand; clay layers were observed below the sand deposits in several locations throughout Salmon Creek Ravine where the creek had cut channels that extended below the sand layers (Photo 1). Where the different geologic units (clay, sand and till) come into contact with each other conduits for groundwater are formed. Groundwater seeps from the ravine walls and enters Salmon Creek.

Photo 1. Clay deposits observed along the main branch of Salmon Creek near Transect 25.

A soil assessment was conducted in the western portion of Salmon Creek Ravine in the fall of 2010 (see Appendix B). Four soil samples were collected from the riparian areas to the west and north of the WWTP and four were collected from higher elevation upland forest locations near the upper pedestrian trail. Soils in the riparian areas were primarily silts and loams of various textures. Soil in the upland areas generally consisted of loamy sand and sandy loam (the sand content of these soil texture types ranges from 50% to 85%). Sandy soils tend to be low in nutrients and susceptible to drought and erosion (Brady and Weil 2004).

Soil horizons A, B, and C were commonly identified during the soil assessment; however, the soil profiles showed limited signs of development. The A horizon, when present, was shallow (12cm at the deepest) and showed only minor coloration from the presence of organic matter. Soil organic matter content was approximately 10% in the riparian areas and approximately 12% in the upland forest areas. The average soil pH was 4.75 and the mean bulk density was between 1.15 and 1.24 (slightly higher in the riparian areas). There were no significant differences in pH, bulk density or soil organic matter content among the riparian areas and the upland forest areas. In many areas of the Salmon Creek Ravine, a thick layer of organic duff material (usually consisting of un-decomposed leaves and sticks) was observed on the forest floor.

The low levels of soil organic matter, weak profile development and generally sandy texture of the soils in Salmon Creek Ravine, along with the site's steep topography, make it susceptible to erosion. During

vegetation assessment activities, sandy, loose soil that easily became dislodged and moved downhill was observed throughout the site on steep ravine slopes.

The majority of Salmon Creek Ravine consists of steeply sloped ravine walls with varying slopes and aspects (see Map 3). Three branches of the creek run through the bottom of the ravines; these will be referred to as the upper or main branch, middle branch, and lower branch throughout this document. The elevation of the site varies from approximately 390 ft above mean sea level (msl) at its southern tip to approximately 60 ft above msl where the main branch and the middle branch of the creek meet and flow out of Salmon Creek Ravine just downstream of the WWTP.

1.3.2 Hydrology and Surface Water Features

Salmon Creek runs through the green space as three primary branches that converge near the southwestern boundary of the site before passing through a culvert under Shorewood Drive (Map 2). Salmon Creek is primarily a groundwater-fed stream; however, each branch is fed by smaller, seasonal tributaries. Many of these tributaries, at least in their upper portions, are intermittent streams that are dry for much of the year. According to information provided by the City of Burien (2010), the current size of the Salmon Creek drainage basin is approximately 1,100 ac (2 mi^2); the Salmon Creek Ravine green space constitutes the lower part (approximately 90 ac) of the Salmon Creek drainage basin.

The upper (northern) branch of Salmon Creek is the main stem and will be referred to as the "main branch" of the creek throughout this report. It begins in a steep ravine just west of Ambaum Blvd and flows from northeast to southwest for approximately 4,000 ft through the northern portion of the site (KCDNRP 2010) (Map 2). The middle branch flows from multiple small tributaries draining the eastern portion of the green space as well as surrounding, developed upland areas. This branch flows generally east to west and is joined near its downstream end by the lower branch of Salmon Creek before flowing under the WWTP. The lower branch of Salmon Creek flows from south to north and drains the southern portion of the green space as well as surrounding, developed upland areas.

Groundwater provides year-round base flow to the upper and middle branches of the creek (KCDNRP 2010). Downstream of where the middle and lower branches meet, the creek passes through the WWTP property (via underground culverts) and then joins the northern branch of the creek under Shorewood Drive. The creek discharges to the Puget Sound approximately 900 ft to the southwest of the Salmon Creek Ravine boundary and adjacent to the south of a large, private beachfront residence. A mudflat delta associated with the creek is visible on aerial photographs (see Map 2).

At its mouth, mean daily flows in Salmon Creek are 3.68 cubic ft per second (KCDNRP 2010). Water quality in Salmon Creek has been tested and shown to be of relatively good quality. In addition, as the creek is primarily groundwater-fed and is not subject to large influxes of stormwater, it generally has stable, non-flashy flows. For these reasons, as well as the presence of a densely forested riparian area, Salmon Creek provides relatively high quality stream habitat within a densely developed urban area.

Although no wetland areas have been formally delineated within Salmon Creek Ravine (based on available information), riparian forest wetland areas were identified by EarthCorps in 2009 (see Map 2). Several of the riparian wetland areas were sampled during the vegetation assessment to better

characterize the vegetation and also to make observations of soils and hydrology. These observations and vegetation inventories confirm the presence of wetlands in many of the riparian corridors of the green space.

In the 1980s and 1990s, a large amount of stormwater was piped into Salmon Creek, creating high stormwater flows and bank erosion (City of Burien 2010 and KCDNRP and KCSWMD 1987). Large amounts of sediment were deposited into Puget Sound at the mouth of the creek. Later drainage improvement projects re-routed stormwater away from the ravine and creek (Unknown Author 1994). The vast majority of stormwater runoff from the Salmon Creek basin located east and north of Ambaum Blvd is diverted into a "bypass pipeline" that is buried underneath the gravel access road. The bypass pipeline carries stormwater under Ambaum and discharges it directly to Puget Sound. Today, some stormwater enters the creek from a stormwater pipe inlet that passes under Ambaum Blvd. There may also be a limited amount of overland stormwater flow that reaches the creek from the properties adjacent to the ravine. Nonetheless, Salmon Creek and its tributaries in the ravine are largely immune from the dramatic and negative impacts of stormwater runoff that frequently dominate the hydrology of smaller streams in the central Puget Sound area.

1.3.3 Native Vegetation Community

Salmon Creek Ravine contains predominantly second- or third-growth forest dominated by deciduous trees, primarily *A. macrophyllum* (big leaf maple) and *A. rubra* (red alder), although stands of mixed conifer-deciduous and conifer-madrone forest are also present and *P. trichocarpa* (black cottonwood) grows in ravine-bottom riparian areas. The green space also contains diverse native understory and groundcover communities. Table 1-1 provides a comprehensive list of the 56 native species observed in Salmon Creek Ravine during vegetation assessment field activities. Section 1.3.6 provides information about invasive plant species observed during the vegetation assessment. Additional detail regarding current conditions of the vegetation community (both native and invasive species) is contained in Section 3 and Appendix A.

Table 1-1. Native plant species observed in Salmon Creek Ravine during the 2010 vegetation assessment

Latin Name	Common Name
Acer macrophyllum	Bigleaf maple
Achlys triphylla	Vanilla leaf
Adiantum pedatum[a]	Maidenhair fern
Alnus rubra	Red alder
Arbutus menziesii	Pacific madrone
Athyrium filix-femina	Lady fern
Blechnum spicant	Deer fern
Cardamine occidentalis	Western bitter-cress
Circaea alpine	Enchanter's nightshade

Latin Name	Common Name
Claytonia sibirica	Siberian miner's lettuce
Cornus nuttallii	Pacific dogwood
Corylus cornuta	Beaked hazelnut
Disporum hookeri	Hooker's fairybells
Dryopteris expansa	Spiny wood fern
Epilobium augustifolium	Fireweed
Epilobium ciliatum	Purple-leaved willow herb
Equisetum arvense	Common horsetail
Galium spp.	Cleavers or bedstraw
Gaultheria shallon	Salal
Geum macrophyllum	Large-leaved avens
Holodiscus discolor	Oceanspray
Juncus effusus	Common rush
Lonicera ciliosa	Orange honeysuckle
Luzula spp.	Wood rush
Lysichiton americanum	Skunk cabbage
Mahonia nervosa	Dull Oregon grape
Oemleria cerasiformis	Indian plum
Oenanthe sarmentosa	Pacific water parsley
Picea sitchensis	Sitka spruce
Philadelphus lewisii[a]	Mock orange
Polypodium glycyrrhiza	Licorice fern
Polystichum munitum	Sword fern
Populus balsamifera ssp. trichocarpa	Black cottonwood
Prunus emarginata	Bitter cherry
Pseudotsuga menziesii	Douglas fir
Pteridium aquilinum	Bracken fern
Ribes bracteosum	Stink currant
Rosa gymnocarpa	Baldhip rose
Rubus leucodermis[a]	Black raspberry
Rubus parviflorus	Thimbleberry
Rubus spectabilis	Salmonberry
Rubus ursinus	Trailing blackberry
Sambucus racemosa	Red elderberry
Smilacina racemosa	False Solomon's seal
Symphoricarpos albus	Snowberry
Taxus brevifolia	Pacific yew
Tellima grandiflora	Fringecup

Latin Name	Common Name
Thuja plicata	Western red cedar
Tiarella trifoliata	Foamflower
Tolmiea menziesii	Youth-on-age
Trillium ovatum	Western trillium
Tsuga heterophylla	Western hemlock
Urtica dioica	Stinging nettle
Vaccinium ovatum	Evergreen huckleberry
Vaccinium parvifolium	Red huckleberry
Veronica beccabunga ssp. Americana	American brooklime

[a] These species were observed in Salmon Creek Ravine but were not sampled within the vegetation transects.

1.3.4 Fish and Wildlife

Salmon Creek likely contains small numbers of sculpin and cutthroat trout as well as coho salmon fry planted annually by Trout Unlimited. Red fox, coyotes, otters, raccoons, muskrat, bats, chipmunks, and squirrels are also reported to inhabit the site (City of Burien 2010). Birds or signs of birds (e.g., owl pellets) observed during the vegetation assessment in the summer of 2010 indicate that wood peckers, flickers, jays, crows, sparrows, wood warblers, flycatchers, belted kingfishers, eagles, owls, osprey and hawks all inhabit the site. Migratory songbirds were observed nesting in the more secluded portions of the Salmon Creek Ravine and in one location a ground nest was observed. Several salamanders were encountered while digging soil pits for the soil assessment in the fall of 2010 (Photo 2).

Photo 2. Western red-backed salamander (*Plethodon vehiculum*)observed near the gravel access road while digging soil pits

There are at least two migratory blockages within the lower 800 ft of Salmon Creek that most likely block all upstream fish migration. One of these blockages is the culvert beneath Shorewood Drive which is considered to block fish migration due to high water velocity, steep grade, and shallow water depth within the pipe (City of Burien 2010 and Unknown Author 1994). Downstream migration of juvenile fish via the culvert probably is unhindered. The second major migratory blockage is a constructed weir and rip rap bank where the stream reaches the sand/gravel beach. If both fish migration barriers were removed, there would be over 2,860 feet of suitable stream habitat suitable available for salmonid spawning and rearing within Salmon Creek Ravine (Unknown Author 1994).

According to historical records, Salmon Creek was once inhabited by sea-run cutthroat and rainbow trout, and coho, chum, and Chinook salmon. Although there is currently thought to be no anadromous salmonid spawning in the creek due to migratory blockages downstream, some resident fish may be present in the creek and juvenile salmon are outplanted in the creek by Trout Unlimited each January. It is expected that Salmon Creek could provide limited but relatively high quality salmonid habitat (due to the relatively small quantity of stormwater that discharges to the creek and the relatively high-value riparian vegetation) in the future.

1.3.5 Roads and Trails

There is a gravel access road that spans from the WWTP on the southwestern end of Salmon Creek Ravine to the north and east, terminating near Ambaum Blvd. The only vehicles allowed access to the road are those associated with WWTP operations (a buried sewer trunk line runs parallel to the access road) and the City of Burien. The gravel access road is one of the main paths used by pedestrians visiting the site. In addition to the gravel road, there is a network of unimproved dirt paths in the southern and eastern portions of the site (Map 2). One of the dirt paths descends from the eastern portion of the site down to the gravel access road. The lower portion of this trail, near where it joins the gravel access road, is very steep and muddy throughout much of the year. The trail used to follow a different route in this area but the old trail was covered by material from the 2001 landslide triggered by the Nisqually earthquake (Spohn 2011). There are also two steep social trails on the ravine wall west of the main branch of Salmon Creek (one of these is shown on Map 2). These trails extend from the residential neighborhoods to the west of Salmon Creek Ravine down the ravine to the main branch of the creek. Based on observations made during the vegetation assessment, these trails are used primarily by neighborhood kids. One of the social trails (not indicated on Map 2), located northwest of the WWTP and visible from the gravel access road, is very wide (approximately 2.5 to 3 meters [m]) and is devoid of vegetation and causing soil erosion (Photo 3).

Photo 3. Wide social trail located northwest of the WWTP and north of the gravel access road

1.3.6 Ongoing Disturbances

Ongoing ecological disturbances within Salmon Creek Ravine include the presence of invasive species, steep social trails that are causing erosion, and natural erosion and landslides. Table 1-2 provides a comprehensive list of the 15 invasive species observed during vegetation assessment field activities.

Invasive species can out-compete native species and shade out native plants. The presence of invasive plants appears to be the largest ongoing ecological disturbance in Salmon Creek Ravine.

Table 1-2. Invasive plant species observed in Salmon Creek Ravine during the 2010 vegetation assessment

Latin Name	Common Name
Buddleia davidii[a]	Butterfly bush
Clematis vitalba	Old man's beard
Convoluvulus arvensis[a]	Field bindweed or morning glory
Crataegus monogyna	European hawthorne
Geranium robertianum	Herb Robert
Hedera helix (or Hedera hibernica)[b]	English ivy
Ilex aquifolium	English holly
Lamiastrum galeobdolon[a]	Yellow archangel
Phalaris arundinacea	Reed canarygrass
Prunus avium	Sweet cherry
Prunus laurocerasus	English laurel
Rubus armeniacus	Himalayan blackberry
Rubus laciniatus	Evergreen blackberry
Solanum dulcamara	Bittersweet nightshade
Sorbus aucuparia	European mountain ash

[a] These species were observed in Salmon Creek Ravine but were not sampled within the vegetation transects.

[b] Much of the ivy observed may actually be *Hedera hibernica*; however, it is difficult to tell these two species apart and the control methods for *H. hibernica* and *Hedera helix* are the same. In subsequent sections of this document, English ivy will be referred to simply as *H. helix*.

The invasive species most commonly observed in Salmon Creek Ravine included *Hedera helix* (English ivy), *Rubus armeniacus* (Himalayan blackberry), *Ilex aquifolium* (English holly), and *Prunus laurocerasus* (cherry laurel). The largest infestation of *H. helix* observed (Photo 4) during the vegetation assessment was located in the northern portion of the site in the ravine surrounding sampling Transect 22 (Map 4).

Photo 4. Large *H. helix* infestation located in the ravine surrounding Transect 22 (see Map 4)

1.3.7 Surrounding Landscape Matrix

Salmon Creek Ravine is surrounded by residential development; however, it is one in a network of parks and green spaces located along the Puget Sound shoreline in the Burien and Shorewood communities (Map 1). Together Salmon Creek Ravine, Shorewood Park to the north, and Seahurst and Eagle Landing Parks to the south represent a significant patch of relatively well-connected lowland forest habitat in an otherwise highly developed environment. Together these parks and green spaces provide habitat benefits for wildlife and recreational opportunities for the public, as well as other ecological services. If a suitable right-of-way could be identified, Salmon Creek Ravine could be connected to neighboring Seahurst Park to the south, creating a valuable interurban hiking trail. The best area for such a connection would likely be off of 16th Ave Southwest at the south end of the Salmon Creek Ravine green space (see Map 1 inset).

1.4 Current Human Use

The main human activities in Salmon Creek Ravine are hiking, dog-walking and habitat restoration. Neighborhood kids also play in the green space. For the past several years, the Shorewood on the Sound Community Club has been removing invasive species like *H. helix* (English ivy) and *R. armeniacus*

(Himalayan blackberry) and planting native species. Recent restoration work has been completed at the western entrance to the site adjacent to the WWTP.

1.5 Importance of Salmon Creek Ravine

As a large, relatively intact patch of habitat within a highly developed area, Salmon Creek Ravine provides a potentially important habitat area that may serve as a wildlife refuge and migratory bird stopover site. It provides nesting habitat for several different bird species, and foraging grounds for belted kingfisher and raptors, as observed during vegetation assessment activities. Salmon Creek has the potential to provide limited but high-quality salmonid rearing habitat if the downstream migratory blockages are removed in the future. It also likely provides habitat to several small-sized resident fish species. Vegetation in Salmon Creek Ravine provides water quality benefits by intercepting, filtering and allowing infiltration of precipitation. Maintaining a diverse native plant community in the green space will allow the site to serve as a seed source to surrounding areas. As a large natural area within a highly-developed landscape matrix, Salmon Creek Ravine provides numerous quality of life benefits and educational opportunities for the surrounding community.

2 Vegetation Assessment Methodology

The vegetation assessment methods used for this project are a modified version of the methods used by EarthCorps Science, formerly Seattle Urban Nature. The methods used by EarthCorps Science are well-established, highly regarded by local parks staff and restoration planners, and have proved to be useful in park and green space planning throughout Seattle, Bellevue, Kirkland, Renton, Burien, and other local communities. Other University of Washington graduate student projects involving vegetation assessments have also based their methods on those of EarthCorps Science. The vegetation assessment methodology used for this project is summarized here but additional information is included in Appendix C (the project work plan).

A general guideline when determining sampling intensity is to sample between 3-10% of the total area of a forested site (Seattle Urban Nature 2007). For the Salmon Creek Ravine vegetation assessment, approximately 3% of the site, equivalent to 2.8 ac, was assessed using rectangular belt-transect sampling plots 8 m wide by 50 m long. Each belt-transect had a total area of approximately 0.1 ac. In total, 28 belt-transect plots were proposed in the work plan in order to survey approximately 3% of Salmon Creek Ravine (Map 4).

Six different habitat types were identified by Earth Corps Science within this 90-ac green space in 2009: conifer-deciduous mixed forest; conifer-madrone mixed forest; deciduous forest; deciduous-madrone mixed forest; riparian forested wetland; and shrubland (Map 2). Sampling transects were placed within each of these habitat types, and as much as possible, the discrete patches of each type located throughout Salmon Creek Ravine were sampled (e.g., conifer-deciduous mixed forest has been identified in 10 separate patches throughout the site; patches of this forest type in different parts of the site were assessed).

The proposed transect locations were selected subjectively using the EarthCorps' habitat type map in order to sample individual habitat patches and to space transect locations throughout the site relatively evenly (Map 4). Transects were intended to be oriented either north-south or east-west; however, because they were planned using true north but established in the field using a compass set to magnetic north, and because the declination was not corrected, the transects are angled slightly when shown on a map set to true north (Map 5). The southeast corner of each transect was marked with a plastic-capped rebar stake[4] and GPS coordinates were collected in order to aid in identification of transect locations in the future.

Each transect was divided into five 8 m x 10 m quadrats for sub-sampling purposes. Qualitative descriptions of vegetation, topography and other notable conditions (e.g., presence of wetlands or streams, quality of trails) within each quadrat were recorded in field notebooks; results are presented in Appendix A. Within each quadrat, 5 m x 5 m subplots were randomly placed for the purpose of quantitative percent cover vegetation surveys, diameter at breast height (DBH) tree measurements and large woody debris (LWD) inventories. In total, 135 subplots were sampled (27 transects x 5 subplots per transect).[5] Percent cover quantities of each species identified in the canopy, shrub, and herbaceous vegetation layers were recorded in field notebooks. For LWD, measurements of the length and circumference of each piece were recorded and decay class was determined.

GPS coordinates were recorded at the southeast corner of each transect, as well as at subplot centers and opposite transect ends (either the west end or the north end, depending on transect orientation).[6] Coordinates were also recorded for patches of invasive species encountered throughout the site during the vegetation assessment (regardless of whether these patches were located within a designated sampling transect or not). GPS coordinates are provided in Appendix D.

3 Vegetation Assessment Results

The following subsections discuss the results of the vegetation assessment on a site-wide basis and by management zone (MZ). The purpose of the MZs is to provide specific information for vegetation management needs within different areas of Salmon Creek Ravine and to divide the 90-ac site into smaller units for assigning and tracking management activities. Nine MZs were delineated primarily based on topography/creek sub-drainages and existing trails/accessibility (Map 7). In general, MZs were not delineated based on vegetation because similar patterns of vegetation were observed throughout the green space, and these patterns appeared to be based primarily on topographic changes and proximity to creeks and riparian areas. One exception is MZ 7 which was delineated based on unique soils and vegetation. This zone is dominated by hummocky wetlands, creek rivulets and very mucky soils; these conditions will affect not only the restoration activities that might be conducted but also the

[4] The plastic cap consisted of a soda bottle spray painted orange.

[5] No quantitative assessment was conducted for Transect 18 due to the location of this transect on a very steep slope that could not be traversed safely for data collection.

[6] The coordinates for Transect 2 were not recorded due to an error with the GPS unit in the field. Therefore, the location of this transect is estimated based on the planned transect location shown on Map 4 and the topographic features observed during transect assessment.

methods by which the area will be accessed and restored. Table 3-1 provides information about the habitat types, acreage, and number of transects sampled for each MZ.

Table 3-1. Salmon Creek Ravine Management Zones

Zone	Habitat Type[a]	Acres (approximate)	Percent of Total Area	Number of Transects Sampled	Transect Nos.
1	1, 5	9	10%	2[b]	17, 18[b], 19
2	1, 3, 4, 5	10	11%	3	20, 21, 22
3	1, 3, 5	8	9%	3	23[c], 25, 26
4	1, 3	8	9%	3	23[c],24, 27, 28
5	3, 5	13	15%	3	13[c], 15, 16
6	1, 2, 4	10	11%	4	6, 7, 8, 12
7	5	3.5	4%	1	9
8	1, 3	10.5	12%	5	1, 2, 3, 4, 5[c]
9	1, 3, 5	15.5	18%	4	5 [c], 10, 11, 13[c],14

[a] The habitat type categories are based on Earth Corps's definitions as shown on Map 2, but the habitat types listed are those that were observed during the vegetation assessment. In some cases the habitat types observed in a MZ were not exactly the same as those mapped by EarthCorps owing to the relative coarseness of the EarthCorps geographic area determinations. Numbers are used for brevity to represent the habitat types in this table; the numbers represent the following habitat types:

1 – Conifer-deciduous mixed forest
2 – Conifer-madrone mixed forest
3 – Deciduous forest
4 – Deciduous-madrone mixed forest
5 – Riparian forested wetland
6 – Shrubland

[b] Three transects (17, 18 and 19) were located within MZ 1; however, quantitative data were not collected in Transect 18 due to the extremely steep topography in the area where the transect was located. A qualitative description of conditions within Transect 18 is available in Appendix A.

[c] MZs 3 and 4 shared Transect 23, MZs 5 and 9 shared Transect 13, and MZs 8 and 9 shared Transect 5. In all three cases, the transect spanned the boundary of the two zones. In these instances, the data for the shared transect were included in the data evaluation for both MZs.

In the field, species present at 20% cover or higher within each vegetation layer (canopy, understory and groundcover) were considered to be dominant.[7] However, species that "contribute more to the character of a plant community than other species present" can also be considered dominant, consistent with the *Washington State Wetlands Identification and Delineation Manual* (Washington State Department of Ecology 1997). For the purposes of this report, species that are present at less than 20% cover but that contributed to the predominant character of the plant community will be referred to as secondary dominant species.

The vegetation assessment results will be discussed by vegetation layer in order to provide information on the condition of the canopy, understory and groundcover throughout Salmon Creek Ravine. This type of assessment also provides information on potential forest succession patterns. For example, tree

[7] This percentage is based on the US Army Corps of Engineers' 50/20 rule for determining dominant vegetation as discussed in their Wetlands Delineation Manual (Environmental Laboratory 1987).

species in the understory provide information about which species might be dominant in the canopy in the future. The condition of the groundcover helps determine whether new shrub and tree seedlings will be able to become established. An area where the groundcover is dominated by *H. helix* may be unavailable for native plants because they will be outcompeted by the invasive vine. In this report, tree species were classified as being present in the canopy if the upper branches and crown extended into the forest canopy. They were classified as being present in the understory if they were seedlings, saplings or small trees not yet extending into the canopy. , If they were small seedlings only a few inches high they were classified as being present in the groundcover layer. These distinctions were made in order to provide additional detail about tree regeneration and the potential succession of the tree species in Salmon Creek Ravine.

Canopy-reaching trees were counted in the subplot data only when the stems of these trees were contained within the boundaries of the 5 m x 5 m subplot. In many cases, the branches of canopy trees extended into the boundaries of the subplot, but these trees were not recorded in the subplot data unless their stems were also within the boundaries of the subplot. The qualitative assessments of the 8 m x 10 m quadrats, summarized in Appendix A, provide additional information on the presence and dominance of canopy species in the larger transects, regardless of whether the stems of these species fell within the boundaries of the sampling quadrats.

When 20% or more of the groundcover layer of a quadrat contained bare ground, this was also recorded along with the vegetation percent cover data. Areas of bare ground were generally located beneath dense canopy cover, devoid of vegetation, and in many cases, covered by a thick layer of duff. Information about the presence of bare ground provides an indication of areas where invasive species could become established (due to lack of native species cover) but it also provides more detail about general conditions within the various MZs.

Graphs and tables are used to present the vegetation sampling results. Graphs show the weighted average percent cover of each species for the MZ overall (i.e., what percentage of the entire MZ does a given species cover). The weighted average was used to account for the different number of accounts of each species in a given MZ (i.e., number of subplots in an MZ within which a species was sampled). Tables are used to present a count of the number of subplots within each MZ where each species was identified, as well as the average percent cover of each species solely within the subplots where it was identified (rather than an average percent cover for the MZ as a whole).

3.1 Site-wide Results

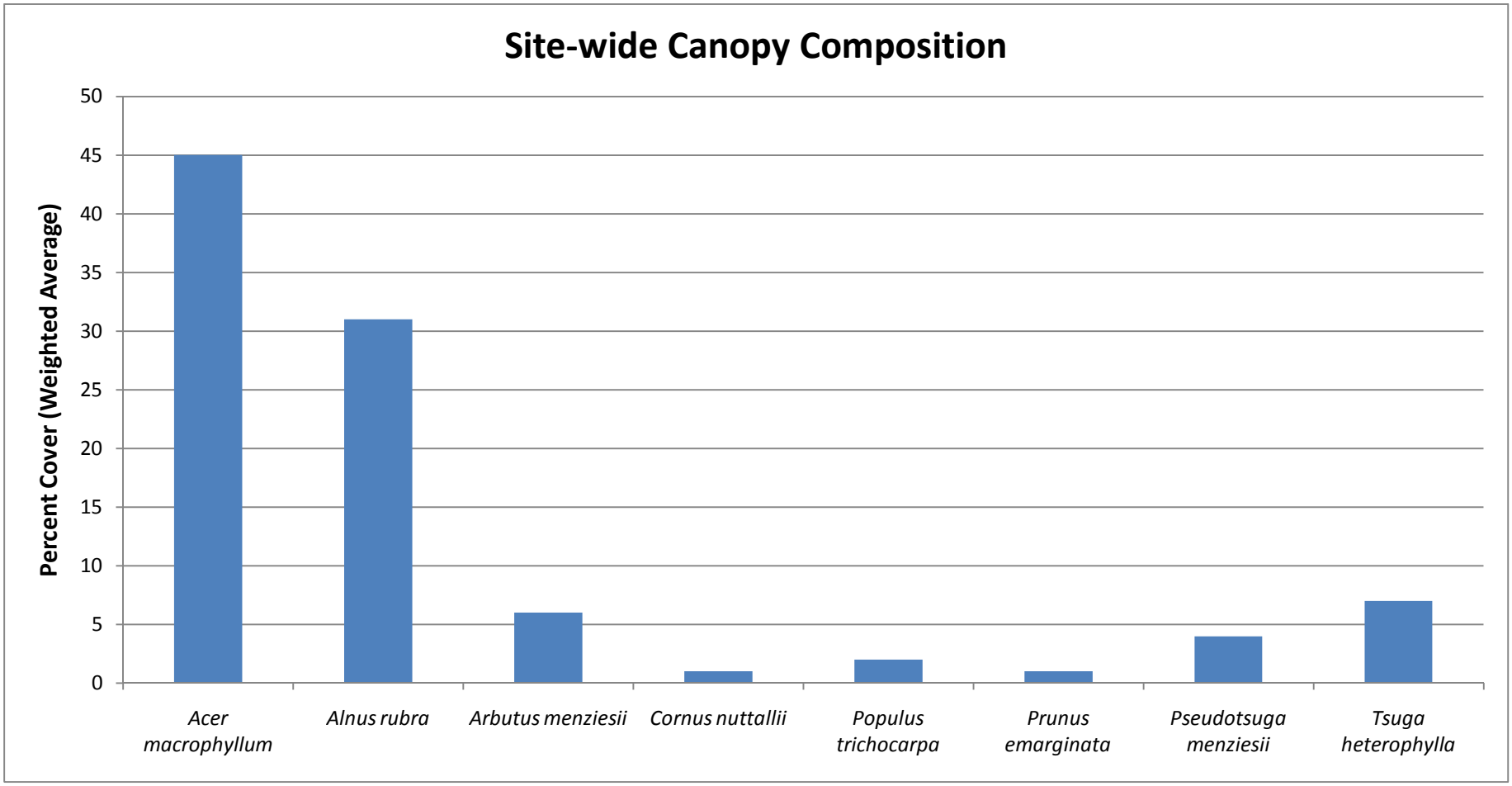
The vegetation assessment results indicate that Salmon Creek Ravine is dominated by an *A. macrophyllum* (bigleaf maple)-*A. rubra* (red alder)-*R. spectabilis* (salmonberry)- *P. munitum* (sword fern) vegetation community. There are also several other secondary dominant native species. The primary invasive species present are *R. armeniacus* (Himalayan blackberry) and *H. helix* (English ivy). The following subsections provide additional results of the site-wide vegetation assessment by vegetation layer (canopy, understory and groundcover).

3.1.1 Site-wide Canopy

The canopy of Salmon Creek Ravine was dominated by *A. macrophyllum* (bigleaf maple) and *A. rubra* (red alder) which were present at an average site-wide percent cover of 45% and 31%, respectively (Figure 3-1). *A. macrophyllum* was present in 27 of the 135 subplots sampled[8] and where present, it comprised an average of 50% of the canopy cover (Table 3-2). *A. rubra* was present in 21 of the subplots sampled and where present, it comprised an average of 44% of the canopy cover. Other native species sampled in the canopy were: *T. heterophylla* (western hemlock), present at an average cover of 7%; *Arbutus menziesii* (Pacific madrone), at an average cover of 6%; *P. menziesii* (Douglas fir), at an average cover of 4%; *P. trichocarpa* (black cottonwood), at an average cover of 2%; and *Prunus emarginata* (bitter cherry) and *Cornus nuttallii* (Pacific dogwood), each present at an average cover of 1% (Figure 3-1). Canopy-reaching *T. plicata* (western red cedar) was sampled in only one of the 135 subplots assessed (Table 3-2). The only invasive species identified in the canopy was *Prunus avium* (sweet cherry) which was present in only one subplot at less than 5% (Table 3-2).

[8] Throughout this report, the figures indicating the number of subplots sampled in the park in which canopy-reaching trees were present reflect the number of subplots in which the stems of these trees were contained within the boundaries of the 5 m x 5 m subplot. Additional subplots had branches of the various tree species present in the canopy layer; however, these were not counted in the subplot data unless the stem was also within the subplot boundaries. The qualitative assessments of the 8 m x 10 m quadrats, summarized in Appendix A, provide additional information on the presence and dominance of canopy species, regardless of whether the stems of these species fell within the boundaries of the quadrats.

Figure 3-1. Percent cover of species sampled in the canopy layer of Salmon Creek Ravine



Note: The graph only shows data for species that were present in the canopy layer at 1% cover or greater. Species identified that were present at less than 1% cover were *T. plicata* (western red cedar) and *P. avium** (sweet cherry). The presence of an asterisk (*) indicates an invasive species.

Table 3-2. Site-wide tally of the number of sampling subplots in which each canopy species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present in the Canopy[a]	Average Percent Cover for Subplots Where Present[b]
Acer macrophyllum	27	50
Alnus rubra	21	44
Arbutus menziesii	12	14
Cornus nuttallii	3	11
Populus balsamifera ssp. trichocarpa	1	60
*Prunus avium**	1	3
Prunus emarginata	1	30
Pseudotsuga menziesii	4	31
Thuja plicata	1	Nr
Tsuga heterophylla	9	22

nr – not recorded in the field

[a] Indicates the number of subplots in which the trunk of a canopy –reaching trees was present.

[b] Species present at an average percent cover of 3% are considered to be present in "trace" amounts.

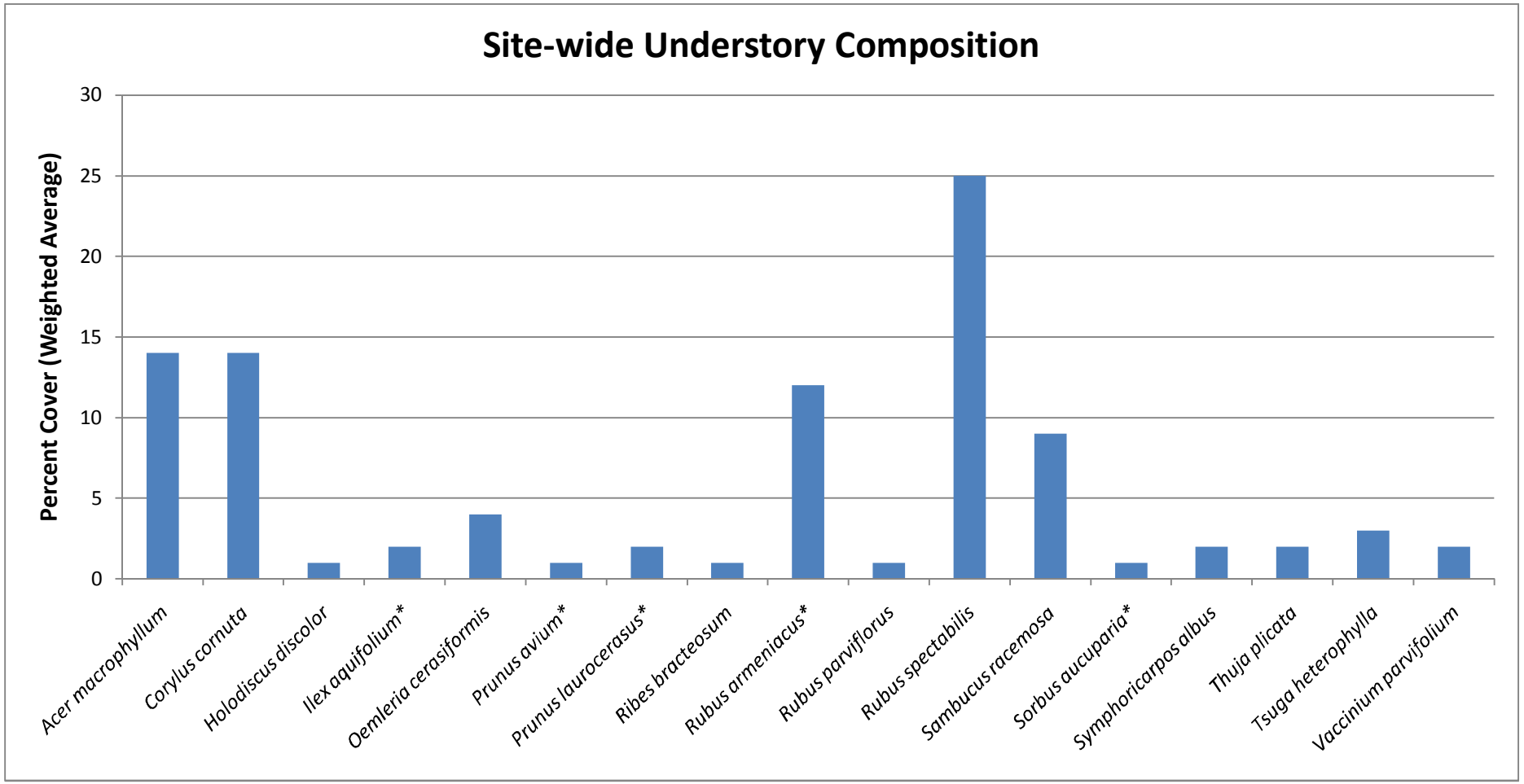
Additional tree species were observed in the canopy of Salmon Creek Ravine during the quadrat-level qualitative assessments (Appendix A). A comprehensive list of native trees observed in Salmon Creek Ravine is presented in Table 1-1. A comprehensive list of invasive tree species observed is presented in Table 1-2.

Diameter at breast height (DBH) information was collected for canopy-reaching trees; data for the most prevalent tree species observed in Salmon Creek Ravine are summarized here. The average DBH for *A. macrophyllum* (bigleaf maple) was 10.9 in. (the range was 2.1 to 46 in.). The average DBH for *A. rubra* (red alder) was 9.2 in. (the range was 1.3 to 31 in.). For *A. menziesii* (Pacific madrone), the average DBH was 13.4 in. (the range was 2.6 in. to 78.5 in.). The average DBH of *P. menziesii* (Douglas fir) was 24.3 in. (the range was 5 to 34.8 in.). *T. heterophylla* (western hemlock) had an average DBH of 17.7 in. (the range was 5.1 to 37 in.). DBH data can be used to help track forest growth and maturation.

3.1.2 Site-wide Understory

The understory of Salmon Creek Ravine is dominated by *R. spectabilis* (salmonberry), which is present at an average of 25% cover site-wide (Figure 3-2). *R. spectabilis* was present in the understory layer of 63 of the 135 subplots sampled and where present, it had an average cover of 21% (Table 3-3). Secondary dominant native species in the understory layer are: *A. macrophyllum* (bigleaf maple) and *Corylus cornuta* (beaked hazelnut), both present at an average cover of 14%; and *Sambucus racemosa* (red elderberry), at an average cover of 9% (Figure 3-2). *R. armeniacus* (Himalayan blackberry) is an invasive species; it was also a secondary dominant species in the understory with an average cover of 12%. *R. armeniacus* was present in the understory layer of 28 of the 135 subplots sampled and where present, it had an average cover of 24% (Table 3-3).

Figure 3-2. Percent cover of species sampled in the understory layer of Salmon Creek Ravine



Notes: The graph only shows data for species that were present in the understory layer at 1% cover or greater. Species identified that were present at less than 1% cover were *A. rubra* (red alder), *A. menziesii* (Pacific madrone), *Clematis vitalba** (old man's beard), *Crataegus monogyna** (European hawthorne), *Lonicera ciliosa* (orange honeysuckle), *P. sitchensis* (Sitka spruce), *Prunus* spp., *P. menziesii* (Douglas fir), *Rosa gymnocarpa* (baldhip rose), *Solanum dulcamara** (bittersweet nightshade), *Taxus brevifolia* (Pacific yew) and *Vaccinium ovatum* (evergreen huckleberry); information is provided for these species in Table 3-3. The presence of an asterisk (*) indicates an invasive species. .

Table 3-3. Site-wide tally of the number of sampling subplots in which each understory species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present in the Understory	Average Percent Cover for Subplots Where Present
Acer macrophyllum	35	22
Alnus rubra	2	13
Arbutus menziesii	2	5
*Clematis vitalba**	3	3
Corylus cornuta	39	20
*Crataegus monogyna**	1	3
Holodiscus discolor	5	10
*Ilex aquifolium**	13	9
Lonicera ciliosa	3	8
Oemleria cerasiformis	17	13
Picea sitchensis	1	3
*Prunus avium**	4	9
*Prunus laurocerasus**	9	15
Prunus spp.	1	3
Pseudotsuga menziesii	5	4
Ribes bracteosum	10	4
Rosa gymnocarpa	6	3
*Rubus armeniacus**	28	24
Rubus parviflorus	6	9
Rubus spectabilis	63	21
Sambucus racemosa	41	12
*Solanum dulcamara**	1	5
*Sorbus aucuparia**	8	4
Symphoricarpos albus	6	17
Taxus brevifolia	1	3
Thuja plicata	6	14
Tsuga heterophylla	13	14
Unidentified shrub	1	3
Vaccinium ovatum	1	3
Vaccinium parvifolium	23	5

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

All other species identified in the understory were present at an average site-wide cover of 5% or less (Figure 3-2). Native tree species growing in the understory included *T. plicata* (western red cedar) (at 2% cover) and *T. heterophylla* (western hemlock) (at 3% cover), as well as *A. rubra* (red alder), *A. menziesii* (Pacific madrone), *P. sitchensis* (Sitka spruce), *P. menziesii* (Douglas fir), and *T. brevifolia* (Pacific yew), all

of which were present at less than 1% cover of Salmon Creek Ravine overall. Native shrub species present in the understory between 1% and 5% cover included *Holodiscus discolor* (oceanspray), *O. cerasiformis* (Indian plum), *Ribes bracteosum* (stink currant), *Rubus parviflorus* (thimbleberry), *Symphoricarpos albus* (snowberry) and *Vaccinium parvifolium* (red huckleberry) (Table 3-3). Native shrub (plus one vine) species present at less than 1% cover were *Rosa gymnocarpa* (baldhip rose), *Vaccinium ovatum* (evergreen huckleberry) and *Lonicera ciliosa* (orange honeysuckle)[9]. Table 3-3 provides additional information about the distribution of these species.

Invasive species present in the understory between 1% and 5% cover were *I. aquifolium* (English holly), *P. laurocerasus* (English laurel), *P. avium* (sweet cherry) and *S. aucuparia* (European mountain ash). Those present at less than 1% cover were *Clematis vitalba* (old man's beard) and *Crataegus monogyna* (English hawthorne). *Solanum dulcamara* (bittersweet nightshade) was also present at less than 1% cover. *I. aquifolium* was present in the understory layer of 13 of the 135 subplots sampled and where present, it comprised an average of 9% of the understory cover (Table 3-3). *P. laurocerasus* was present in 9 of the subplots at an average cover of 15%. *S. aucuparia* was present in 8 subplots at an average cover of 4%, and *P. avium* was present in 4 subplots at an average of 9% cover.

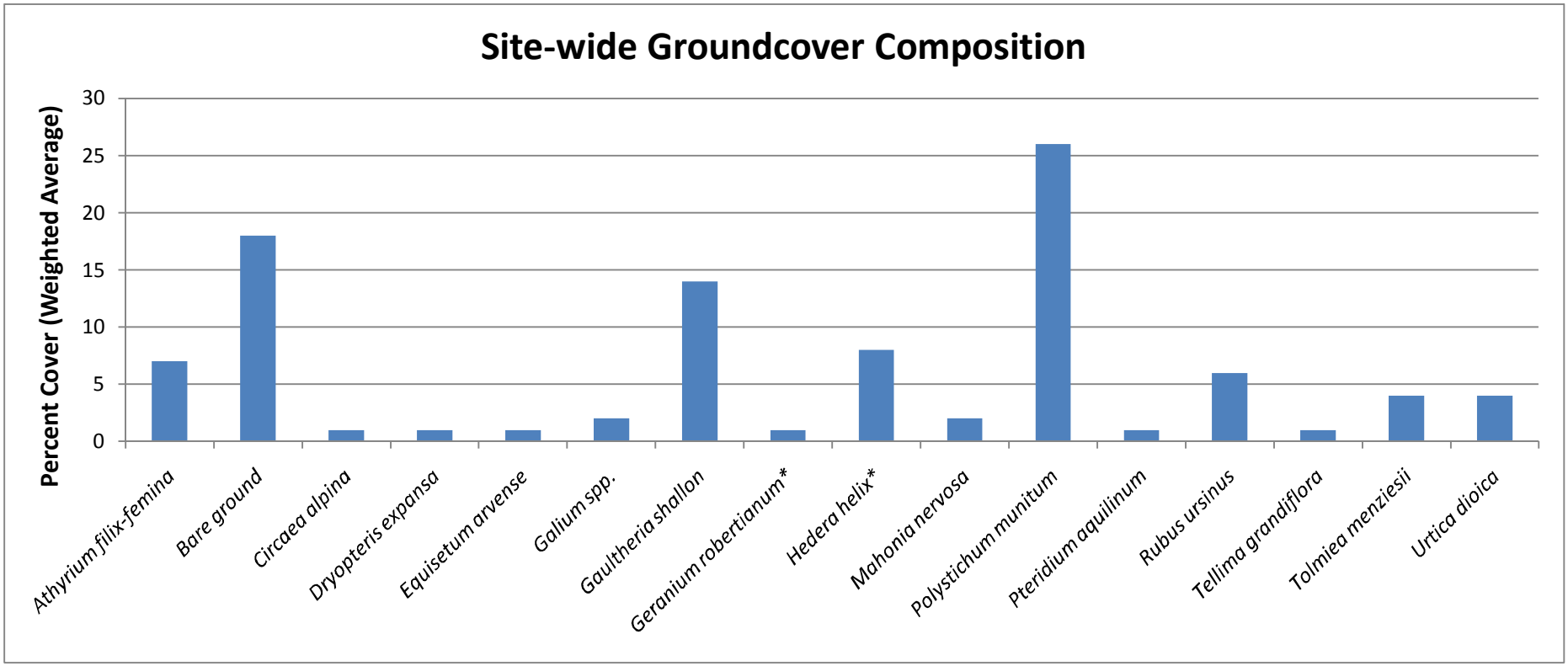
3.1.3 Site-wide Groundcover

The groundcover of Salmon Creek Ravine was dominated by *P. munitum* (sword fern), which was present at an average of 26% cover site-wide (Figure 3-3). *P. munitum* was present in the understory layer of 106 of the 135 subplots sampled and where present, it had an average cover of 22% (Table 3-4). Secondary dominant native species in the groundcover layer were: *G. shallon* (salal), present at an average cover of 14%; *Athyrium filix-femina* (lady fern), present at an average cover of 7%; and *Rubus ursinus* (trailing blackberry), present at an average cover of 6% (Figure 3-3). *H. helix* (English ivy)[10] is an invasive species; it was also a secondary dominant species in the groundcover layer with an average cover of 8%. *H. helix* was present in the groundcover layer of 34 of the 135 subplots sampled and where present, it had an average cover of 20% (Table 3-4). Several subplots also contained large areas of bare ground; these areas are generally located beneath dense canopy cover, devoid of vegetation, and in many cases, covered by a thick layer of duff. Site-wide, 18% of the groundcover consisted of such areas (Figure 3-3).

[9] Although *L. ciliosa* (orange honeysuckle), *C. vitalba* (old man's beard) and *S. dulcamara* (bittersweet nightshade) are vines, they were categorized as understory species because they were generally observed growing on trees and shrubs in the understory.

[10] Although *H. helix* (English ivy) is a vine, it was categorized as a groundcover species because it was generally observed growing along the ground (although it was also observed climbing trees in many locations).

Figure 3-3. Percent cover of species sampled in the groundcover layer of Salmon Creek Ravine



Notes: The graph only shows data for species that were present in the groundcover layer at 1% cover or greater. Species identified that were present at less than 1% cover were *A. macrophyllum* (bigleaf maple seedlings), *Achlys triphylla* (vanilla leaf), *A. rubra* (red alder seedlings), *Blechnum spicant* (deer fern), *Claytonia sibirica* (Siberian miner's lettuce), *Disporum hookeri* (Hooker's fairybells), *Epilobium augustifolium* (fireweed), *Epilobium ciliatum* (purple-leaved willowherb), *Geum macrophyllum* (large-leaved avens), *I. aquifolium** (English holly seedlings), *Juncus effuses* (common rush), *Lapsana communis* (nipplewort), *Luzula* spp. (wood-rush), *Lysichiton americanum* (skunk cabbage), *O. cerasiformis* (Indian plum seedlings), *Oenanthe sarmentosa* (Pacific water parsley), *Phalaris arundinacea** (reed canarygrass), *Polypodium glycyrrhiza* (licorice fern), *P. avium** (sweet cherry seedlings), *P. menziesii* (Douglas fir seedlings), *Ranunculus* spp. (buttercup), *Rubus laciniatus** (evergreen blackberry), *Rumex* spp. (dock), *Smilacina racemosa* (false Solomon's seal), *T. plicata* (western red cedar seedlings), *Tiarella trifoliata* (foamflower), *Trifolium repens* (white clover), *Trillium ovatum* (western trillium), *T. heterophylla* (western hemlock seedlings), an unidentified grass, an unidentified sedge and *Veronica beccabunga ssp. Americana* (American brooklime); information is provided for these species in Table 3-4. The presence of an asterisk (*) indicates an invasive species.

Table 3-4. Site-wide tally of the number of sampling subplots in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present in the Groundcover	Average Percent Cover for Subplots Where Present
Acer macrophyllum (seedlings)	14	3
Achlys triphylla	4	3
Alnus rubra (seedlings)	3	3
Athyrium filix-femina	46	14
Bare ground	39	42
Blechnum spicant	1	3
Circaea alpine	17	3
Claytonia sibirica	2	3
Disporum hookeri	1	3
Dryopteris expansa	23	5
Epilobium augustifolium	1	5
Epilobium ciliatum	3	4
Equisetum arvense	17	4
Galium spp.	20	7
Gaultheria shallon	44	29
*Geranium robertianum**	12	8
Geum macrophyllum	3	4
*Hedera helix**	34	20
*Ilex aquifolium** (seedlings)	3	3
Juncus effuses	1	15
Lapsana communis	5	3
Luzula spp.	1	3
Lysichiton americanum	2	4
Mahonia nervosa	28	7
Oemleria cerasiformis	5	4
Oenanthe sarmentosa	1	3
*Phalaris arundinacea**	4	3
Polypodium glycyrrhiza	3	3
Polystichum munitum	106	22
*Prunus avium** (seedlings)	1	3
Pseudotsuga menziesii (seedlings)	1	3
Pteridium aquilinum	15	4
Ranunculus repens	3	5
Ranunculus spp.	1	3
*Rubus laciniatus**	3	12
Rubus ursinus	76	7
Rumex spp.	2	3

Species	No. of Subplots Where Present in the Groundcover	Average Percent Cover for Subplots Where Present
Smilacina racemosa	4	3
Tellima grandiflora	13	5
Thuja plicata (seedlings)	1	3
Tiarella trifoliata	2	3
Tolmiea menziesii	22	15
Trifolium repens	1	3
Trillium ovatum	5	3
Tsuga heterophylla (seedlings)	1	3
Unidentified grasses	3	12
Unidentified sedges	2	7
Urtica dioica	52	8
Veronica beccabunga ssp. Americana	1	3

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

Several other species were identified in the groundcover layer at an average site-wide cover of 5% or less (Figure 3-3). Native groundcover species included *Tolmeia menziesii* (youth-on-age) and *Urtica dioica* (stinging nettle) (both present at 4% cover), and *M. nervosa* (dull Oregon grape) (at 2% cover). The only invasive groundcover species present between 1% and 5% cover was *G. robertianum* (herb Robert) (1% cover site-wide). Invasive species present at less than 1% cover were *I. aquifolium* (English holly seedlings), *Phalaris arundinacea* (reed canarygrass), and *P. avium* (sweet cherry seedlings). Table 3-4 provides additional information about all of the groundcover species identified.

3.2 Results by Management Zone

The nine MZs delineated within Salmon Creek Ravine are shown on Map 7. The vegetation results will be discussed separately for each MZ in order to help guide vegetation management activities within specific parts of Salmon Creek Ravine.

3.2.1 Management Zone 1

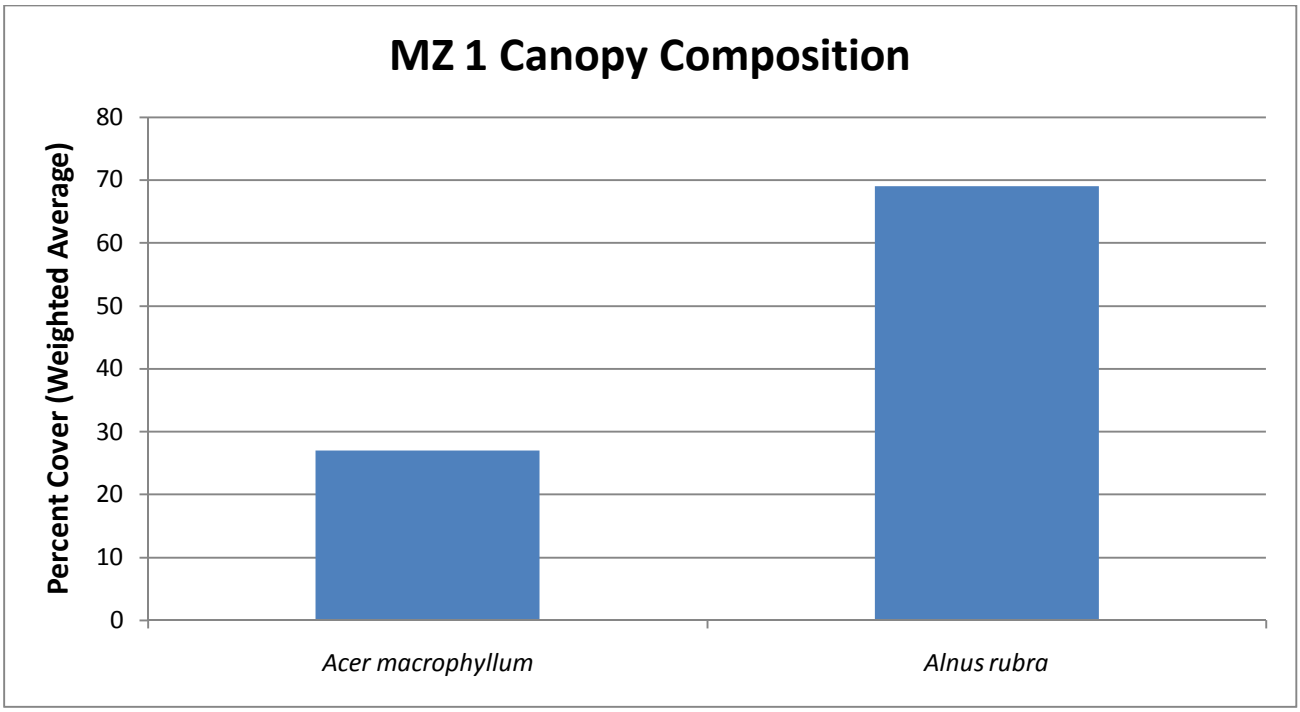
Management Zone 1 includes the western entrance to the site near the WWTP. It is approximately nine ac in size and contains the downstream portion of the main branch of Salmon Creek. The majority of MZ 1 consists of a very steep, southeast-facing slope (ravine wall). Habitat restoration and trail renovation were initiated in this MZ in 2010 and are ongoing. Three sampling transects are located within MZ 1 (Transects 17, 18 and 19); however, quantitative data collection was only conducted for two of the transects. One transect (Transect 18) spanned a very steep ravine wall and could not be traversed for the purposes of data collection; it was assessed qualitatively from the trail below.

3.2.1.1 MZ 1 Canopy

The canopy of MZ 1 is dominated by *A. rubra* (red alder) and *A. macrophyllum* (bigleaf maple) which are present at an average cover of 69% and 27%, respectively (Figure 3-4). Five of the 10 subplots sampled in MZ 1 contained *A. rubra* in the canopy; in these subplots, *A. rubra* comprised an average of 63% of

the canopy cover. Three of the subplots in this MZ contained *A. macrophyllum* in the canopy; in these subplots, *A. macrophyllum* comprised an average of 42% of the canopy cover. No other canopy species were identified in the subplots or quadrats of MZ 1 (Appendix A).

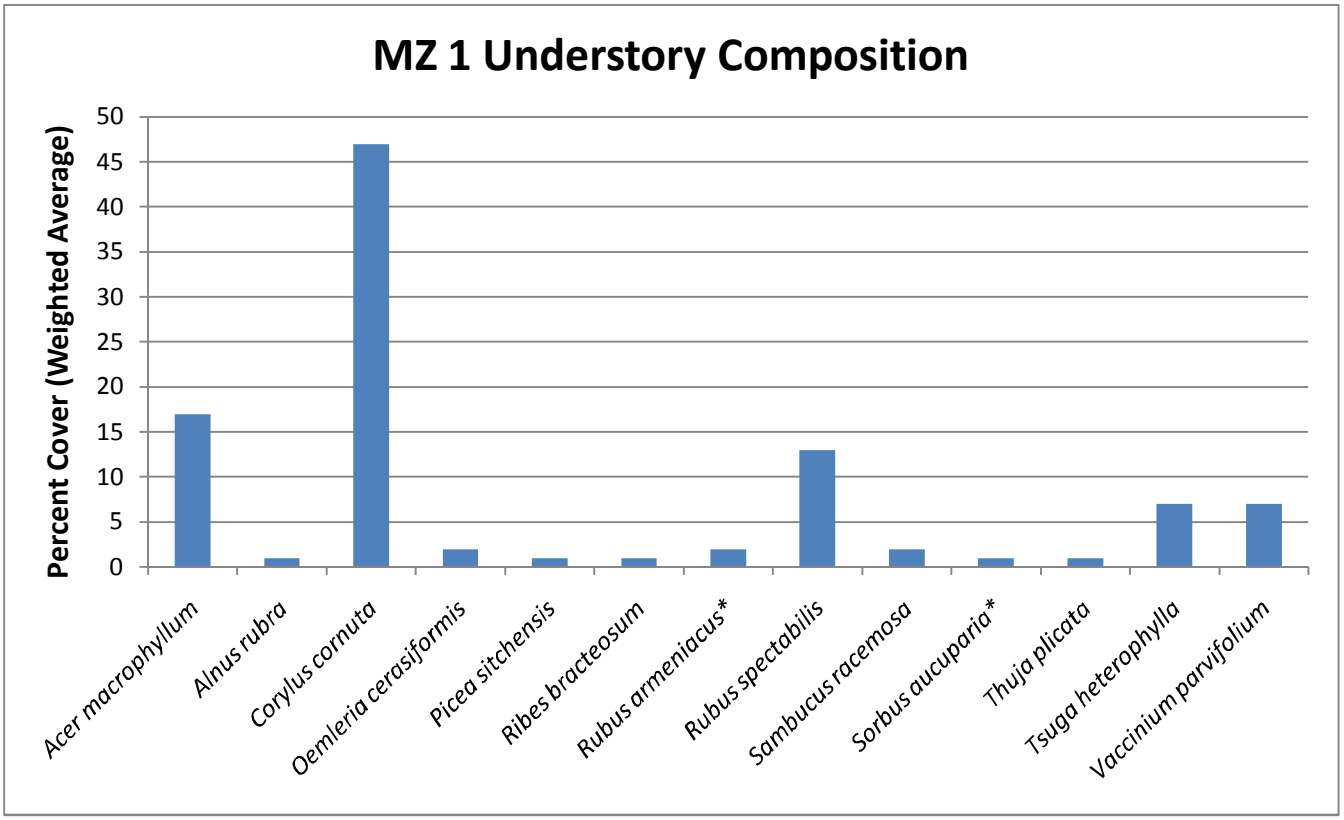
Figure 3-4. Percent cover of species sampled in the canopy layer of MZ 1



3.2.1.2 MZ 1 Understory

The understory of MZ 1 is dominated by *C. cornuta* (beaked hazelnut), which is present at an average cover of 47% for the zone as a whole (Figure 3-5). *C. cornuta* was present in the understory layer of 5 of the 10 subplots sampled in MZ 1 and where present, it had an average cover of 40% (Table 3-5). Secondary dominant native species in the understory layer were: *A. macrophyllum* (bigleaf maple), present at an average cover of 17%; *R. spectabilis* (salmonberry), at an average cover of 13%; *T. heterophylla* (western hemlock) and *V. parvifolium* (red huckleberry), each present at an average cover of 7% (Figure 3-5). Several other native species were identified in the understory of MZ 1, including the only specimen of *P. sitchensis* (Sitka spruce) observed in Salmon Creek Ravine, which was located in Subplot 4 of Transect 17 in the riparian zone of the main branch of Salmon Creek (Map 6). The only invasive species sampled in the understory of MZ 1 were *R. armeniacus* (Himalayan blackberry) and *S. aucuparia* (European mountain ash), at average covers of just 2% and 1%, respectively, throughout this zone. Figure 3-5 and Table 3-5 provide additional information about the distribution of understory species in MZ 1.

Figure 3-5. Percent cover of species sampled in the understory layer of MZ 1



Note: The presence of an asterisk (*) indicates an invasive species.

Table 3-5. Number of sampling subplots in MZ 1 in which each understory species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	4	18
Alnus rubra	1	5
Corylus cornuta	5	40
Oemleria cerasiformis	3	3
Picea sitchensis	1	3
Ribes bracteosum	1	5
*Rubus armeniacus**	2	4
Rubus spectabilis	8	7
Sambucus racemosa	3	3
*Sorbus aucuparia**	1	3
Thuja plicata	1	3
Tsuga heterophylla	1	30

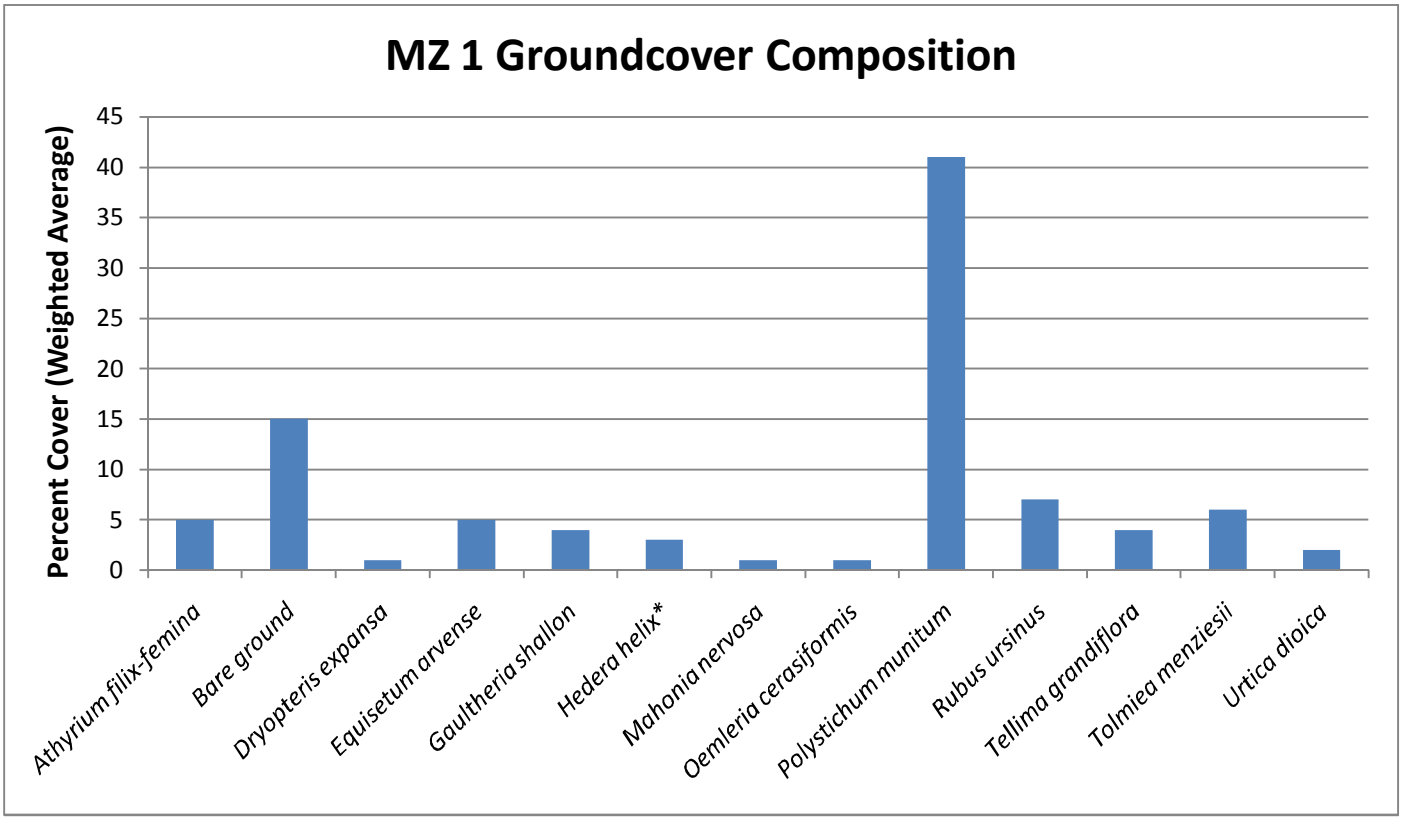
Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Vaccinium parvifolium	2	14

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

3.2.1.3 MZ 1 Groundcover

The groundcover of MZ 1 was dominated by *P. munitum* (sword fern), which was present at an average cover of 41% for the zone as a whole (Figure 3-6). *P. munitum* was present in the understory layer of 7 of the 10 subplots sampled in MZ 1 and where present, it had an average cover of 36% (Table 3-6). Secondary dominant native species in the groundcover layer were: *R. ursinus* (trailing blackberry), present at an average cover of 7%; and *T. menziesii* (youth-on-age), present at an average cover of 6% (Figure 3-6). Several other native species were identified in the groundcover layer of MZ 1, including *A. filix-femina* (lady fern), *Equisetum arvense* (common horsetail) and *Tellima grandiflora* (fringecup). The only invasive species sampled in the groundcover layer of MZ 1 were *H. helix* (English ivy) and *P. arundinacea* (reed canarygrass); these species were present in trace amounts throughout this zone (an average cover of 3% and 0.5%, respectively). Figure 3-6 and Table 3-6 provide additional information about the distribution of groundcover species in MZ 1. A significant amount of bare ground (areas without vegetation) was also observed in MZ 1; the overall average cover of bare ground was 15% throughout the zone.

Figure 3-6. Percent cover of species sampled in the groundcover layer of MZ 1



Notes: The graph only shows data for species that were present in the groundcover layer at 1% cover or greater. Species identified that were present at less than 1% cover were *A. macrophyllum* (bigleaf maple seedlings), *A. rubra* (red alder seedlings), *Circaea alpina* (enchanter's nightshade), *Epilobium ciliatum* (purple-leaved willowherb), *Lapsana communis* (nipplewort), *P. arundinacea** (reed canarygrass) and an unidentified grass; information is provided for these species in Table 3-6. The presence of an asterisk (*) indicates an invasive species.

Table 3-6. Number of sampling subplots in MZ 1 in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum (seedlings)	1	3
Alnus rubra (seedlings)	1	3
Athyrium filix-femina	2	17
Bare ground	2	48
Circaea alpina	1	3
Dryopteris expansa	2	4
Epilobium ciliatum	1	3
Equisetum arvense	4	7
Gaultheria shallon	3	9
*Hedera helix**	3	6

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Lapsana communis	1	3
Mahonia nervosa	2	3
Oemleria cerasiformis	1	5
*Phalaris arundinacea**	1	3
Polystichum munitum	7	36
Rubus ursinus	9	5
Tellima grandiflora	3	9
Tolmiea menziesii	4	10
Unidentified grass	1	3
Urtica dioica	3	4

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

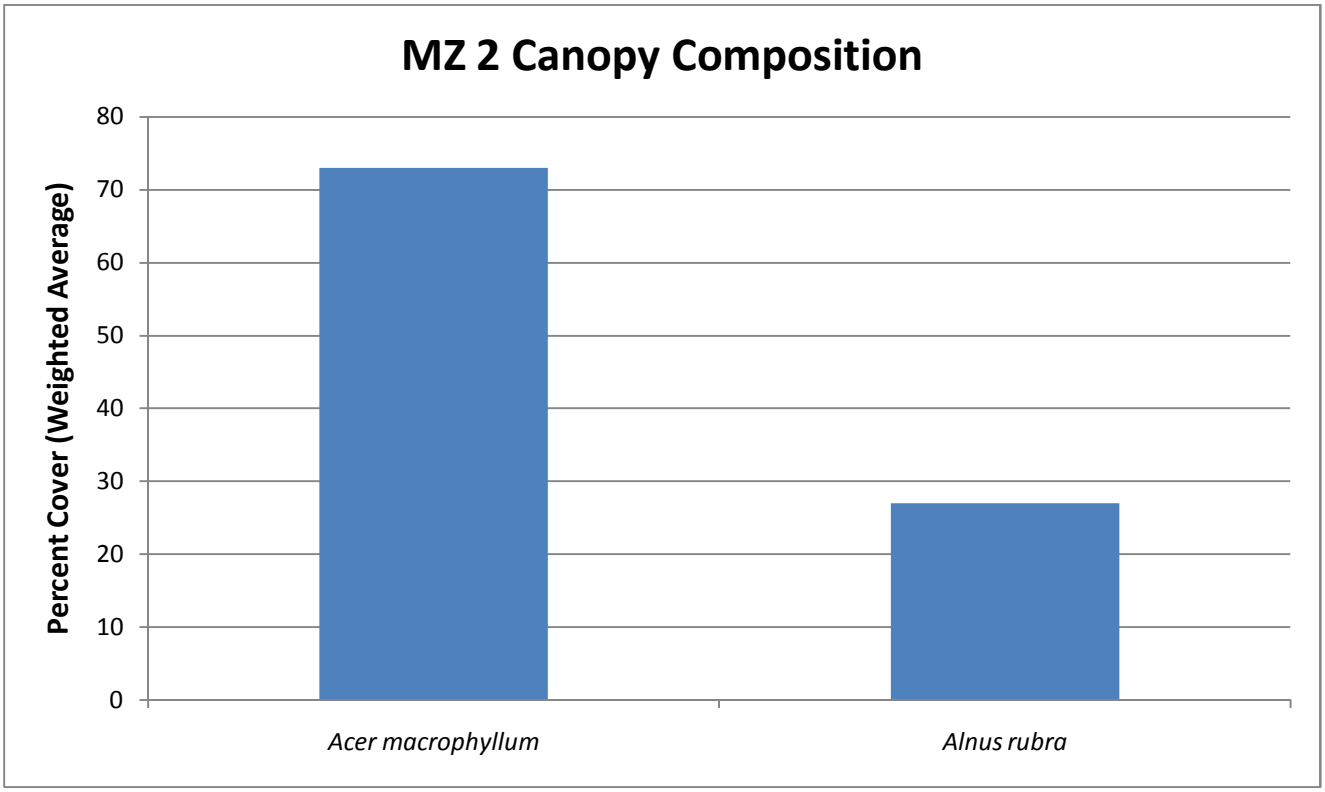
3.2.2 Management Zone 2

MZ 2 is approximately 10 ac in size and contains the middle portion of the main branch of Salmon Creek as well as two tributaries to this branch. Each tributary runs approximately north to south through a ravine bottom. The topography of MZ 2 generally consists of a steep, southeast-facing slope; however, there are variations in the topography throughout the zone (ridges, steep ravine walls and ravine bottoms). There are steep social trails spanning from the main branch of Salmon Creek to the northwest toward the surrounding neighborhood that allow some access to this MZ. Three sampling transects are located within MZ 2 (Transects 20, 21 and 22).

3.2.2.1 MZ 2 Canopy

The canopy of MZ 2 is dominated by *A. macrophyllum* (bigleaf maple) and *A. rubra* (red alder), which are present at average percent covers of 73% and 27%, respectively (Figure 3-7). *A. macrophyllum* was present in the canopy layer of 3 of the 15 subplots sampled in MZ 2, and where present it comprised an average of 73% of the canopy cover. *A. rubra* was present in the canopy layer of two of the subplots sampled at an average cover of 40% in those subplots. No other canopy species had stems within the subplots of MZ 2. However, based on the qualitative surveys of the larger sampling quadrats (8 m x 10 m) in MZ 2, *A. menziesii* (Pacific madrone), *T. heterophylla* (western hemlock), *T. plicata* (western red cedar) and *C. nuttallii* (Pacific dogwood) were secondary dominant species in some of the quadrats assessed (see Appendix A).

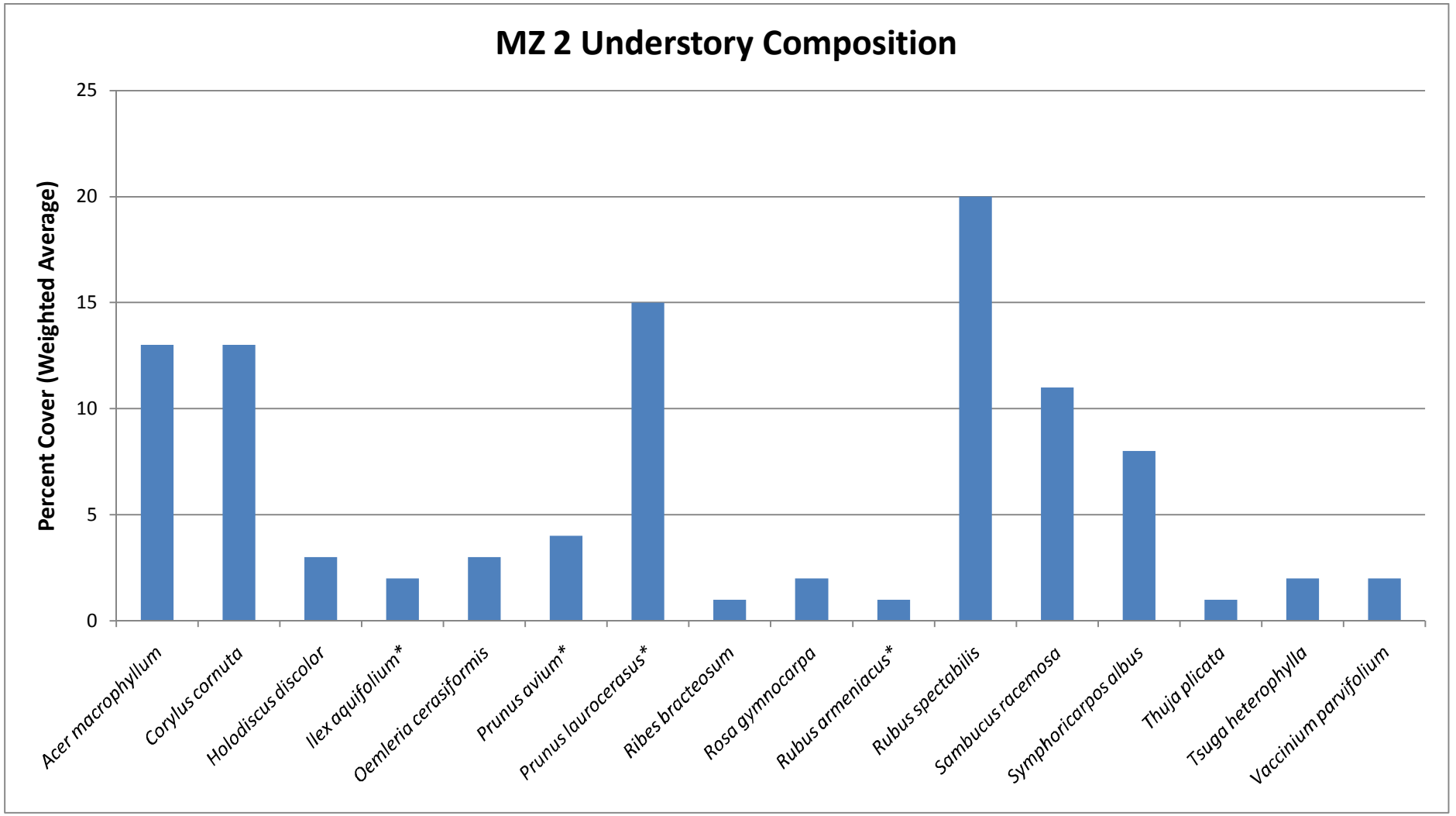
Figure 3-7. Percent cover of species sampled in the canopy layer of MZ 2



3.2.2.2 MZ 2 Understory

The understory of MZ 2 is dominated by *R. spectabilis* (salmonberry), which is present at an average cover of 20% for the zone as a whole (Figure 3-8). *R. spectabilis* was present in the understory layer of eight of the 15 subplots sampled in MZ 2 and where present, it had an average cover of 13% (Table 3-7). Secondary dominant native species in the understory layer were: *A. macrophyllum* (bigleaf maple) and *C. cornuta* (beaked hazelnut), each present at an average cover of 13%; *S. racemosa* (red elderberry) at an average cover of 11%; and *S. albus* (snowberry), present at an average cover of 8% (Figure 3-8). Several other non-dominant native species were identified in the understory of MZ 2 including *T. plicata* (western red cedar) and *T. heterophylla* (western hemlock) understory trees, and shrubs such as *H. discolor* (oceanspray), *O. cerasiformis* (Indian plum) and *V. parvifolium* (red huckleberry). Figure 3-8 and Table 3-7 provide additional information about the distribution of understory species in MZ 2.

Figure 3-8. Percent cover of species sampled in the understory layer of MZ 2



Note: The presence of an asterisk (*) indicates an invasive species.

Table 3-7. Number of sampling subplots in MZ 2 in which each understory species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	5	13
Corylus cornuta	8	9
Holodiscus discolor	1	15
*Ilex aquifolium**	2	5
Oemleria cerasiformis	2	7
*Prunus avium**	2	12
*Prunus laurocerasus**	3	26
Ribes bracteosum	1	5
Rosa gymnocarpa	3	3
*Rubus armeniacus**	2	3
Rubus spectabilis	8	13
Sambucus racemosa	5	11
Symphoricarpos albus	1	40
Thuja plicata	1	5
Tsuga heterophylla	2	5
Vaccinium parvifolium	3	4

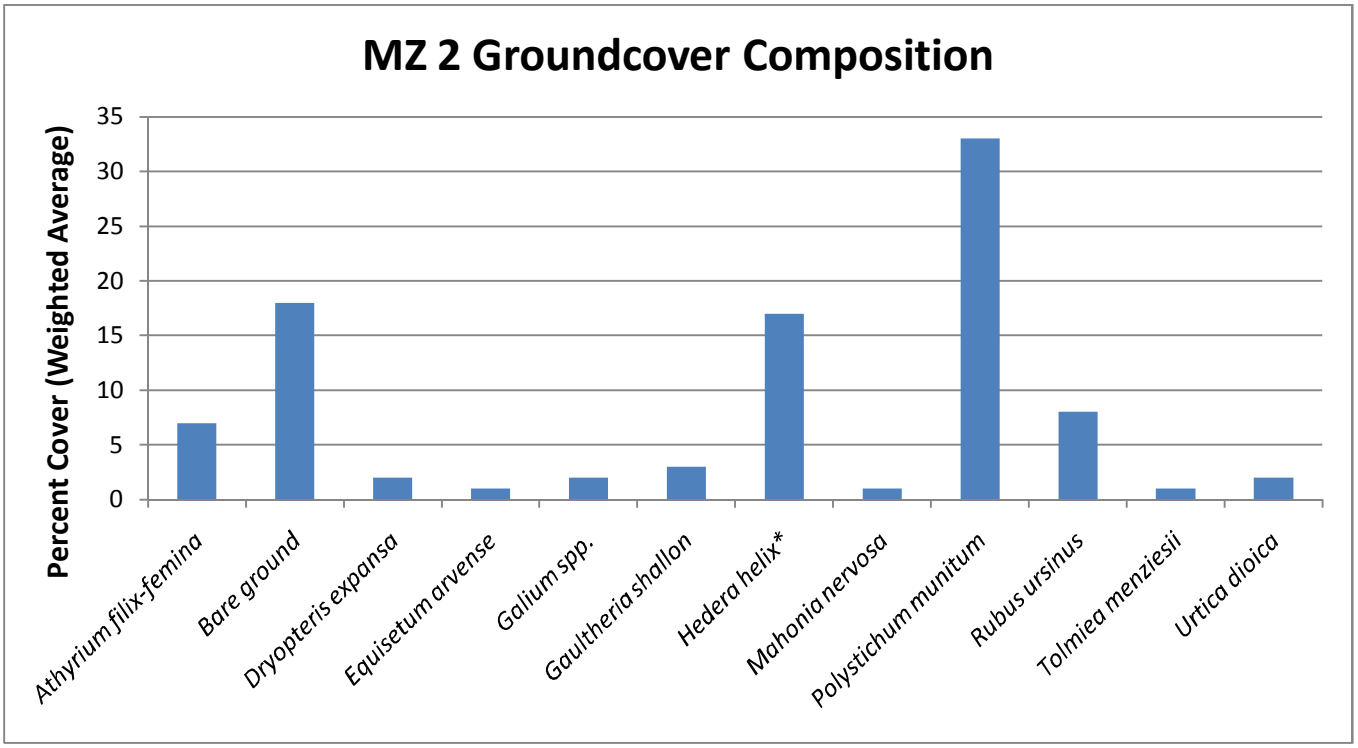
Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

Invasive species sampled in the understory of MZ 2 were: *P. laurocerasus* (English laurel), present at an average cover of 15% throughout the zone; *P. avium* (sweet cherry), present at an average cover of 4%; *I. aquifolium* (English holly), present at an average cover of 2%; and *R. armeniacus* (Himalayan blackberry), present at an average cover of 1% (Figure 3-8). *P. laurocerasus* was present in the understory layer of 3 of the 15 subplots sampled in MZ 2 and where present, it had an average cover of 26% (Table 3-7).

3.2.2.3 MZ 2 Groundcover

The groundcover of MZ 2 is dominated by *P. munitum* (sword fern), which is present at an average cover of 33% for the zone as a whole (Figure 3-9). *P. munitum* was present in the groundcover layer of 12 of the 15 subplots sampled in MZ 2 and where present, it had an average cover of 31% (Table 3-8). Secondary dominant native species in the groundcover layer are: *R. ursinus* (trailing blackberry), present at an average percent cover of 8%; and *A. filix-femina* (lady fern), present at an average percent cover of 7% (Figure 3-9). Several other native species were identified in the groundcover layer of MZ 2, including *Dryopteris expansa* (spiny wood fern), *G. shallon* (salal) and *U. dioica* (stinging nettle). In addition, a significant amount of bare ground (areas without vegetation) was also observed in MZ 2; the overall average cover of bare ground was 18% throughout the zone. Figure 3-9 and Table 3-8 provide additional information about the distribution of groundcover species in MZ 2.

Figure 3-9. Percent cover of species sampled in the groundcover layer of MZ 2



Notes: The graph only shows data for species that were present in the groundcover layer at 1% cover or greater. Species identified that were present at less than 1% cover were *A. macrophyllum* (bigleaf maple seedlings), *A. triphylla* (vanilla leaf), *C. alpina* (enchanter's nightshade), *L. communis* (nipplewort), *Luzula* spp. (wood-rush), *P. arundinacea** (reed canarygrass), *T. grandiflora* (fringecup), *T. ovatum* (western trillium), *T. heterophylla* (western hemlock seedlings) and an unidentified grass; information is provided for these species in Table 3-8. The presence of an asterisk (*) indicates an invasive species.

Table 3-8. Number of sampling subplots in MZ 2 in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum (seedlings)	1	3
Achlys triphylla	2	3
Athyrium filix-femina	3	28
Bare ground	4	50
Circaea alpine	1	3
Dryopteris expansa	7	4
Equisetum arvense	4	3
Galium spp.	3	8
Gaultheria shallon	6	7
*Hedera helix**	5	38
Lapsana communis	1	3
Mahonia nervosa	4	4

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
*Phalaris arundinacea**	1	3
Polystichum munitum	12	31
Rubus ursinus	12	8
Tellima grandiflora	1	5
Tolmiea menziesii	2	8
Trillium ovatum	1	3
Tsuga heterophylla (seedlings)	1	3
Unidentified grass	1	3
Urtica dioica	7	4

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

The only invasive species sampled in the groundcover layer of MZ 2 were *H. helix* (English ivy) and *P. arundinacea* (reed canarygrass). *P. arundinacea* was present in trace amounts in only one subplot (Table 3-8). *H. helix*, on the other hand, was present at average cover of 17% throughout MZ 2. All *H. helix* sampled was within Transect 22 (Map 5); every subplot in this transect contained *H. helix* at covers ranging from 15% to 70% (average 38%, Table 3-8). Transect 22 is located at the north end of a north-south trending ravine. The largest infestation of *H. helix* observed anywhere in Salmon Creek Ravine was within this portion of the ravine; *H. helix* was the dominant groundcover species throughout much of the area and it also covered many of the mature trees to their canopies (see Photo 4 in Section 1.3.6).

3.2.3 Management Zone 3

MZ 3 is located to the east of MZ 2 (Map 7). This zone includes the northern portion of the site, north of the gravel access road. It is approximately eight acres in size and contains the upstream portion of the main branch of Salmon Creek. The majority of MZ 3 consists of a very steep, generally southern-facing slope (ravine wall). Three sampling transects are located within MZ 3 (Transects 23, 25 and 26).[11] Transect 26 was erroneously located just east of the Salmon Creek Ravine green space boundary during the vegetation assessment due to the lack of a demarcated property boundary in this area; however, conditions within this transect will be assumed to represent nearby conditions inside the green space and so the data for Transect 26 are included with the other data from MZ 3.

3.2.3.1 MZ 3 Canopy

The canopy of MZ 3 is dominated by *A. rubra* (red alder) and *P. trichocarpa* (black cottonwood), which are present at average covers of 48% and 20%, respectively (Figure 3-10). Three of the 15 subplots sampled in MZ 3 contained *A. rubra* stems; in these subplots, *A. rubra* had an average cover of 48% (Table 3-9). Only one of the subplots sampled in the MZ contained *P. trichocarpa* in the canopy; however, in this subplot the cover of *P. trichocarpa* was 60% (Table 3-9). Secondary dominant native canopy species in MZ 3 were *T. heterophylla* (western hemlock) and *A. macrophyllum* (bigleaf maple),

[11] Transect 23 spanned the boundary of MZs 3 and 4. The data for this transect were included in the analysis of both of these MZs because conditions within a transect spanning two zones can be used to help characterize both zones.

present at average covers of 17% and 15%, respectively (Figure 3-10). Based on the qualitative surveys of the larger sampling quadrats (8 m x 10 m) in MZ 3, *P. menziesii* (Douglas fir) and an invasive species, *P. avium* (sweet cherry) were also observed in the canopy of some of the quadrats in MZ 3 (see Appendix A).

Figure 3-10. Percent cover of species sampled in the canopy layer of MZ 3

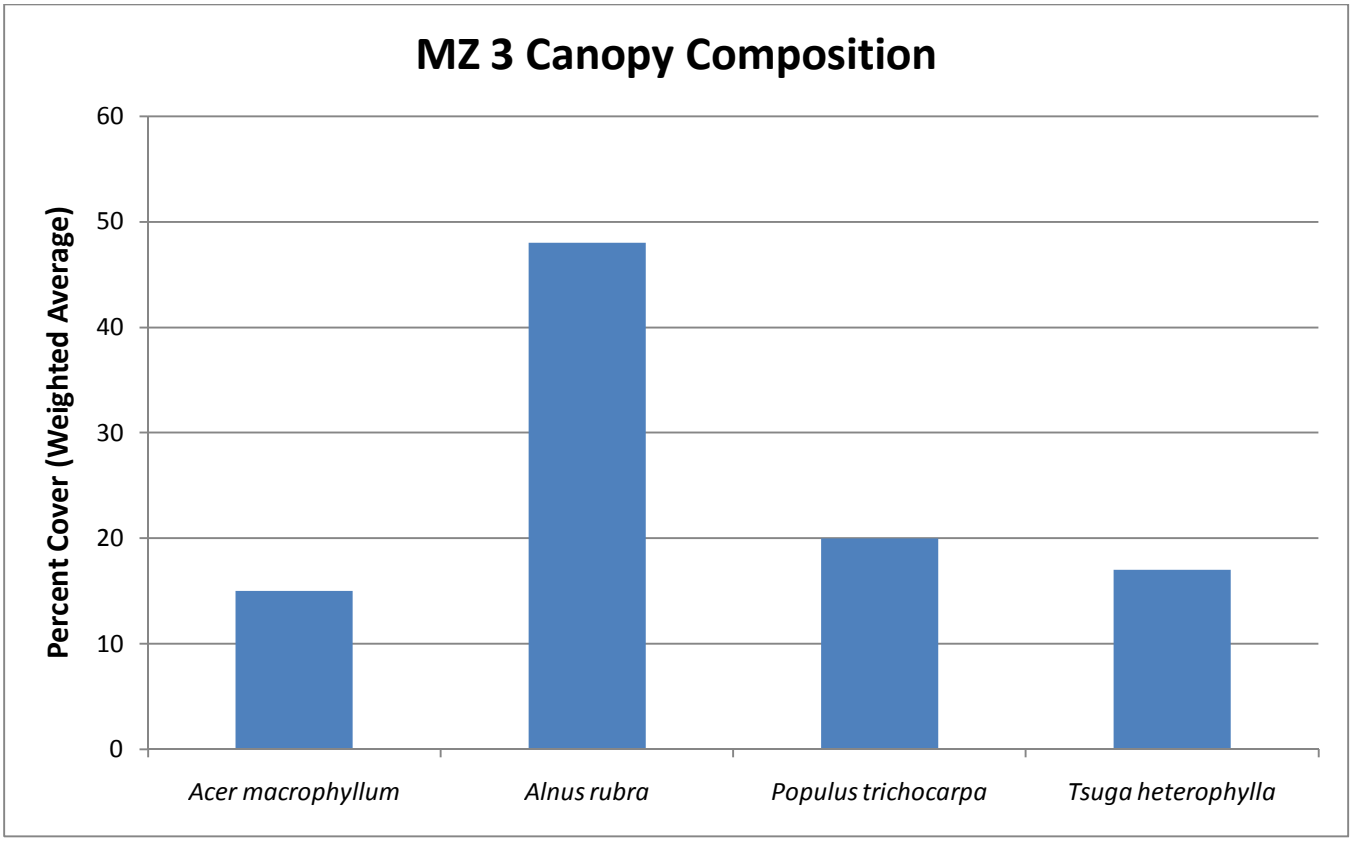


Table 3-9. Number of sampling subplots in MZ 3 in which each canopy species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present[a]	Average Percent Cover for Subplots Where Present
Acer macrophyllum	1	45
Alnus rubra	3	48
Populus balsamifera ssp. trichocarpa	1	60
Tsuga heterophylla	2	25

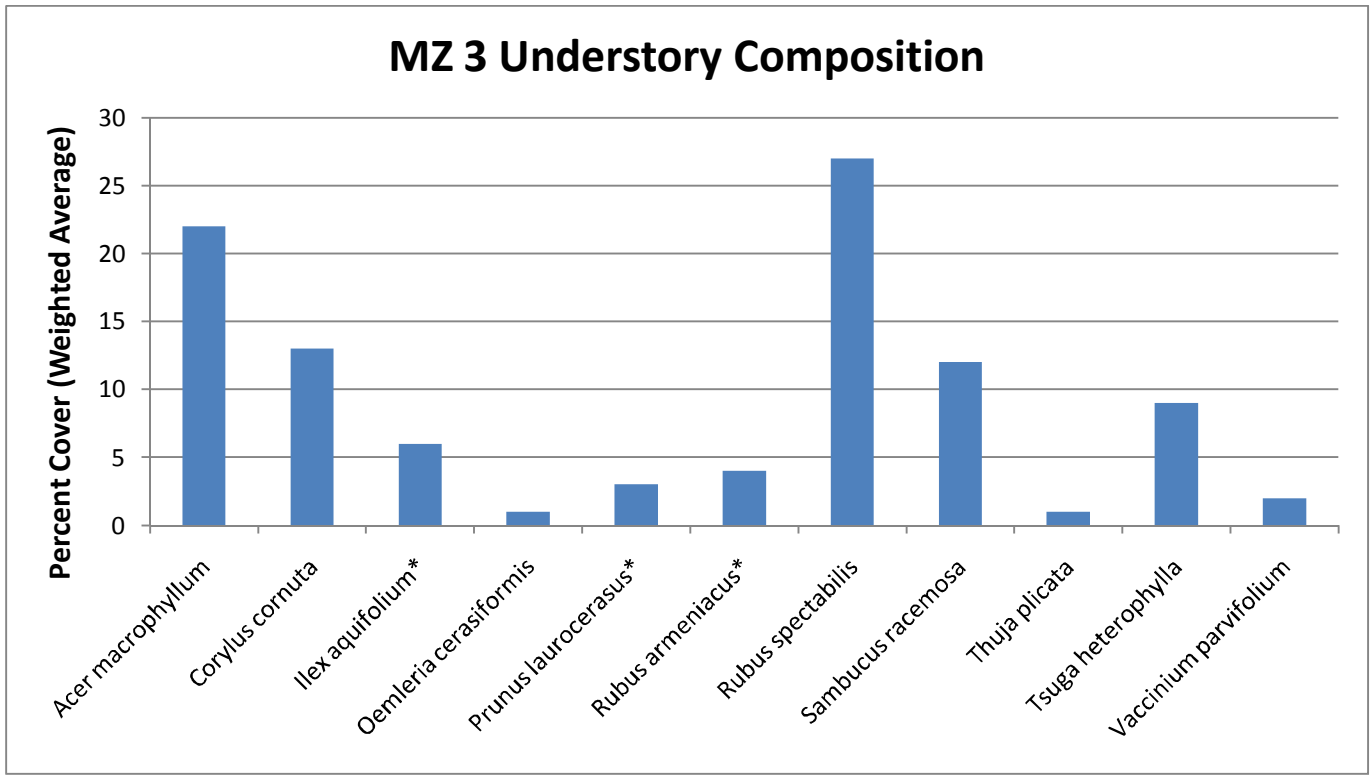
[a] Indicates the number of subplots in which the trunk of a canopy –reaching trees was present.

3.2.3.2 MZ 3 Understory

The understory of MZ 3 is dominated by *R. spectabilis* (salmonberry) and *A. macrophyllum* (bigleaf maple), which are present at an average cover of 27% and 22%, respectively (Figure 3-11). *R. spectabilis* was present in the understory layer of nine of the 15 subplots sampled in MZ 3 and where present, it

had an average cover of 31% (Table 3-10). *A. macrophyllum* was present in the understory layer of five of the 15 subplots sampled at an average cover of 45%. Secondary dominant native species in the understory layer were: *C. cornuta* (beaked hazelnut), present at an average cover of 13%; *S. racemosa* (red elderberry) at an average cover of 12%; and *T. heterophylla* (western hemlock) at an average cover of 9% (Figure 3-11). Several other, non-dominant native species were identified in the understory of MZ 3 including *T. plicata* (western red cedar), *V. parvifolium* (red huckleberry) and *R. bracteosum* (stink currant). Figure 3-11 and Table 3-10 provide additional information about the distribution of understory species in MZ 3.

Figure 3-11. Percent cover of species sampled in the understory layer of MZ 3



Notes: The graph only shows data for species that were present in the canopy layer at 1% cover or greater. Species identified that were present at less than 1% cover were *R. bracteosum* (stink currant) and *S. aucuparia** (European mountain ash). The presence of an asterisk (*) indicates an invasive species.

Table 3-10. Number of sampling subplots in MZ 3 in which each understory species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	5	45
Corylus cornuta	6	23
*Ilex aquifolium**	4	15
Oemleria cerasiformis	2	4

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
*Prunus laurocerasus**	2	15
Ribes bracteosum	1	3
*Rubus armeniacus**	4	10
Rubus spectabilis	9	31
Sambucus racemosa	5	25
*Sorbus aucuparia**	1	3
Thuja plicata	1	10
Tsuga heterophylla	5	20
Vaccinium parvifolium	4	4

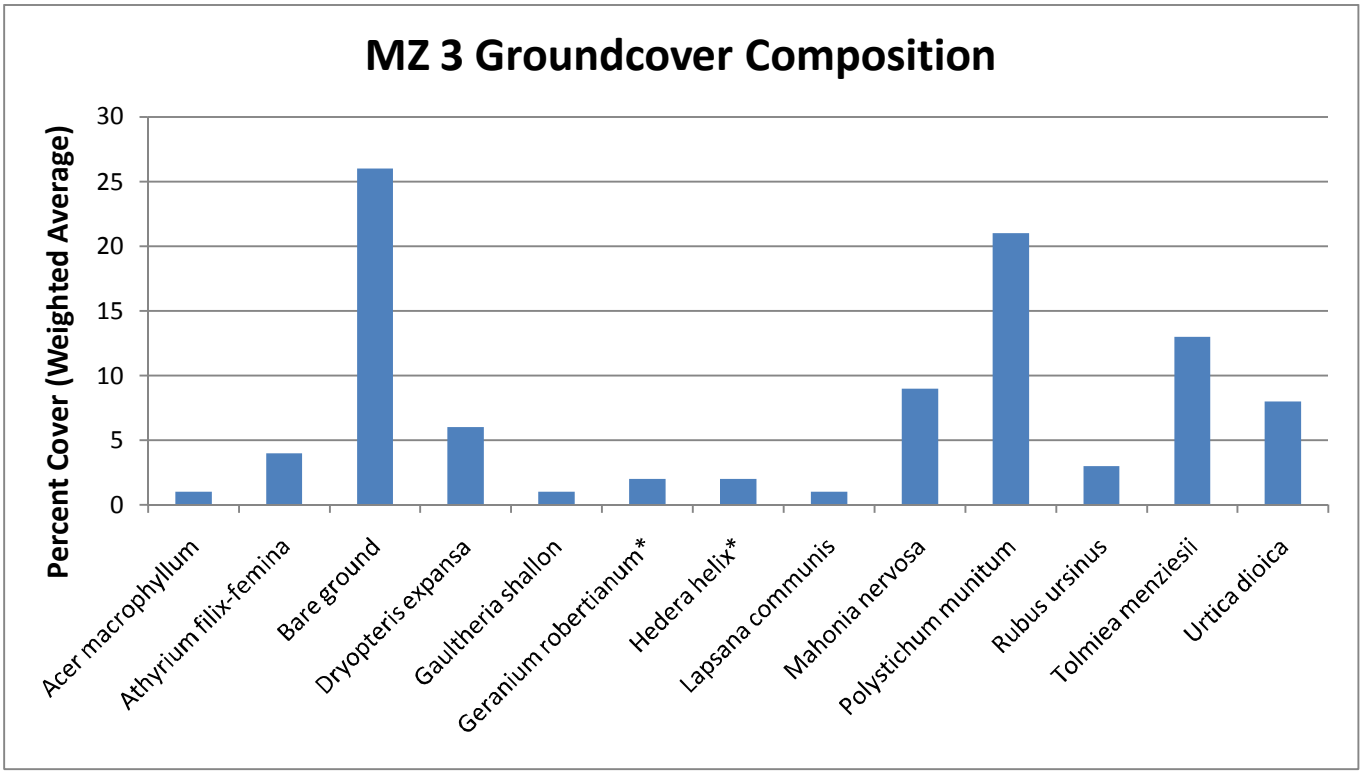
Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

Invasive species sampled in the understory of MZ 3 were: *I. aquifolium* (English holly), present at an average cover of 6% throughout the zone; *R. armeniacus* (Himalayan blackberry), present at an average cover of 4%; and *P. laurocerasus* (English laurel), present at an average cover of 3% (Figure 3-11). *I. aquifolium* was present in the understory layer of four of the 15 subplots sampled in MZ 3 and where present, it had an average cover of 15% (Table 3-10). *R. armeniacus* was present in the understory layer of four subplots at an average cover of 10%, and *P. laurocerasus* (English laurel) was present in two of the 15 subplots at an average cover of 15%. In addition, *S. aucuparia* (European mountain ash) was present in trace amounts in one subplot in MZ 3 (Table 3-10).

3.2.3.3 MZ 3 Groundcover

There was a significant amount of bare ground (areas without vegetation) in MZ 3; the average cover of bare ground was 26% throughout the zone (Figure 3-12). The dominant native groundcover species in MZ 3 is *P. munitum* (sword fern), which is present at an average cover of 21% for the zone overall; it was present in 14 of the 15 subplots sampled in MZ 3 and where present, it had an average cover of 11% (Table 3-11). Secondary dominant native species in the groundcover layer are: *T. menziesii* (youth-on-age), present at an average cover of 13%; *M. nervosa* (dull Oregon grape), present at an average cover of 9%; *U. dioica* (stinging nettle), present at an average cover of 8%; and *D. expansa* (spiny wood fern), present at an average cover of 6% (Figure 3-12). Several other, non-dominant native species were identified in the groundcover layer of MZ 3, including *G. shallon* (salal), *A. filix-femina* (lady fern), and *R. ursinus* (trailing blackberry). Figure 3-12 and Table 3-11 provide additional information about the distribution of groundcover species in MZ 3.

Figure 3-12. Percent cover of species sampled in the groundcover layer of MZ 3



Notes: The graph only shows data for species that were present in the groundcover layer at 1% cover or greater. Species identified that were present at less than 1% cover were *C. alpina* (enchanter's nightshade), *D. hookeri* (Hooker's fairybells), *G. macrophyllum* (large-leaved avens), *I. aquifolium** (English holly seedlings), *P. aquilinum* (bracken fern), *T. grandiflora* (fringecup), *T. plicata* (western red cedar seedlings) and an unidentified sedge. Information for these species is provided in Table 3-11. The presence of an asterisk (*) indicates an invasive species.

Table 3-11. Number of sampling subplots in MZ 3 in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum (seedlings)	2	3
Athyrium filix-femina	6	5
Bare ground	5	40
Circaea alpina	1	3
Disporum hookeri	1	3
Dryopteris expansa	8	6
Gaultheria shallon	3	3
*Geranium robertianum**	4	4
Geum macrophyllum	1	3
*Hedera helix**	4	4

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
*Ilex aquifolium** (seedlings)	1	3
Lapsana communis	3	3
Mahonia nervosa	5	14
Polystichum munitum	14	11
Pteridium aquilinum	1	3
Rubus ursinus	5	4
Tellima grandiflora	1	3
Thuja plicata (seedlings)	1	3
Tolmiea menziesii	6	16
Unidentified sedge	1	3
Urtica dioica	8	8

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

The only invasive species sampled in the groundcover layer of MZ 3 were *H. helix* (English ivy), *G. robertianum* (herb Robert) and *I. aquifolium* (English holly seedlings). *I. aquifolium* was present in trace amounts in only one subplot (Table 3-11). *H. helix* and *G. robertianum* were each present at an average cover of 2% throughout the MZ (Figure 3-12).

3.2.4 Management Zone 4

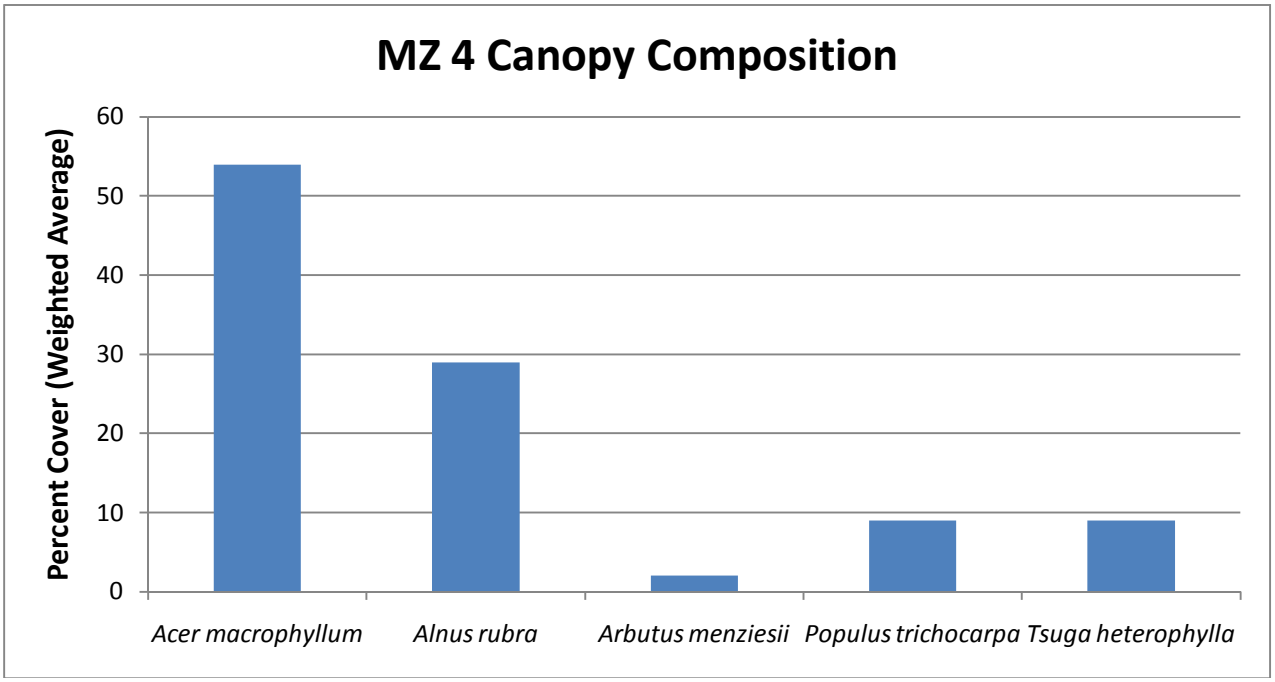
MZ 4 is located to the south of MZ 3 (Map 7). This zone includes the southern portion of the northeast end of Salmon Creek Ravine, south of the gravel access road. It is approximately eight ac in size and consists of a ravine ridge (at the southern boundary of the site) and a very steep, generally northern-facing slope (ravine wall) which slopes downward from the top of the ridge north toward the gravel access road. Four sampling transects are located within MZ 4 (Transects 23, 24, 27 and 28).[12]

3.2.4.1 MZ 4 Canopy

The canopy of MZ 4 is dominated by *A. macrophyllum* (bigleaf maple) and *A. rubra* (red alder), present at average covers of 54% and 29%, respectively, throughout the zone (Figure 3-13). Five of the 20 subplots sampled in MZ 4 contained *A. macrophyllum* in the canopy; in these subplots, *A. macrophyllum* had an average cover of 69% (Table 3-12). Three of the 20 subplots sampled in MZ 4 contained *A. rubra* in the canopy; in these subplots, *A. rubra* had an average cover of 62% (Table 3-12). Secondary dominant native canopy species in MZ 4 were and *T. heterophylla* (western hemlock) and *P. trichocarpa* (black cottonwood), each present at an average cover of 9% (Figure 3-13). *A. menziesii* (Pacific madrone) and *P. avium* (sweet cherry, an invasive species) were present in the sampling subplots in trace amounts. Based on the qualitative surveys of the larger sampling quadrats (8 m x 10 m) in MZ 4, *P. menziesii* (Douglas fir) was co-dominant in the canopy of some quadrats, and *P. emarginata* (bitter cherry) was present in small quantities in one quadrat of Transect 27 (see Appendix A).

[12] Transect 23 spanned the boundary between MZs 3 and 4; however the data for this transect were included in the analysis of both MZs. Conditions within the transect help characterize both zones.

Figure 3-13. Percent cover of species sampled in the canopy layer of MZ 4



Notes: The graph only shows data for species that were present in the canopy layer at 1% cover or greater. *P. avium** (sweet cherry) was present in the canopy at less than 1% cover. Information is provided for this species in Table 3-12. The presence of an asterisk (*) indicates an invasive species.

Table 3-12. Number of sampling subplots in MZ 4 in which each canopy species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present[a]	Average Percent Cover for Subplots Where Present[b]
Acer macrophyllum	5	69
Alnus rubra	3	62
Arbutus menziesii	1	10
Populus trichocarpa	1	60
*Prunus avium**	1	3
Tsuga heterophylla	2	30

[a] Indicates the number of subplots in which the trunk of a canopy –reaching trees was present.

[b] Species present at an average percent cover of 3% are considered to be present in "trace" amounts.

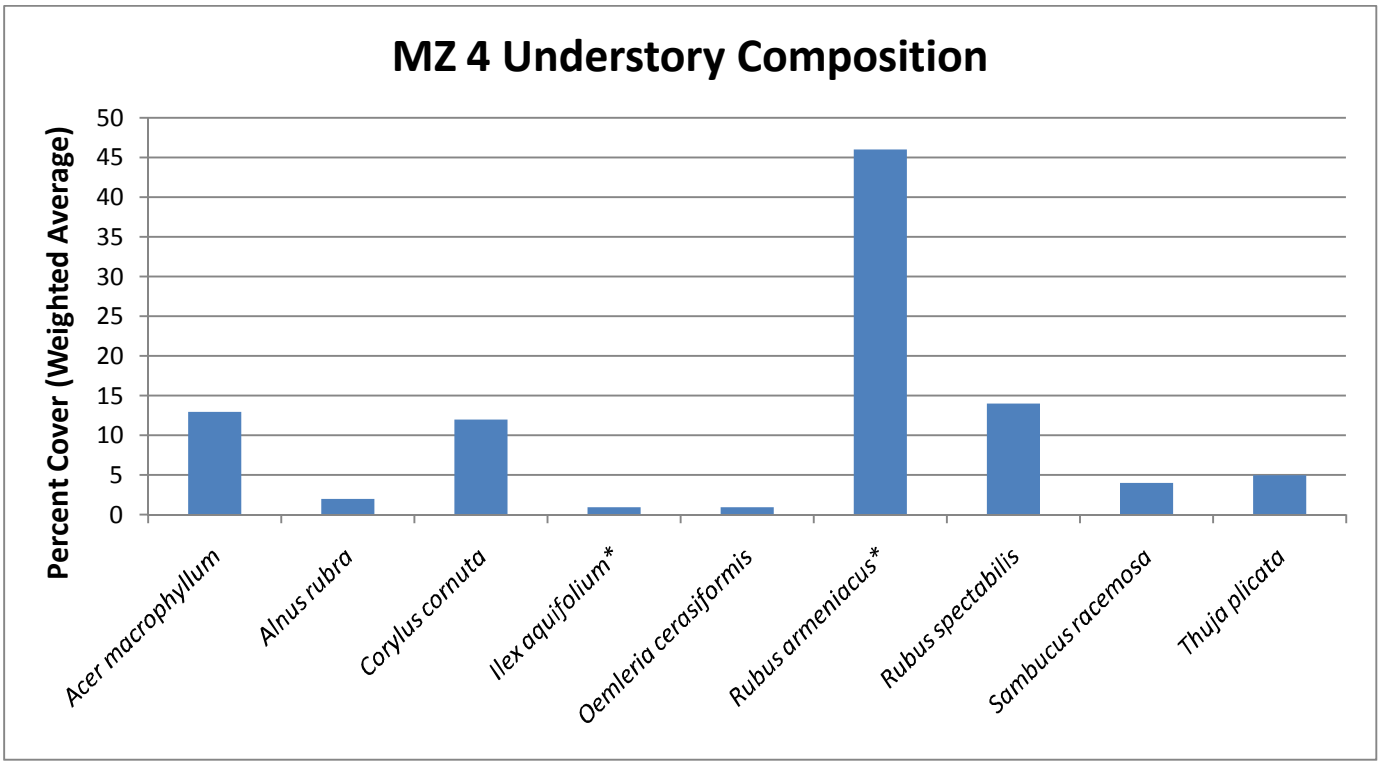
* - indicates an invasive species

3.2.4.2 MZ 4 Understory

The understory of MZ 4 is dominated by an invasive species, *R. armeniacus* (Himalayan blackberry) (Figure 3-14). *R. armeniacus* was present in the understory layer of 12 of the 20 subplots sampled in MZ 4 and where present, it had an average cover of 42% (Table 3-13). The largest infestation of *R. armeniacus* observed within Salmon Creek Ravine is located in Transect 27 (Map 5). Almost the entire understory of this transect (mapped as "shrubland" by EarthCorps- Map 2) is covered by *R. armeniacus*

with few other species present in the understory. The general quadrat descriptions in Appendix A provide additional detail about conditions within this transect.

Figure 3-14. Percent cover of species sampled in the understory layer of MZ 4



Notes: The graph only shows data for species that were present in the understory layer at 1% cover or greater. Species identified that were present at less than 1% cover were *P. avium* (sweet cherry), *P. menziesii* (Douglas fir), *S. aucuparia** (European mountain ash), *S. albus* (snowberry) and *V. parvifolium* (red huckleberry); information is provided for these species in Table 3-13. The presence of an asterisk (*) indicates an invasive species.

Table 3-13. Number of sampling subplots in MZ 4 in which each understory species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	4	37
Alnus rubra	1	20
Corylus cornuta	5	27
*Ilex aquifolium**	1	15
Oemleria cerasiformis	2	4
*Prunus avium**	1	5
Pseudotsuga menziesii	1	3
*Rubus armeniacus**	12	42

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Rubus spectabilis	5	31
Sambucus racemosa	7	6
*Sorbus aucuparia**	1	5
Symphoricarpos albus	1	3
Thuja plicata	1	60
Vaccinium parvifolium	1	3

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

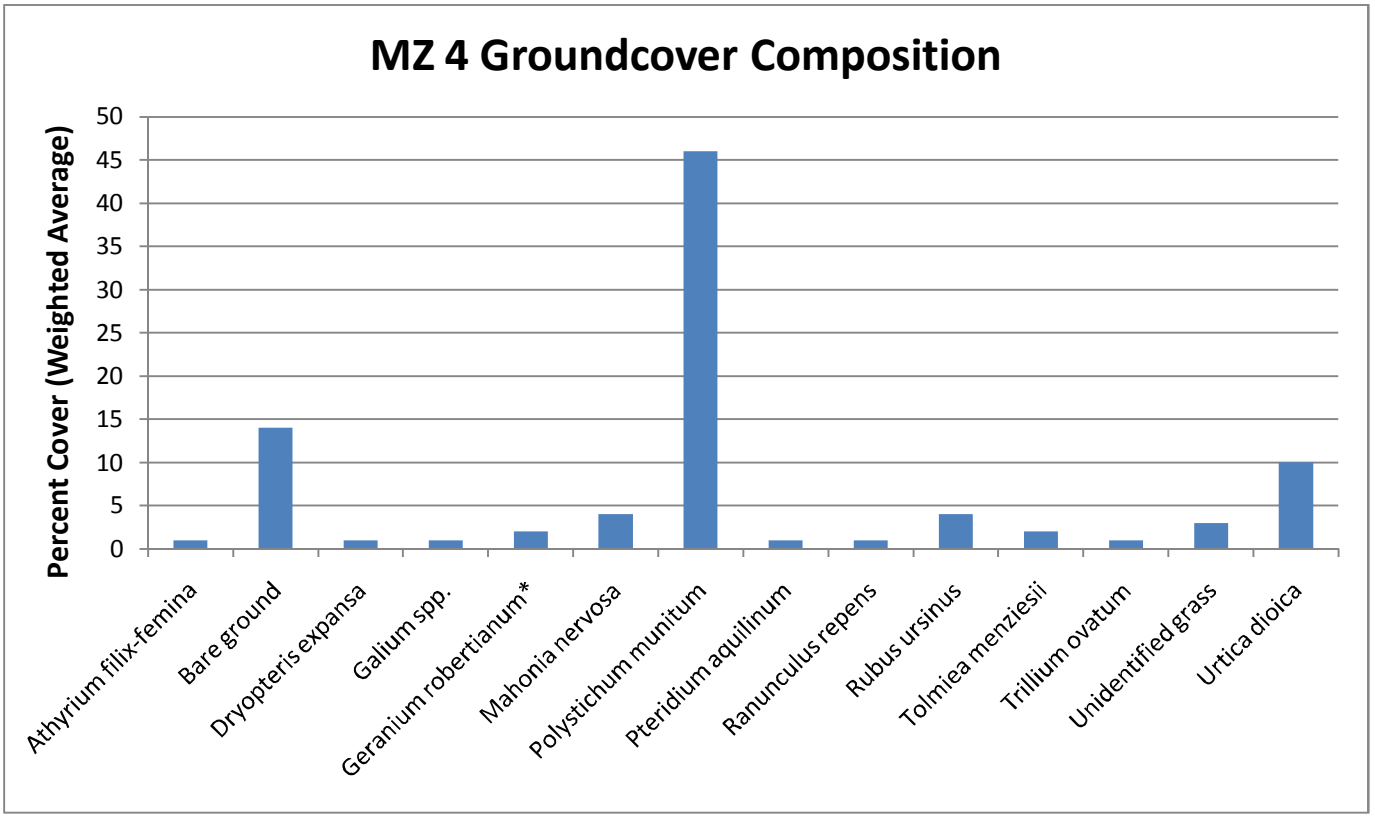
Secondary dominant native species within MZ 4 were: *C. cornuta* (beaked hazelnut), present at an average cover of 12%; *A. macrophyllum* (bigleaf maple), present at an average cover of 13%; and *R. spectabilis* (salmonberry), present at an average cover of 14% (Figure 3-14). There were several non-dominant native species identified in the understory of MZ 4 including *T. plicata* (western red cedar), *A. rubra* (red alder), *S. racemosa* (red elderberry) and *O. cerasiformis* (Indian plum). Invasive species present at 1% cover or less for the MZ overall were *I. aquifolium* (English holly), *P. avium* (sweet cherry) and *S. aucuparia* (European mountain ash). Figure 3-14 and Table 3-13 provide additional information about the distribution of understory species in MZ 4.

3.2.4.3 MZ 4 Groundcover

The groundcover of MZ 4 is dominated by *P. munitum* (sword fern), which is present at an average cover of 46% for the zone as a whole (Figure 3-15). *P. munitum* was present in the groundcover layer of 15 of the 20 subplots sampled in MZ 4, and where present it had an average cover of 29% (Table 3-14). Other native species in the groundcover layer included: *U. dioica* (stinging nettle), present at an average cover of 10%; *M. nervosa* (dull Oregon grape), present at an average cover of 4%; and *R. ursinus* (trailing blackberry), present at an average cover of 4%, among many others present at low percentages (Figure 3-15). The invasive species sampled within the groundcover layer of MZ 4 were *G. robertianum* (herb Robert), *H. helix* (English ivy), *P. arundinacea* (reed canarygrass), *R. laciniatus* (evergreen blackberry) and *P. avium* (sweet cherry seedlings)[13]; these were all present in only trace amounts. Figure 3-15 and Table 3-14 provide additional information about the distribution of groundcover species in MZ 4.

[13] *P. avium* was present in all three vegetation layers in MZ 4.

Figure 3-15. Percent cover of species sampled in the groundcover layer of MZ 4



Notes: The graph only shows data for species that were present in the groundcover layer at 1% cover or greater. Species identified that were present at less than 1% cover were *A. macrophyllum* (bigleaf maple seedlings), A. triphylla (vanilla leaf), *A. rubra* (red alder seedlings), *C. alpina* (enchanter's nightshade), *C. sibirica* (Siberian miner's lettuce), *E. augustifolium* (fireweed), *E. ciliatum* (purple leaved willowherb), *G. shallon* (salal), *G. macrophyllum* (large-leaved avens), *H. helix** (English ivy), *L. communis* (nipplewort), *P. arundinacea** (reed canarygrass), *P. avium** (sweet cherry seedlings), *R. laciniatus* (evergreen blackberry), *S. racemosa* (false Solomon's seal), *T. grandiflora* (fringecup), *T. repens* (white clover) and an unidentified sedge; information is provided for these species in Table 3-14. The presence of an asterisk (*) indicates an invasive species.

Table 3-14. Number of sampling subplots in MZ 4 in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	**No. of Subplots Where Present**	**Average Percent Cover for Subplots Where Present**
Acer macrophyllum (seedlings)	1	3
Achlys triphylla	1	3
Alnus rubra (seedlings)	1	3
Athyrium filix-femina	4	4
Bare ground	3	45
Circaea alpina	1	3
Claytonia sibirica	2	3

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Dryopteris expansa	3	4
Epilobium augustifolium	1	5
Epilobium ciliatum	1	5
Galium spp.	4	3
Gaultheria shallon	1	3
*Geranium robertianum**	5	3
Geum macrophyllum	2	3
*Hedera helix**	2	3
Lapsana communis	1	3
Mahonia nervosa	7	5
*Phalaris arundinacea**	1	3
Polystichum munitum	15	29
*Prunus avium** (seedlings)	1	3
Pteridium aquilinum	2	7
Ranunculus repens	2	7
*Rubus laciniatus**	1	3
Rubus ursinus	10	4
Smilacina racemosa	1	3
Tellima grandiflora	1	3
Tolmiea menziesii	2	9
Trifolium repens	1	3
Trillium ovatum	3	3
Unidentified grass	1	30
Unidentified sedge	1	3
Urtica dioica	11	9

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

3.2.5 Management Zone 5

MZ 5 is located to the southwest of MZ 4, southeast of the gravel access road (Map 7). This zone is approximately 13 ac in size and includes two tributaries to the main branch of Salmon Creek. These tributaries flow generally east to west down a western-facing slope to join the main branch of the creek. The MZ also contains the pedestrian trail that breaks off from the gravel access road and ascends to join the upper pedestrian trail. Three sampling transects are located within MZ 5 (Transects 13, 15 and 16).[14]

[14] Transect 13 spanned the boundary of MZs 5 and 9. The data for this transect were included in the analysis of both of these MZs because conditions within a transect spanning two zones can be used to help characterize both zones.

3.2.5.1 MZ 5 Canopy

The canopy of MZ 5 is dominated by *A. macrophyllum* (bigleaf maple), which is present at an average percent cover of 73% throughout the zone (Figure 3-16). Four of the 15 subplots sampled in MZ 5 contained *A. macrophyllum* stems; in these subplots, *A. macrophyllum* had an average cover of 44% (Table 3-15). Other native canopy species sampled in the suplots of MZ 5 were *P. emarginata* (bitter cherry), present at an average cover of 13%; *A. rubra* (red alder), present at an average cover of 10%; and *A. menziesii* (Pacific madrone), present at an average cover of 4% (Figure 3-16). Based on the qualitative surveys of the larger sampling quadrats (8 m x 10 m) in MZ 5, *P. menziesii* (Douglas fir) was a secondary dominant species in the canopy of three of the five quadrats within Transect 13, and *T. heterophylla* (western hemlock) was present in one quadrat of each Transects 15 and 16 (Appendix A).

Figure 3-16. Percent cover of species sampled in the canopy layer of MZ 5

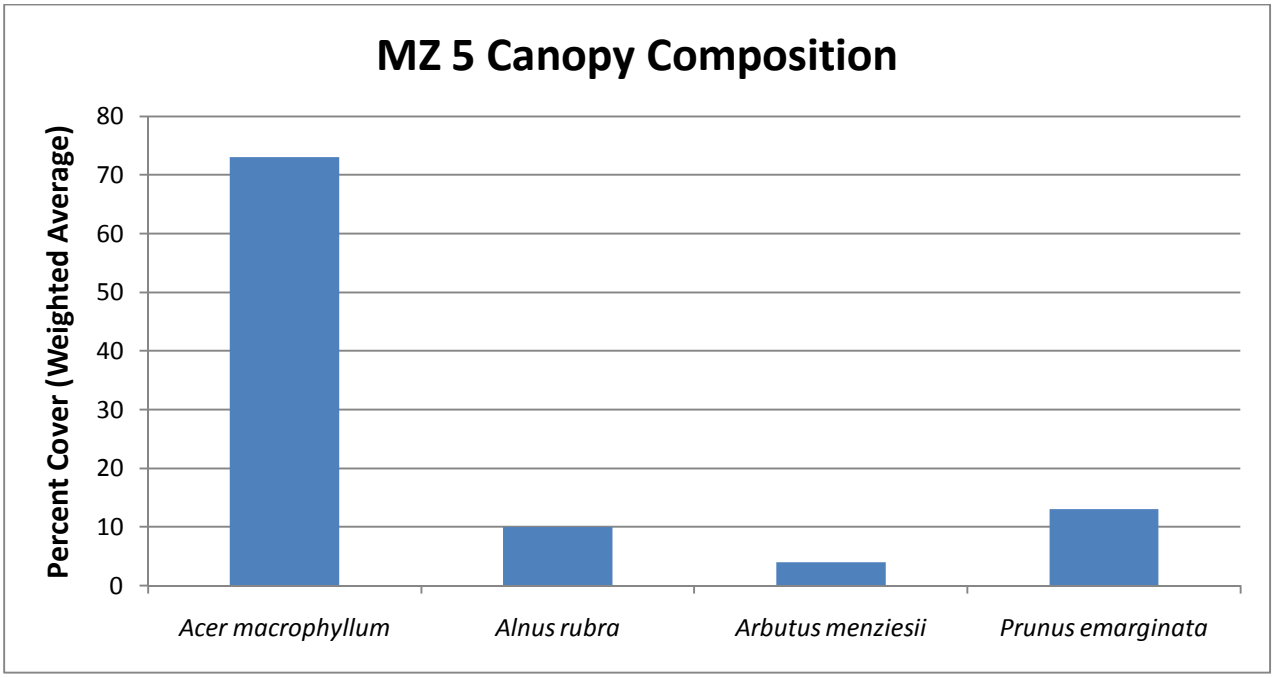


Table 3-15. Number of sampling subplots in MZ 5 in which each canopy species was identified and the average percent cover of each species within those subplots

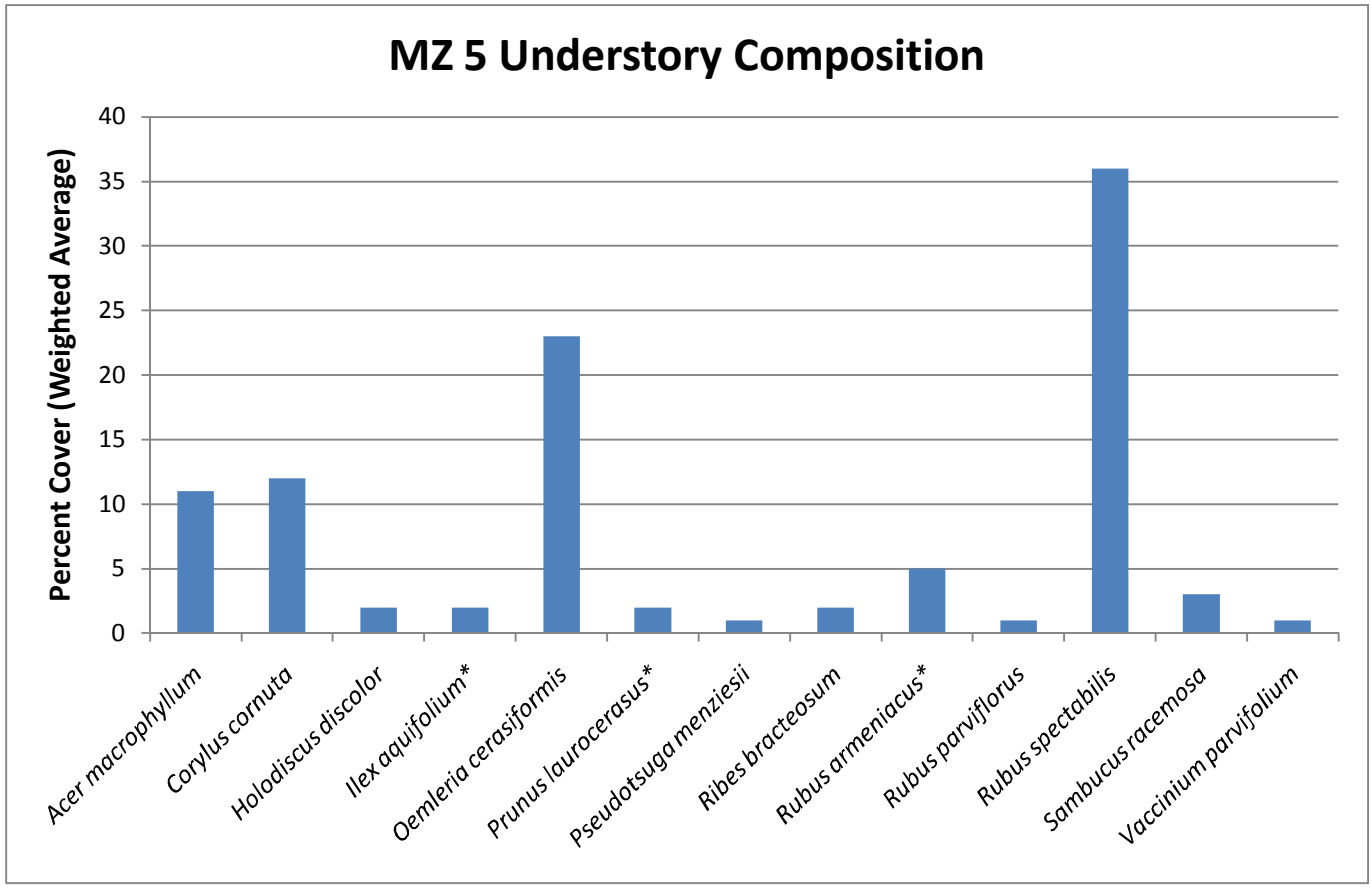
Species	No. of Subplots Where Present[a]	Average Percent Cover for Subplots Where Present
Acer macrophyllum	4	44
Alnus rubra	1	25
Arbutus menziesii	1	10
Prunus emarginata	1	30

[a] Indicates the number of subplots in which the trunk of a canopy –reaching tree was present.

3.2.5.2 MZ 5 Understory

The understory of MZ 5 is dominated by *R. spectabilis* (salmonberry) and *O. cerasiformis* (Indian plum), present at average covers of 36% and 23%, respectively, throughout the zone (Figure 3-17). *R. spectabilis* was present in the understory layer of 5 of the 15 subplots sampled in MZ 5 and where present, it had an average cover of 45% (Table 3-16). *O. cerasiformis* was present in the understory layer of seven subplots at an average cover of 21%. Secondary dominant native species in the understory layer were: *C. cornuta* (beaked hazelnut), present at an average cover of 12%; and *A. macrophyllum* (bigleaf maple), at an average cover of 11% (Figure 3-17). Several other native species were identified in the understory of MZ 5 including *P. menziesii* (Douglas fir) understory trees and shrubs such as *H. discolor* (oceanspray) and *R. bracteosum* (stink currant). Figure 3-17 and Table 3-16 provide additional information about the distribution of understory species in MZ 5.

Figure 3-17. Percent cover of species sampled in the understory layer of MZ 5



Notes: The graph only shows data for species that were present in the understory layer at 1% cover or greater. Species identified that were present at less than 1% cover were *V. ovatum* (evergreen huckleberry) and *S. aucuparia** (European mountain ash); information is provided for these species in Table 3-16. The presence of an asterisk (*) indicates an invasive species.

Table 3-16. Number of sampling subplots in MZ 5 in which each understory species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	5	14
Corylus cornuta	3	25
Holodiscus discolor	1	10
*Ilex aquifolium**	2	8
Oemleria cerasiformis	7	21
*Prunus laurocerasus**	1	10
Pseudotsuga menziesii	1	5
Ribes bracteosum	3	4
*Rubus armeniacus**	3	10
Rubus parviflorus	2	4
Rubus spectabilis	5	45
Sambucus racemosa	2	9
*Sorbus aucuparia**	1	3
Vaccinium ovatum	1	3
Vaccinium parvifolium	2	3

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

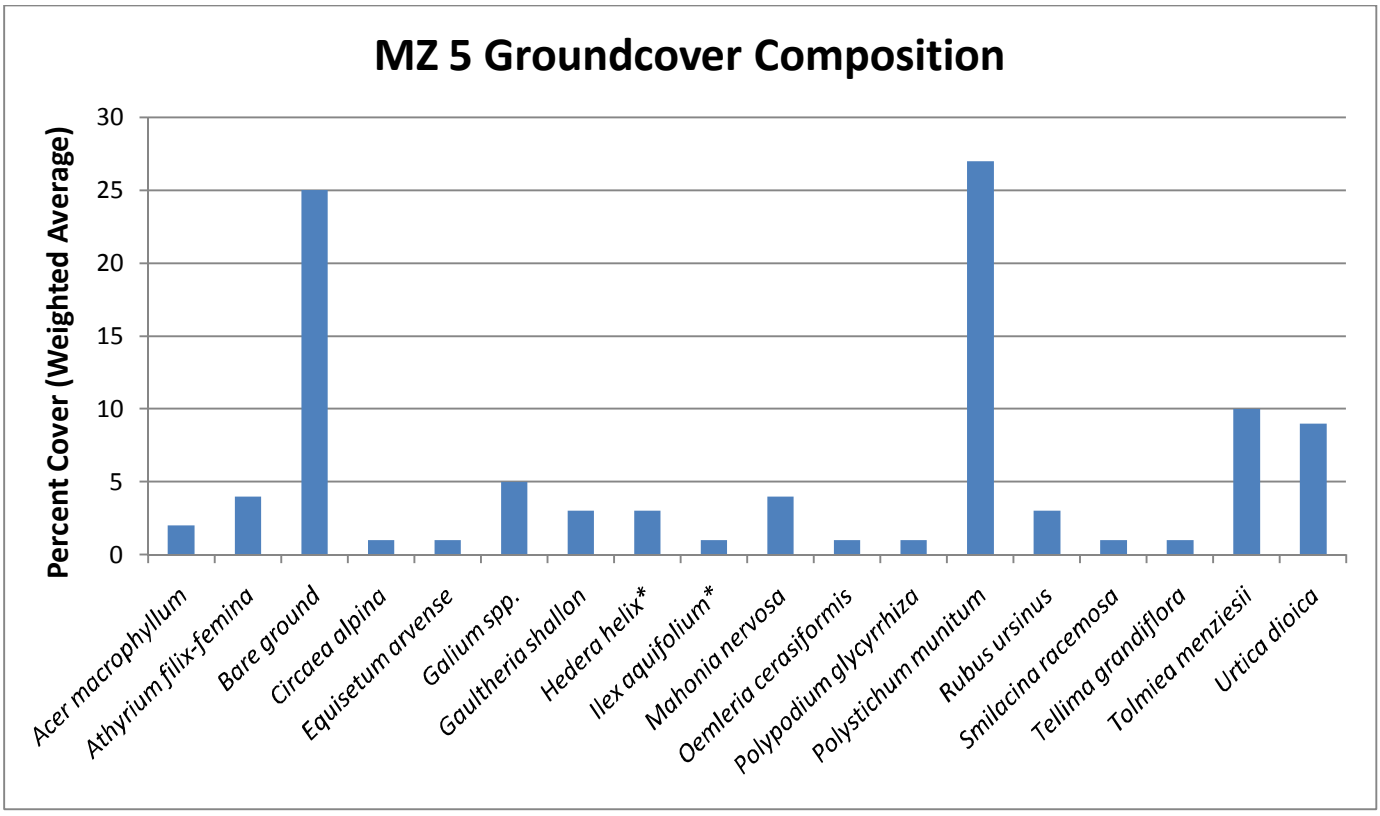
Invasive species sampled in the understory of MZ 5 were: *R. armeniacus* (Himalayan blackberry), present at an average cover of 5%; and *I. aquifolium* (English holly) and *P. laurocerasus* (English laurel), each present at an average cover of 2% throughout the zone (Figure 3-17). *R. armeniacus* was present in the understory layer of three of the 15 subplots sampled in MZ 5 and where present, it had an average cover of 10% (Table 3-16). *I. aquifolium* was present in the understory layer of two subplots at an average cover of 8%, *P. laurocerasus* and was present in one of the 15 subplots at an average cover of 10%. In addition, *S. aucuparia* (European mountain ash) was present in trace amounts in one subplot in MZ 5 (Table 3-16).

3.2.5.3 MZ 5 Groundcover

The groundcover of MZ 5 is dominated by *P. munitum* (sword fern), which is present at an average cover of 27% for the zone as a whole (Figure 3-18). *P. munitum* was present in the groundcover layer of 13 of the 15 subplots sampled in MZ 5, and where present it had an average cover of 25% (Table 3-17). A significant amount of bare ground (areas without vegetation) was also observed in MZ 5; the overall average cover of bare ground was 25% throughout the zone (Figure 3-18). Secondary dominant native species in the groundcover layer were: *T. menziesii* (youth-on-age), present at an average cover of 10%; and *U. dioica* (stinging nettle), present at an average cover of 9%. In addition, there were several non-dominant native species present in the groundcover layer including *Galium* spp. (cleavers or bedstraw), *M. nervosa* (dull Oregon grape) and *A. filix-femina* (lady fern). The invasive species sampled within the

groundcover layer of MZ 5 were *H. helix* (English ivy), *I. aquifolium* (English holly), and *P. arundinacea* (reed canarygrass); these were all present in only trace amounts. Figure 3-18 and Table 3-17 provide additional information about the distribution of groundcover species in MZ 5.

Figure 3-18. Percent cover of species sampled in the groundcover layer of MZ 5



Notes: The graph only shows data for species that were present in the groundcover layer at 1% cover or greater. Species identified that were present at less than 1% cover were *P. arundinacea** (reed canarygrass), *R. repens* (creeping buttercup) and *Rumex* spp. (dock); information is provided for these species in Table 3-17. The presence of an asterisk (*) indicates an invasive species.

Table 3-17. Number of sampling subplots in MZ 5 in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum (seedlings)	6	3
Athyrium filix-femina	3	15
Bare ground	7	44
Circaea alpina	2	3
Equisetum arvense	2	3
Galium spp.	5	13
Gaultheria shallon	3	12

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
*Hedera helix**	5	8
*Ilex aquifolium** (seedlings)	2	3
Mahonia nervosa	5	9
Oemleria cerasiformis	2	4
*Phalaris arundinacea**	1	3
Polypodium glycyrrhiza	2	3
Polystichum munitum	13	25
Ranunculus repens	1	3
Rubus ursinus	8	4
Rumex spp.	1	3
Smilacina racemosa	3	3
Tellima grandiflora	4	3
Tiarella trifoliata	1	3
Tolmiea menziesii	4	30
Urtica dioica	12	9

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

3.2.6 Management Zone 6

MZ 6 is located to the south of MZ 5 (Map 7). This zone includes the central portion of the eastern side of Salmon Creek Ravine. The southern and western boundaries of the MZ are delineated by the upper pedestrian trail. The northern boundary is marked by a portion of the upper pedestrian trail that follows a topographic ridge. MZ 6 is approximately 10 ac in size and it is topographically diverse containing ravine ridges, walls and bottoms. Seasonal tributaries to the middle branch of Salmon Creek run through the ravine bottoms; however, these areas were dry at the time of the vegetation assessment in the summer of 2010. Four sampling transects are located within MZ 6 (Transects 6, 7, 8 and 12).

3.2.6.1 MZ 6 Canopy

The canopy of MZ 6 is dominated by *A. macrophyllum* (bigleaf maple) and *A. menziesii* (Pacific madrone), which are present at an average cover of 35% and 24%, respectively, throughout the zone (Figure 3-19). Seven of the 20 subplots sampled in MZ 6 contained *A. macrophyllum* in the canopy; in these subplots, *A. macrophyllum* had an average cover of 29% (Table 3-18). Nine subplots contained *A. menziesii* in the canopy; in these subplots *A. menziesii* had an average cover of 16%. Secondary dominant native canopy species were *P. menziesii* (Douglas fir), present at an average cover of 19% and *A. rubra* (red alder), present at an average cover of 15% (Figure 3-19). Non-dominant species sampled in MZ 6 were *C. nuttallii* (Pacific dogwood) (at an average cover of 5% throughout the zone) and *T. heterophylla* (western hemlock) (at an average cover of 2%). Based on the qualitative surveys of the larger sampling quadrats (8 m x 10 m) in MZ 6, small quantities of *T. plicata* (western red cedar) and *P. emarginata* (bitter cherry) are also present in MZ 6 (see Appendix A). No invasive tree species were identified in the canopy of this zone.

Figure 3-19. Percent cover of species sampled in the canopy layer of MZ 6

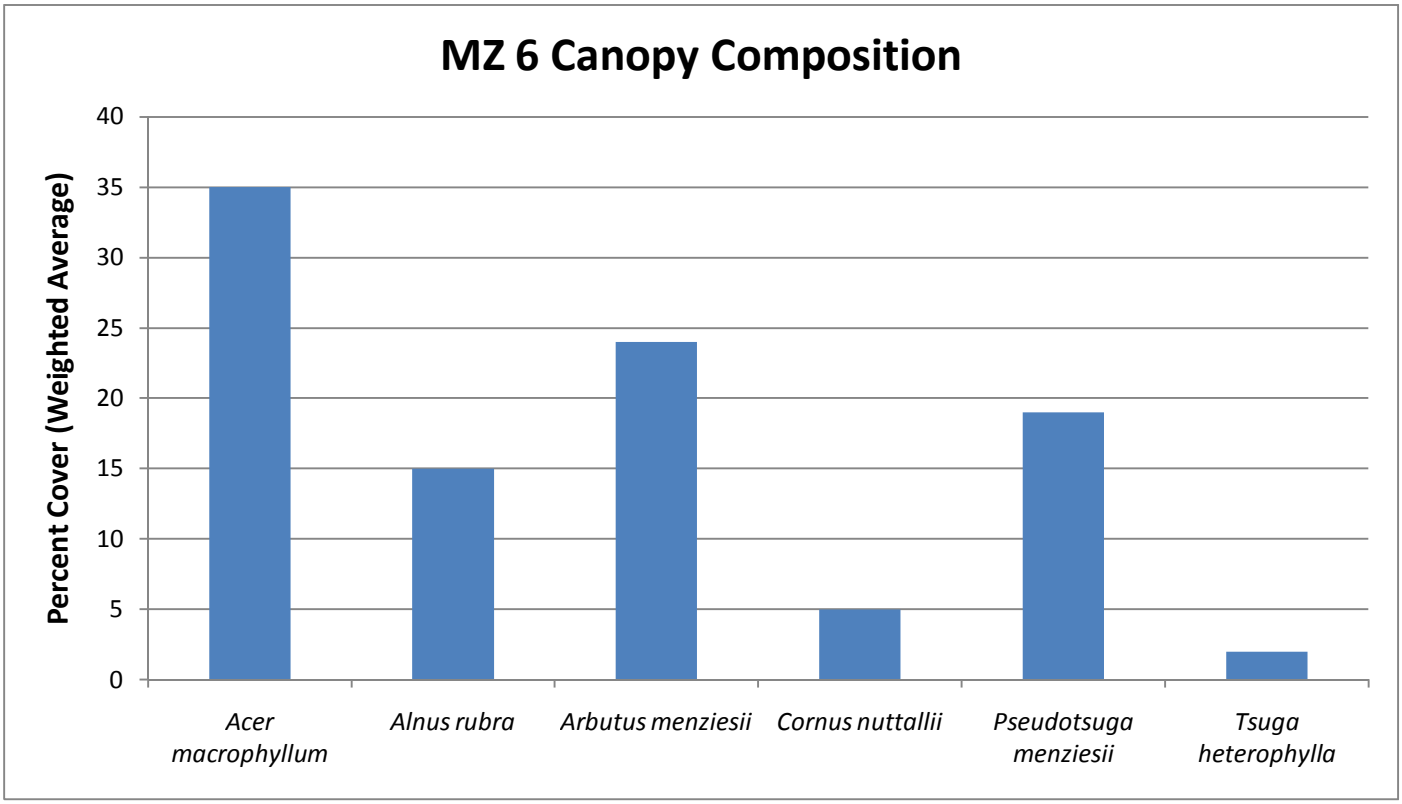


Table 3-18. Number of sampling subplots in MZ 6 in which each canopy species was identified and the average percent cover of each species within those subplots

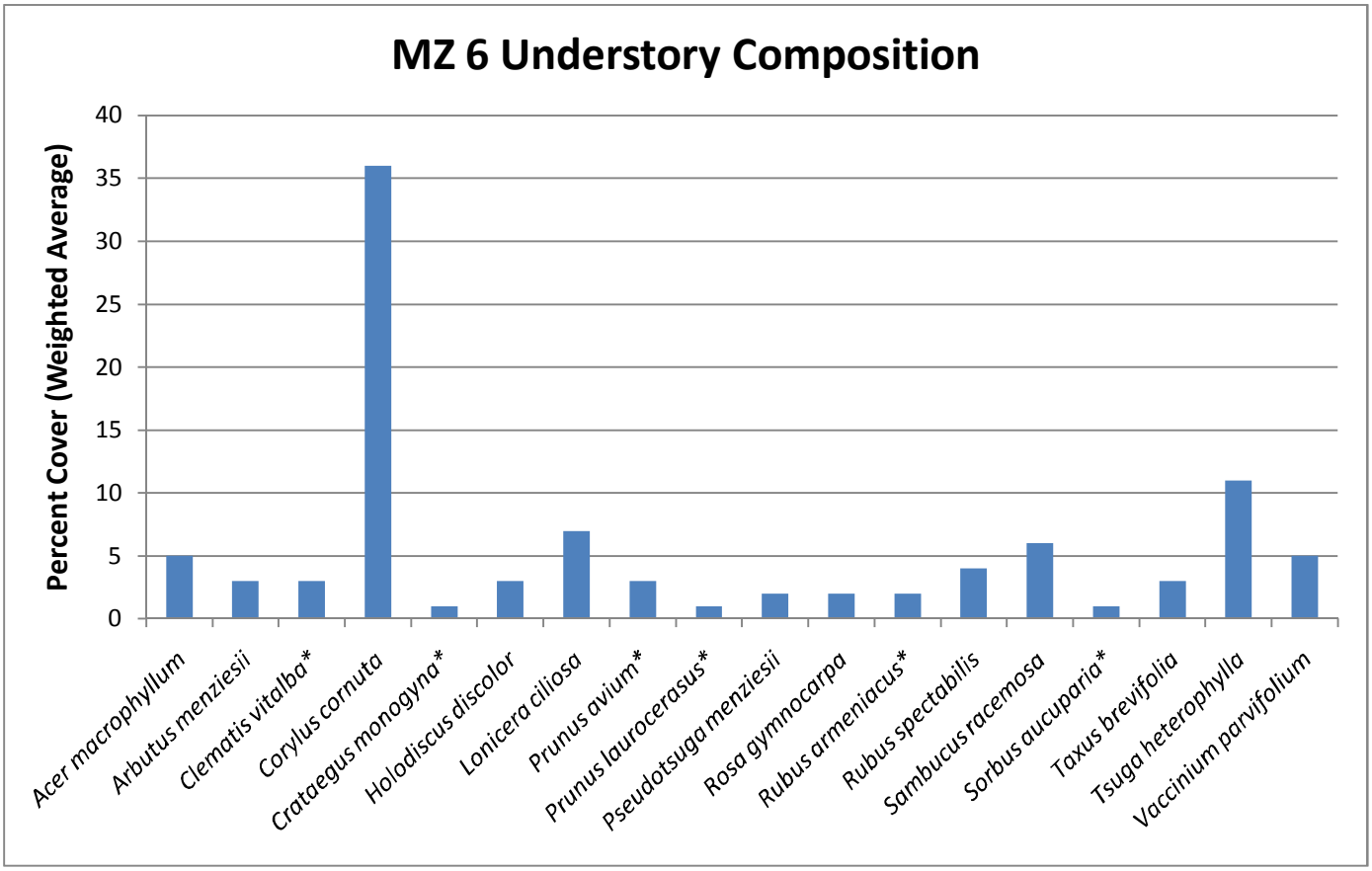
Species	No. of Subplots Where Present[a]	Average Percent Cover for Subplots Where Present
Acer macrophyllum	7	29
Alnus rubra	3	28
Arbutus menziesii	9	16
Cornus nuttallii	2	15
Pseudotsuga menziesii	2	55
Tsuga heterophylla	1	10

[a] Indicates the number of subplots in which the trunk of a canopy –reaching tree was present.

3.2.6.2 MZ 6 Understory

The understory of MZ 6 is dominated by *C. cornuta* (beaked hazelnut), present at average cover of 36% throughout the zone (Figure 3-20). Several other native species were present in the understory at an overall cover ranging from 2% (*P. menziesii* and *R. gymnocarpa)* to 11% (*T. heterophylla*). One of the highest overall coverages by *L. ciliosa* (orange honeysuckle) in Salmon Creek Ravine was observed in this zone (7%). Figure 3-20 and Table 3-19 provide additional information about all native species identified in the understory of MZ 6.

Figure 3-20. Percent cover of species sampled in the understory layer of MZ 6



Notes: The percent cover of *C. vitalba** (old man's beard) and *P. avium** (sweet cherry) are estimates; these two species were each present in one subplot in the MZ; however, their percent cover in these subplots was not recorded in the field. The presence of an asterisk (*) indicates an invasive species.

Table 3-19. Number of sampling subplots in MZ 6 in which each understory species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	4	4
Arbutus menziesii	2	5
*Clematis vitalba**	1	nr
Corylus cornuta	4	28
*Crataegus monogyna**	1	3
Holodiscus discolor	1	10
Lonicera ciliosa	3	8
*Prunus avium**	1	nr
*Prunus laurocerasus**	1	3

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Pseudotsuga menziesii	2	3
Rosa gymnocarpa	2	3
*Rubus armeniacus**	1	5
Rubus spectabilis	3	4
Sambucus racemosa	2	10
*Sorbus aucuparia**	1	3
Taxus brevifolia	1	nr
Tsuga heterophylla	3	12
Vaccinium parvifolium	3	5

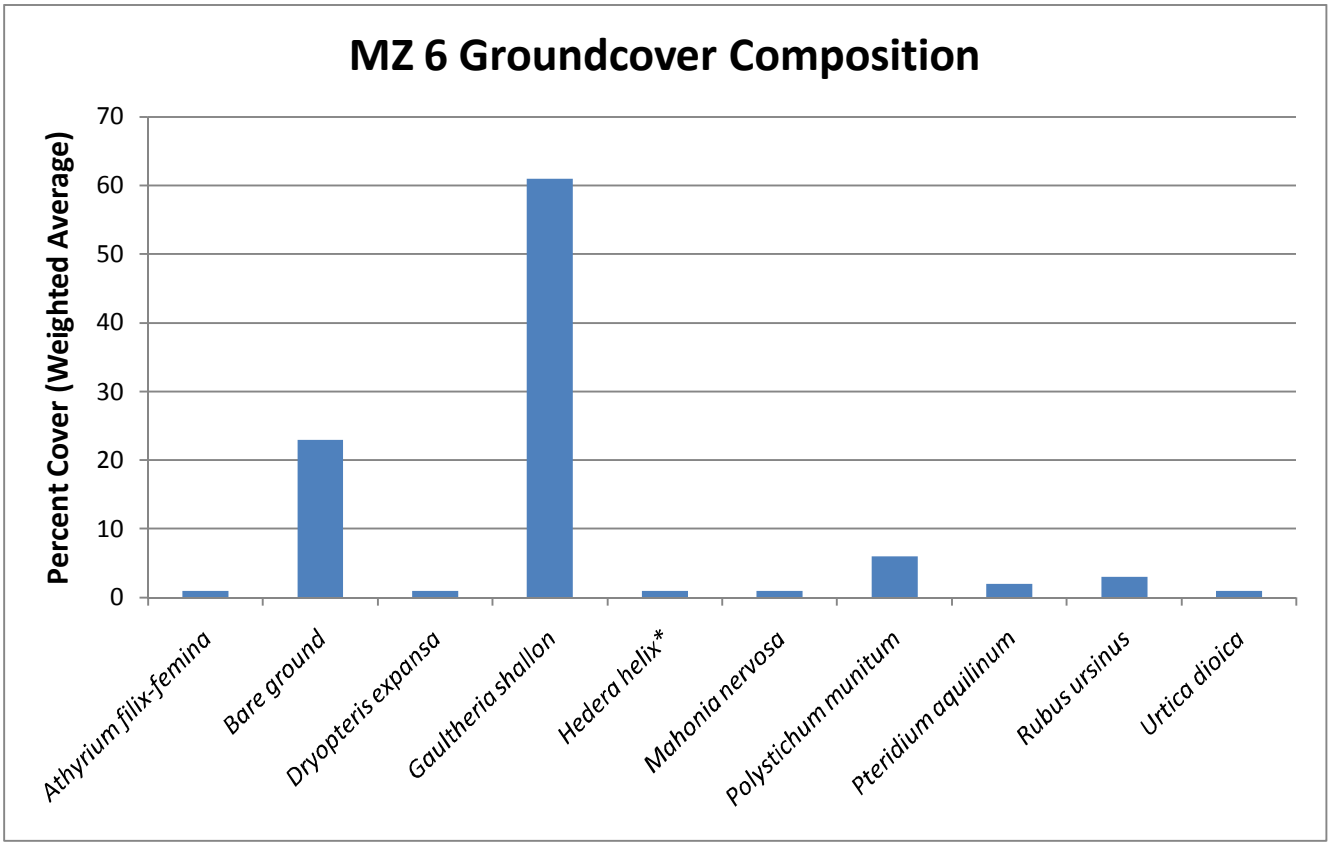
Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

Several invasive species were sampled in the understory of MZ 6; however, these species were present in small quantities. *C. vitalba* (old man's beard) and *P. avium* were each present in one subplot (the percent cover of these species was not recorded in the field) (Table 3-19). *P. laurocerasus* (English laurel), *S. aucuparia* (European mountain ash) and *C. monogyna* (English hawthorne) were each present in one of the 15 subplots in trace amounts.

3.2.6.3 MZ 6 Groundcover

The groundcover of MZ 6 is dominated by *G. shallon* (salal), which is present at an average cover of 61% for the zone as a whole (Figure 3-21). *G. shallon* was present in the groundcover layer of 19 of the 20 subplots sampled in MZ 6, and where present it had an average cover of 52% (Table 3-20). A significant amount of bare ground (areas without vegetation) was also observed in MZ 6; the overall average cover of bare ground was 23% throughout the zone (Figure 3-21). Several non-dominant native species were present in the groundcover layer at overall coverages ranging from 1% to 6%; these included *P. munitum* (sword fern), *R. ursinus* (trailing blackberry) and *P. aquilinum* (bracken fern). The only invasive species sampled within the groundcover layer of MZ 6 was *H. helix* (English ivy), present in two subplots at an average cover of 7% (Table 3-20). Figure 3-21 and Table 3-20 provide additional information about the distribution of groundcover species in MZ 6.

Figure 3-21. Percent cover of species sampled in the groundcover layer of MZ 6



Notes: The graph only shows data for species that were present in the groundcover layer at 1% cover or greater. The only species identified at less than 1% cover was *P. menziesii* (Douglas fir seedlings); information is provided for this species in Table 3-20. The presence of an asterisk (*) indicates an invasive species.

Table 3-20. Number of sampling subplots in MZ 6 in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Athyrium filix-femina	2	12
Bare ground	9	42
Dryopteris expansa	1	10
Gaultheria shallon	19	52
*Hedera helix**	2	7
Mahonia nervosa	1	15
Polystichum munitum	10	9
Pseudotsuga menziesii	1	3
Pteridium aquilinum	11	3
Rubus ursinus	10	5

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Urtica dioica	3	3

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

3.2.7 Management Zone 7

MZ 7 is located to the west of MZ 6 (Map 7). This zone is relatively small (approximately 3.5 ac) and it consists of a hummocky wetland area with several small creek rivulets and very mucky soils. This area appears to be the headwaters of the middle branch of Salmon Creek. It is bordered on its north, east and south sides by the upper pedestrian trail. The topography of MZ 7 is relatively flat compared to the other MZs, however it does slope gently to the west. There is only one sampling transect located within MZ 7 (Transect 9) due to its small size.

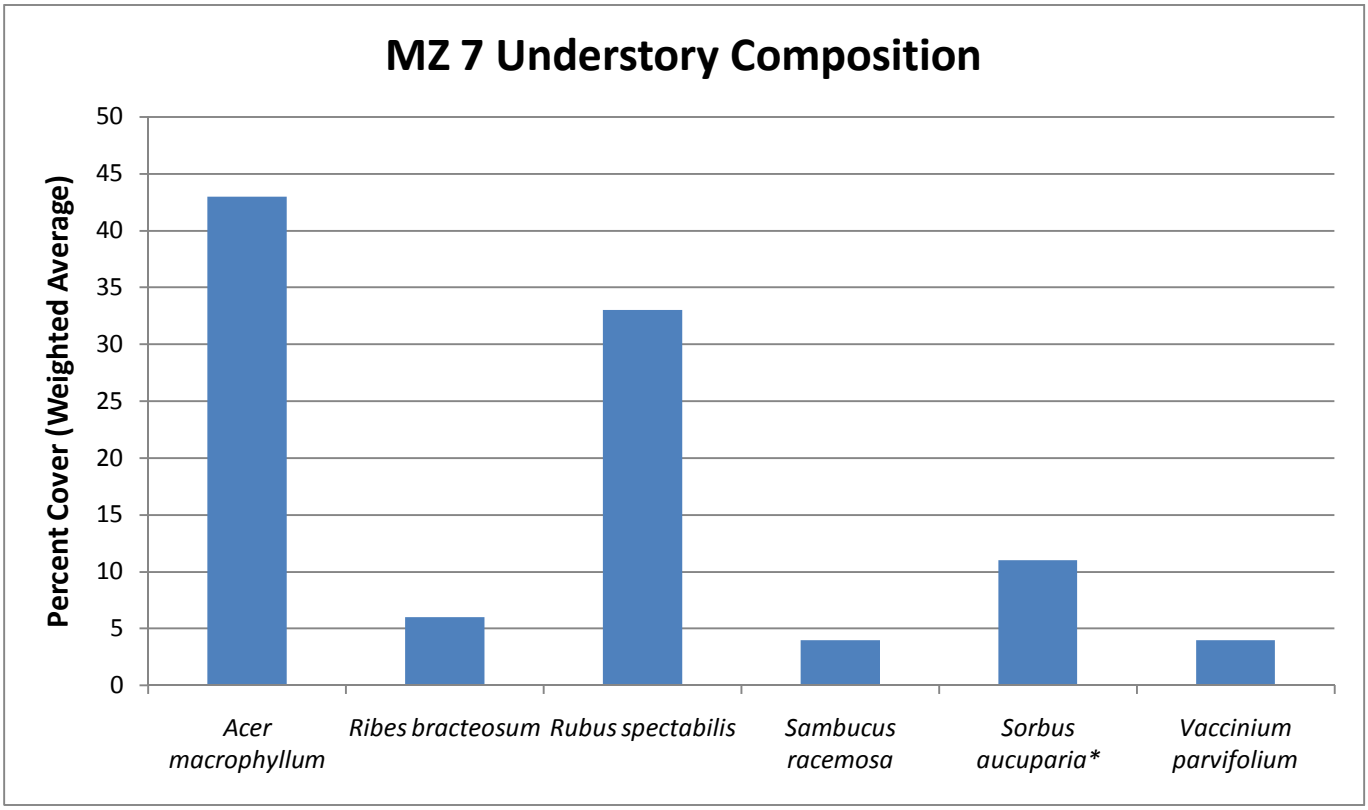
3.2.7.1 MZ 7 Canopy

Only one subplot within MZ 7 contained the stem of a canopy-reaching tree and this specimen was a *T. heterophylla* (western hemlock) tree. Therefore, the qualitative quadrat descriptions in Appendix A were relied upon to provide additional information about the canopy composition in MZ 7. Based on the quadrat-level assessments, the canopy of MZ 7 is dominated by *A. macrophyllum* (bigleaf maple) and *T. heterophylla* (western hemlock) is a secondary dominant species. In addition, some *A. rubra* (red alder) is present in the canopy. No invasive canopy species were identified.

3.2.7.2 MZ 7 Understory

The understory of MZ 7 is dominated by *A. macrophyllum* (bigleaf maple) and *R. spectabilis* (salmonberry), which are present at average covers of 43% and 33%, respectively, throughout the zone (Figure 3-22). *A. macrophyllum* was present in the understory layer of one of the subplots at 60% cover; *R. spectabilis* was present in the understory layer of all 5 of the subplots sampled in MZ 7 and where present, it had an average cover of 9% (Table 3-21). The other native species sampled within the understory layer of MZ 7 were: *R. bracteosum* (stink currant), present at an overall average cover of 6%; and *S. racemosa* (red elderberry) and *V. parvifolium* (red huckleberry), each present at an overall average cover of 4%. The only invasive species sampled within the understory layer of this zone was *S. aucuparia* (European mountain ash) which was present in two of the five subplots at an average cover of 8% (Table 3-21).

Figure 3-22. Percent cover of species sampled in the understory layer of MZ 7



Note: The presence of an asterisk (*) indicates an invasive species.

Table 3-21. Number of sampling subplots in MZ 7 in which each understory species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	1	60
Ribes bracteosum	2	4
Rubus spectabilis	5	9
Sambucus racemosa	2	3
*Sorbus aucuparia**	2	8
Vaccinium parvifolium	2	3

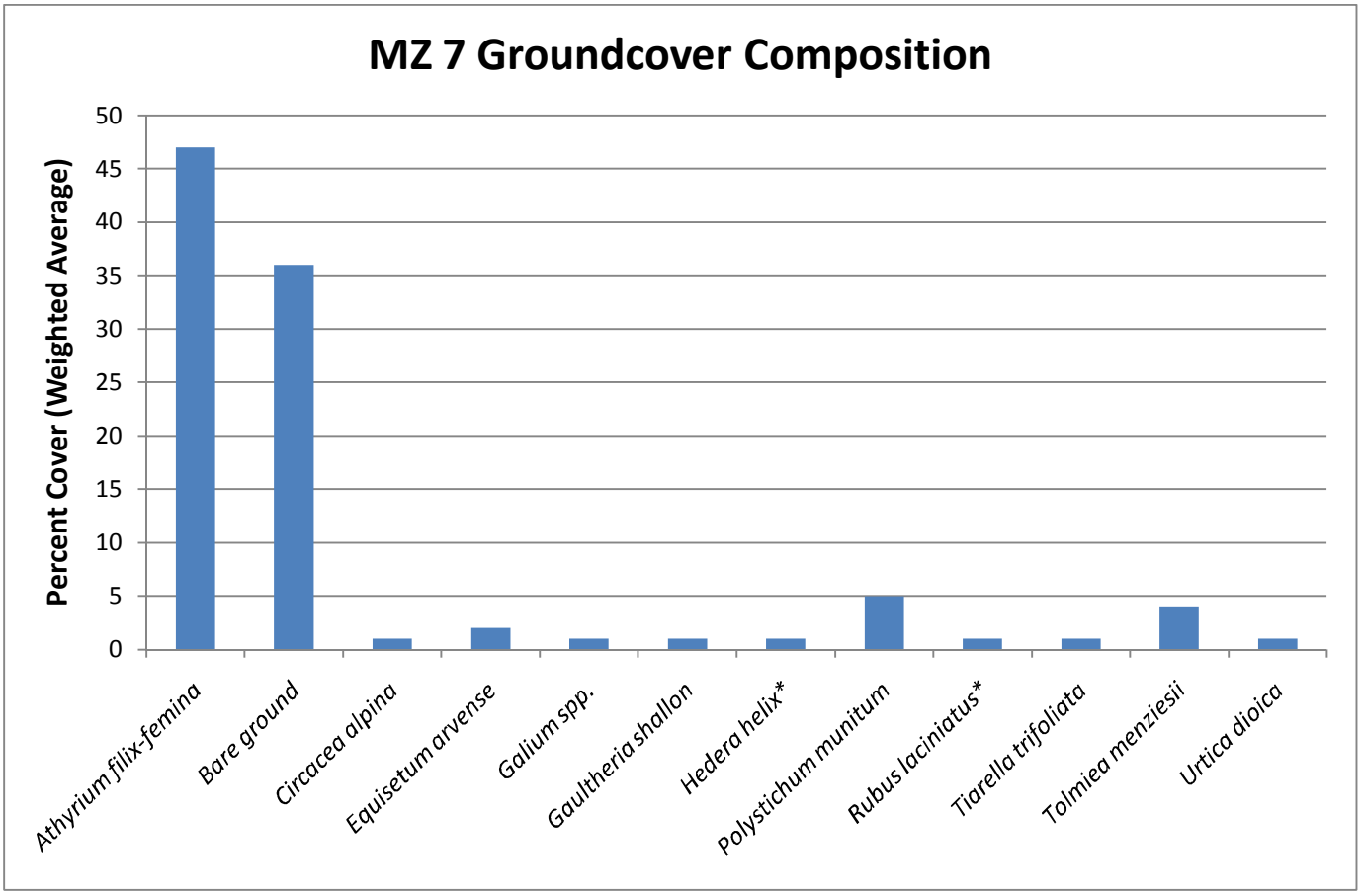
Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

3.2.7.3 MZ 7 Groundcover

The groundcover of MZ 7 is dominated by *A. filix-femina* (lady fern), which is present at an average cover of 47% for the zone as a whole (Figure 3-23). A significant amount of bare ground (areas without vegetation) was also observed in MZ 7; the overall average cover of bare ground was 36% throughout

the zone (Figure 3-23). Several other non-dominant native species were also sampled in the groundcover layer: *P. munitum* (sword fern), at an overall cover of 5%; *T. menziesii* (youth-on-age), at an overall cover of 4%; *E. arvense* (common horsetail), at an overall cover of 2%; and *C. alpina* (enchanter's nightshade), *Galium* spp. (cleavers or bedstraw), *G. shallon* (salal), *T. trifoliata* (foamflower) and *U. dioica* (stinging nettle), each present at an average cover of 1%. The invasive species sampled within the groundcover layer of MZ 7 were *H. helix* (English ivy) and *R. laciniatus* (evergreen blackberry); both were present in low quantities in only one subplot within the MZ (Table 3-22).

Figure 3-23. Percent cover of species sampled in the groundcover layer of MZ 7



Note: The presence of an asterisk (*) indicates an invasive species.

Table 3-22. Number of sampling subplots in MZ 7 in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Athyrium filix-femina	5	39
Bare ground	3	50
Circaea alpina	1	3

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Equisetum arvense	3	3
Galium spp.	1	3
Gaultheria shallon	1	3
*Hedera helix**	1	5
Polystichum munitum	5	4
*Rubus laciniatus**	1	3
Tiarella trifoliata	1	3
Tolmiea menziesii	3	5
Urtica dioica	2	3

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

3.2.8 Management Zone 8

MZ 8 is located at the southern end of Salmon Creek Ravine, south of MZ 6 (Map 6). This zone includes the southern portion of the upper pedestrian trail. The western half of the north boundary of the zone is delineated by the pedestrian trail that extends into Salmon Creek Ravine from Shorewood Drive, and the eastern half of the north boundary is delineated by a ravine bottom which runs east-west perpendicular to the upper pedestrian trail. There is an informal, overgrown path that extends partially into the ravine bottom from the upper pedestrian trail. MZ 8 is approximately 10.5 ac in size and is topographically diverse. The topography of the southern tip of the MZ slopes to the north from 16th Avenue Southwest. The pedestrian trail runs through a topographically low area with ravine walls ascending on either side. The eastern half of MZ 8 contains ravine ridges and bottoms (in addition to the ravine bottom that demarcates the eastern half of the north boundary, Transect 2 is also located in a ravine bottom area). Most of the western half of MZ 8 consists of a steep, northeast-facing ravine wall. Five sampling transects are located within MZ 8 (Transects 1, 2, 3, 4 and 5).[15]

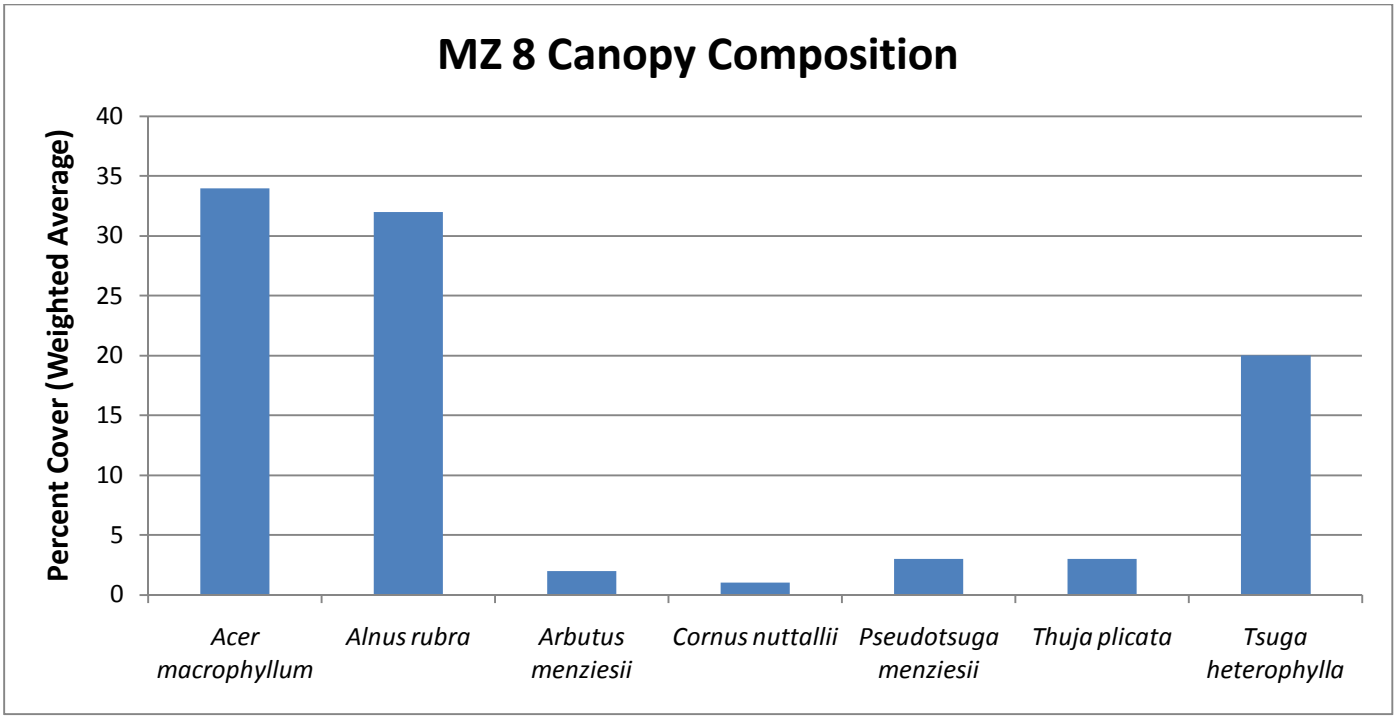
3.2.8.1 MZ 8 Canopy

The canopy of MZ 8 is dominated by *A. macrophyllum* (bigleaf maple), *A. rubra* (red alder) and *T. heterophylla* (western hemlock) (Figure 3-24). *A. macrophyllum* was present at an average percent cover of 34% throughout the zone (Figure 3-24); it was sampled in the canopy layer of two of the 25 subplots at an average cover of 70% in those subplots (Table 3-23). *A. rubra* was present at an average percent cover of 32% throughout the zone; it was sampled in the canopy layer of four of the 25 subplots at an average cover of 33% in those subplots (Table 3-23). *T. heterophylla* was sampled in the canopy layer of three of the 25 subplots at an average cover of 28%; it had an overall average cover of 20% for MZ 8 as a whole. Other native canopy species sampled in the subplots of MZ 8 were: *P. menziesii* (Douglas fir) and *T. plicata* (western red cedar), each present at an average cover of 3% for the zone; *A. menziesii* (Pacific madrone), present at an average cover of 2%; and *C. nuttallii* (Pacific dogwood), present at an average

[15] Transect 5 spanned the boundary of MZs 8 and 9. The data for this transect were included in the analysis of both of these MZs because conditions within a transect spanning two zones can be used to help characterize both zones.

cover of 1% (Figure 3-24). Based on the qualitative surveys of the larger sampling quadrats (8 m x 10 m) in MZ 8, a significant open canopy area and several recently fallen *T. heterophylla* and *A. macrophyllum* trees were observed in Transect 3; this represents a potential root rot pocket (see Appendix A). No invasive species were sampled in the canopy layer of MZ 8.

Figure 3-24. Percent cover of species sampled in the canopy layer of MZ 8



Note: *T. plicata* (western red cedar) was sampled in the canopy layer of only one subplot (in Transect 2) and the percent cover was not recorded; therefore, it is assumed that this species is present in the canopy in only trace amounts (shown as 3% average percent cover on the graph).

Table 3-23. Number of sampling subplots in MZ 8 in which each canopy species was identified and the average percent cover of each species within those subplots

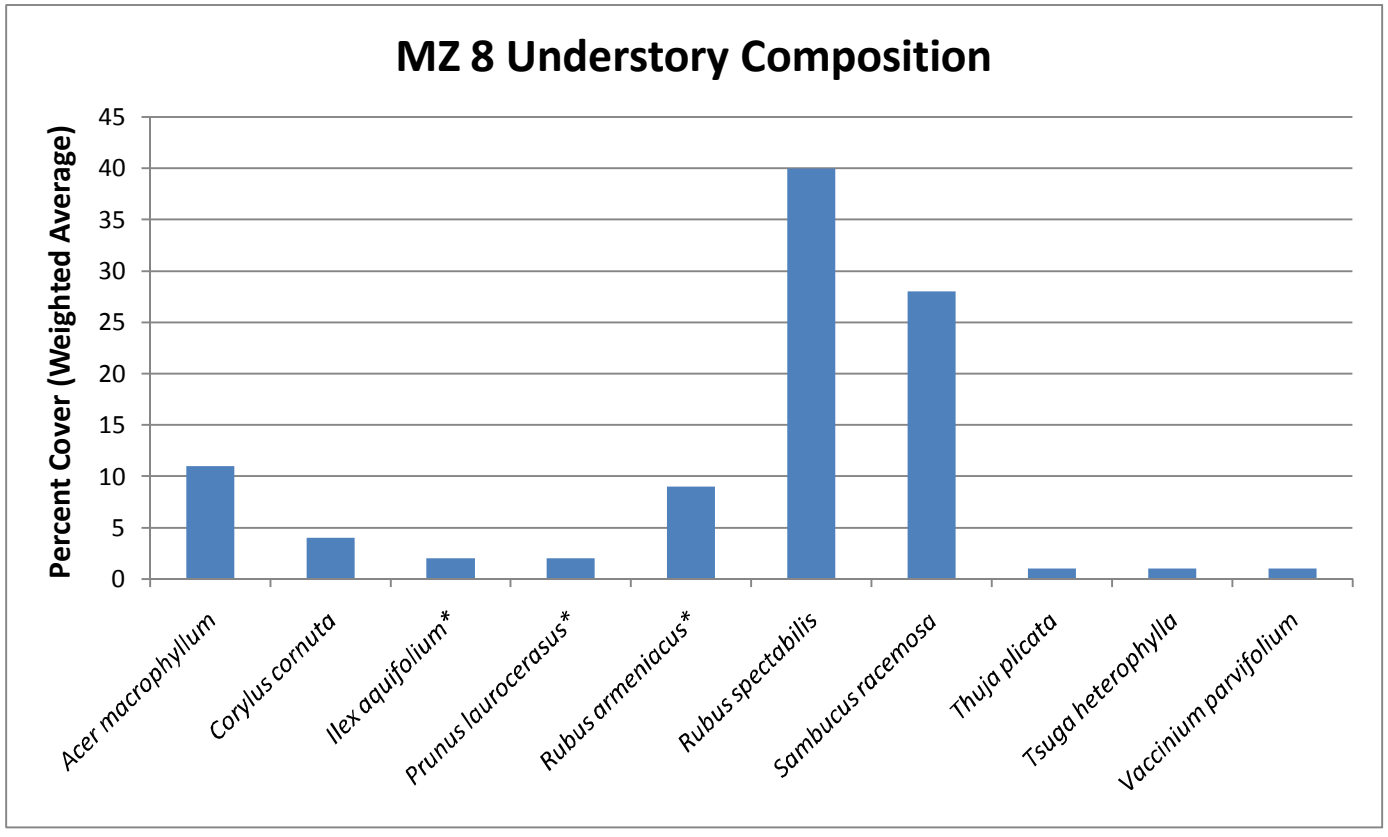
Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	2	70
Alnus rubra	4	33
Arbutus menziesii	1	10
Cornus nuttallii	1	3
Pseudotsuga menziesii	2	7
Thuja plicata	1	nr
Tsuga heterophylla	3	28

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
nr – not recorded

3.2.8.2 MZ 8 Understory

The understory of MZ 8 is dominated by *R. spectabilis* (salmonberry) and *S. racemosa* (red elderberry, present at average covers of 40% and 28%, respectively, throughout the zone (Figure 3-25). *R. spectabilis* was present in the understory layer of 13 of the 25 subplots sampled in MZ 8 and where present, it had an average cover of 25% (Table 3-24). *S. racemosa* was present in the understory layer of 13 subplots at an average cover of 17%. The secondary dominant native species in the understory layer was *A. macrophyllum* (bigleaf maple) which was present at an average cover of 11%. Non-dominant native tree species present in the understory were *T. plicata* (western red cedar), *T. heterophylla* (western hemlock) and *P. menziesii* (Douglas fir), each present at 1% cover or less for the zone overall. Native shrub species present at less than 5% cover included *C. cornuta* (beaked hazelnut), *V. parvifolium* (red huckleberry), *H. discolor* (oceanspray), *R. gymnocarpa* (baldhip rose) and *S. albus* (snowberry). Figure 3-25 and Table 3-24 provide additional information about the distribution of understory species in MZ 8.

Figure 3-25. Percent cover of species sampled in the understory layer of MZ 8



Notes: The graph only shows data for species that were present in the understory layer at 1% cover or greater. Species identified that were present at less than 1% cover were *H. discolor* (oceanspray), *Prunus* spp., *P. menziesii* (Douglas fir), *R. gymnocarpa* (baldhip rose), *S. aucuparia** (European mountain ash), *S. albus* (snowberry) and an unidentified shrub; information is provided for these species in Table 3-24. The presence of an asterisk (*) indicates an invasive species.

Table 3-24. Number of sampling subplots in MZ 8 in which each canopy species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	5	17
Corylus cornuta	6	5
Holodiscus discolor	1	3
*Ilex aquifolium**	4	5
*Prunus laurocerasus**	2	7
Prunus spp.	1	3
Pseudotsuga menziesii	1	3
Rosa gymnocarpa	1	3
*Rubus armeniacus**	4	19
Rubus spectabilis	13	25
Sambucus racemosa	13	17
*Sorbus aucuparia**	1	3
Symphoricarpos albus	1	3
Thuja plicata	2	3
Tsuga heterophylla	2	4
Unidentified shrub	1	3
Vaccinium parvifolium	3	3

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

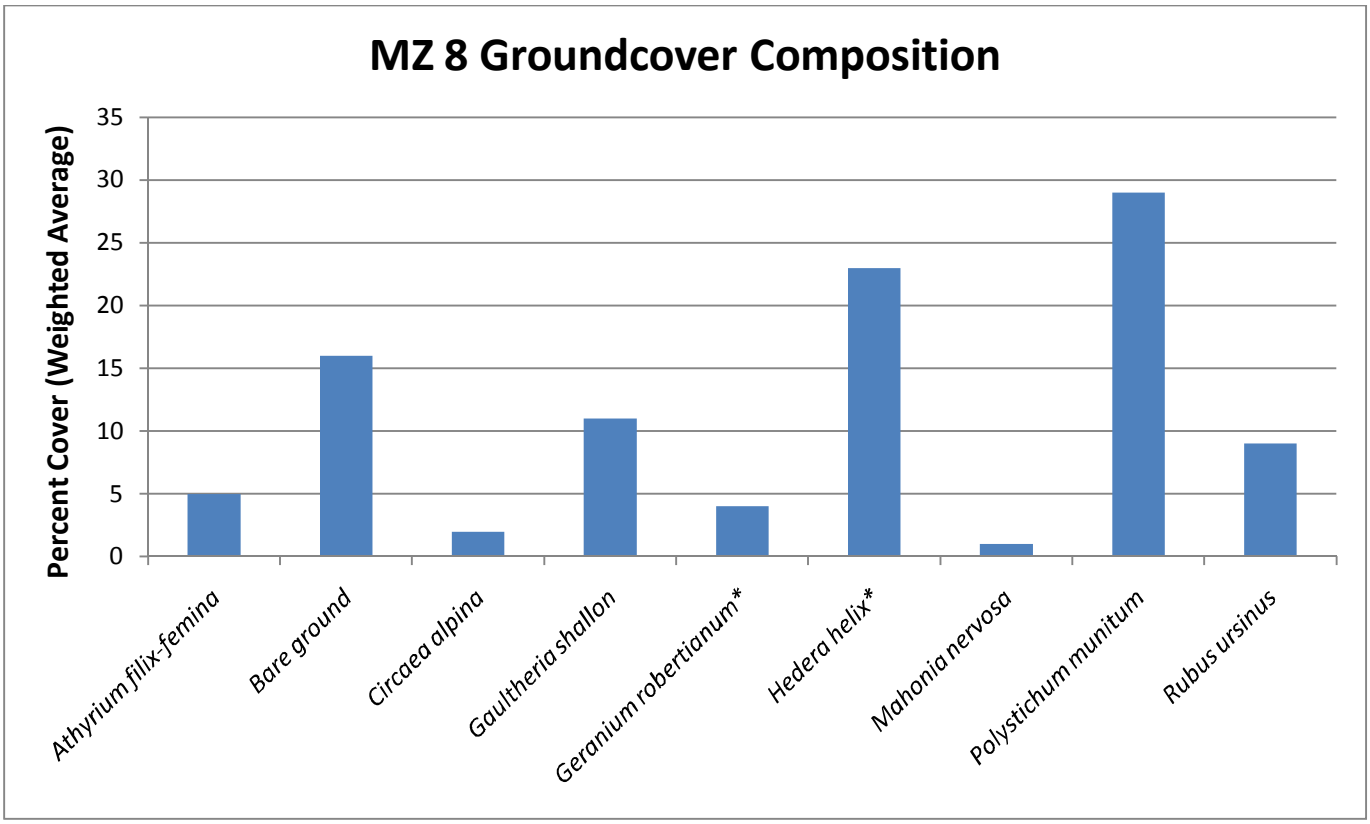
The most abundant invasive species in MZ 8 was *R. armeniacus* (Himalayan blackberry), present at an average cover of 9% for the zone overall (Figure 3-25); this species was sampled in four of the 25 subplots at an average cover of 19% in those subplots (Table 3-24). Other invasive species sampled in MZ 8 were *I. aquifolium* (English holly) and *P. laurocerasus* (English laurel), each present at an average cover of 2%, and *S. aucuparia* (European mountain ash), present at less than 1% overall cover. Based on the qualitative surveys of the larger sampling quadrats (8 m x 10 m) in MZ 8, there was also an infestation of invasive *Polygonum* spp. (knotweed) consisting of approximately 20-25 stems located in the ravine bottom near Transect 3 (see Appendix A). This is the only patch of *Polygonum* spp. that was encountered during the vegetation assessment. Native species present in the surrounding ravine bottom area include *T. heterophylla, M. nervosa, T. ovatum* and *P. menziesii* seedlings. There is also *H. helix* growing in the ravine bottom.

3.2.8.3 MZ 8 Groundcover

The groundcover of MZ 8 is dominated by *P. munitum* (sword fern) and an invasive species, *H. helix* (English ivy). *P. munitum* is present at an average cover of 29% for the zone as a whole (Figure 3-26); it was present in the groundcover layer of 22 of the 25 subplots sampled in MZ 8, and where present it had an average cover of 22% (Table 3-25). *H. helix* is present at an average cover of 23% for the zone as

a whole; it was present in the groundcover layer of 10 subplots at an average cover of 39% (Table 3-25). A significant amount of bare ground (areas without vegetation) was also observed in MZ 8; the overall average cover of bare ground was 16% throughout the zone (Figure 3-26).

Figure 3-26. Percent cover of species sampled in the groundcover layer of MZ 8



Notes: The graph only shows data for species that were present in the groundcover layer at 1% cover or greater. Species identified that were present at less than 1% cover were *A. triphylla* (vanilla leaf), *Galium* spp. (cleavers or bedstraw), *P. aquilinum* (bracken fern), *Ranunculus* spp. (buttercup), *T. grandiflora* (fringecup) and *T. ovatum* (western trillium); information is provided for these species in Table 3-25. The presence of an asterisk (*) indicates an invasive species.

Table 3-25. Number of sampling subplots in MZ 8 in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Achlys triphylla	1	3
Athyrium filix-femina	14	6
Bare ground	7	38
Circacea alpina	9	3
Galium spp.	1	5
Gaultheria shallon	8	23

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
*Geranium robertianum**	4	17
*Hedera helix**	10	39
Mahonia nervosa	3	3
Polystichum munitum	22	22
Pteridium aquilinum	1	3
Ranunculus spp.	1	3
Rubus ursinus	14	11
Tellima grandiflora	2	3
Trillium ovatum	1	3

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

Secondary dominant native species in the groundcover layer were *G. shallon* (salal), present at an average cover of 11%, and *R. ursinus* (trailing blackberry), present at an average cover of 9% (Figure 3-26). Non-dominant native species present in the groundcover layer at 5% cover or less included: *A. filix-femina* (lady fern), *C. alpina* (enchanter's nightshade), *M. nervosa* (dull Oregon grape), *A. triphylla* (vanilla leaf), *Galium* spp. (cleavers or bedstraw), *P. aquilinum* (bracken fern), *Ranunculus* spp. (buttercup)*, T. grandiflora* (fringecup) and *T. ovatum* (western trillium). The only other invasive species sampled within the groundcover layer of MZ 8 was *G. robertianum* (herb Robert) (4% cover for the zone). Figure 3-26 and Table 3-25 provide additional information about the distribution of groundcover species in MZ 8.

3.2.9 Management Zone 9

MZ 9 is approximately 15.5 ac in size; it is located in the central portion of Salmon Creek Ravine, east of the WWTP (Map 7). This zone is bordered on its north and south sides by portions of the upper pedestrian trail and yet it is a very difficult area of the green space to access due to the lack of trails within the interior of the zone. The topography of MZ 9 slopes at varying gradients to the south and west. It includes the majority of the middle branch of Salmon Creek and also contains significant riparian wetland habitat. Five sampling transects were located within MZ 9 (Transects 5, 10, 11, 13 and 14).[16]

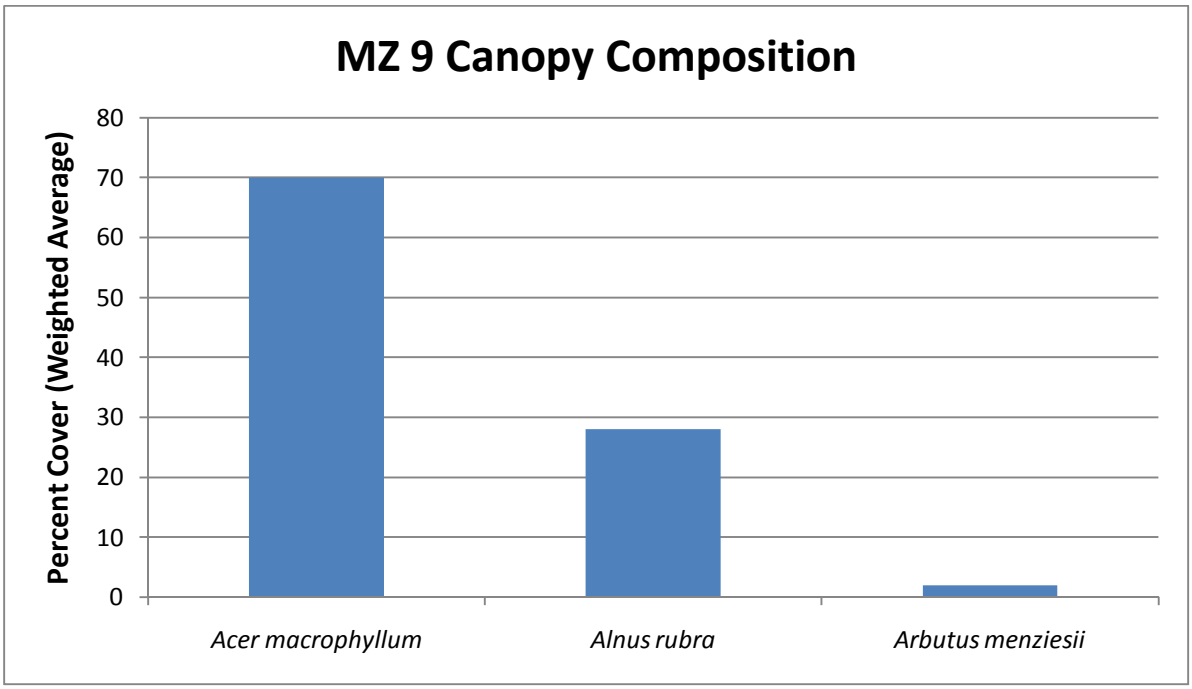
3.2.9.1 MZ 9 Canopy

The canopy of MZ 9 is dominated by *A. macrophyllum* (bigleaf maple) and *A. rubra* (red alder), which are present at average covers of 70% and 28%, respectively, throughout the zone (Figure 3-27). Seven of the 25 subplots sampled in MZ 9 contained *A. macrophyllum* in the canopy; in these subplots, *A. macrophyllum* had an average cover of 55%. Six of the 25 subplots sampled in MZ 9 contained *A. rubra* stems; in these subplots, *A. rubra* had an average cover of 26%. *A. menziesii* (Pacific madrone) was sampled in one subplot within the MZ at 10% cover and this species had an overall average cover of 2% throughout the zone (Figure 3-27). Based on the qualitative surveys of the larger sampling quadrats (8 m

[16] Transect 5 spanned the boundary between MZs 8 and 9 and Transect 13 spanned the boundary of MZs 5 and 9; however, the data for both of these transects were included in the analysis of both of the MZs that they spanned. Conditions within a transect spanning two zones can be used to help characterize both zones.

x 10 m) in MZ 9, *T. heterophylla* (western hemlock), *T. plicata* (western red cedar) and *P. menziesii* (Douglas fir) were also present in the canopy layer of some of the quadrats (see Appendix A).

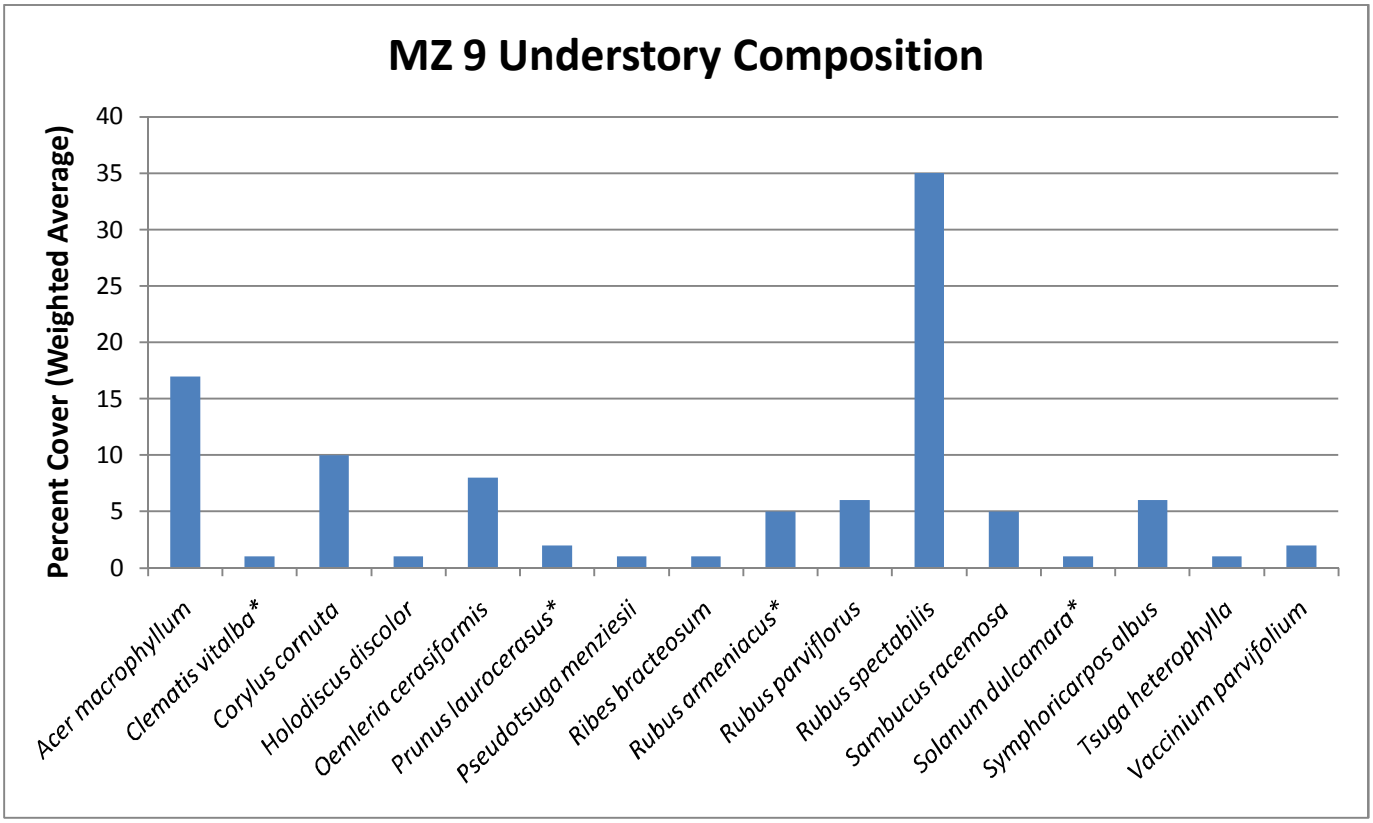
Figure 3-27. Percent cover of species sampled in the canopy layer of MZ 9



3.2.9.2 MZ 9 Understory

The understory of MZ 9 is dominated by *R. spectabilis* (salmonberry), which was present at an average zone-wide cover of 35% (Figure 3-28). *R. spectabilis* was present in the understory layer of 14 of the 25 subplots sampled in MZ 9 and where present, it had an average cover of 22% (Table 3-26). *A. macrophyllum* (bigleaf maple) was a secondary dominant native species in the understory, with an average cover of 17% for the zone. There were also several non-dominant native species present in the understory layer. These included: *C. cornuta* (beaked hazelnut) at an average cover of 10%; *O. cerasiformis* at an average cover of 8%; and *S. albus* (snowberry) and *R. parviflorus* (thimbleberry), each present at an average cover of 6% (Figure 3-28). Invasive species sampled in the understory of MZ 9 were: *R. armeniacus* (Himalayan blackberry), *P. laurocerasus* (English laurel), *S. dulcamara* (bittersweet nightshade), *C. vitalba* (old man's beard) and *S. aucuparia* (European mountain ash); these were all present at an overall average cover of 5% or less in MZ 9. Figure 3-28 and Table 3-26 provide additional information about the distribution of understory species in MZ 9.

Figure 3-28. Percent cover of species sampled in the understory layer of MZ 9



Notes: The graph only shows data for species that were present in the understory layer at 1% cover or greater. Species identified that were present at less than 1% cover were *V. ovatum* (evergreen huckleberry) and *S. aucuparia** (European mountain ash); information is provided for these species in Table 3-26. The presence of an asterisk (*) indicates an invasive species.

Table 3-26. Number of sampling subplots in MZ 9 in which each understory species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum	8	19
*Clematis vitalba**	2	3
Corylus cornuta	4	23
Holodiscus discolor	1	10
Oemleria cerasiformis	5	15
*Prunus laurocerasus**	2	10
Pseudotsuga menziesii	1	5
Ribes bracteosum	2	3
*Rubus armeniacus**	5	9
Rubus parviflorus	6	9
Rubus spectabilis	14	22

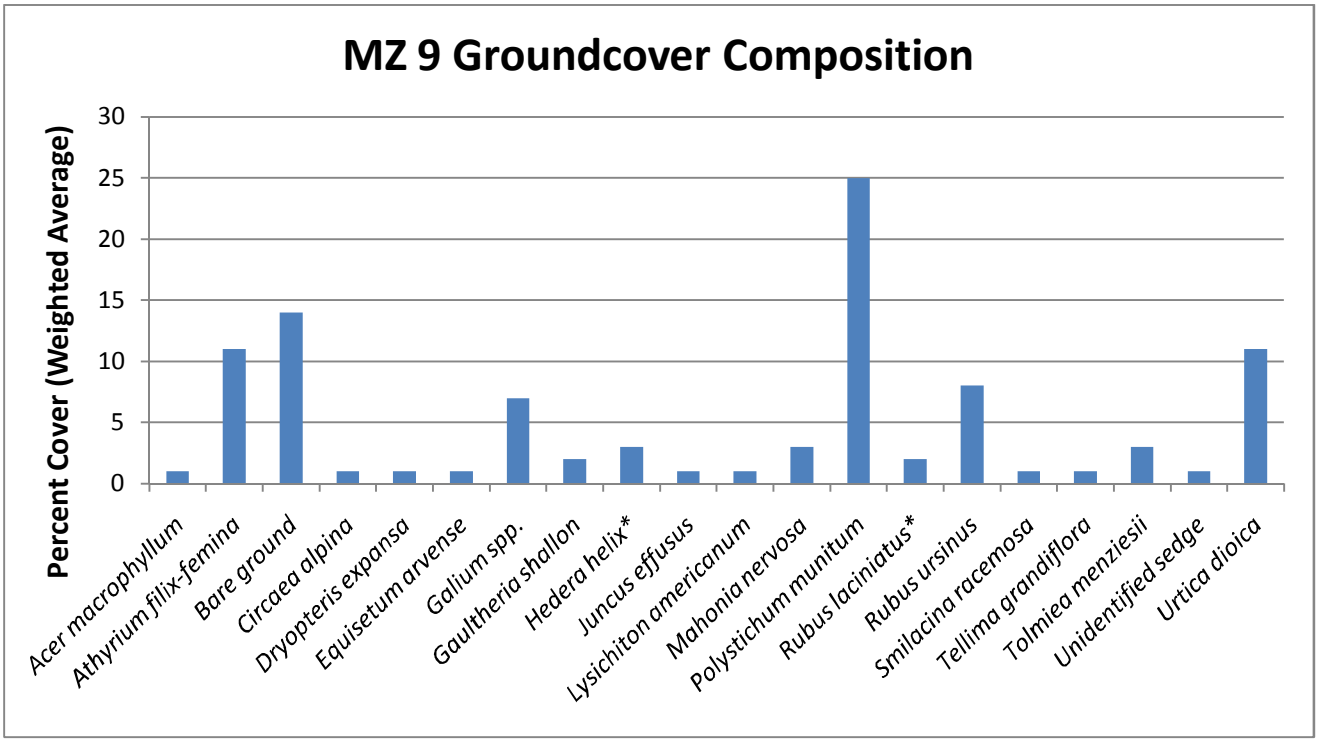
Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Sambucus racemosa	8	6
*Solanum dulcamara**	1	5
*Sorbus aucuparia**	1	3
Symphoricarpos albus	3	18
Tsuga heterophylla	1	5
Vaccinium ovatum	1	3
Vaccinium parvifolium	4	5

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

3.2.9.3 MZ 9 Groundcover

The groundcover of MZ 9 is dominated by *P. munitum* (sword fern), which is present at an average cover of 25% for the zone as a whole (Figure 3-29). *P. munitum* was present in the groundcover layer of 20 of the 25 subplots sampled in MZ 9, and where present it had an average cover of 19% (Table 3-27). Secondary dominant species in this zone were: *A. filix-femina* (lady fern) and *U. dioica* (stinging nettle), each present at an average cover of 11% (Figure 3-29). In addition, there were several non-dominant native species present in the groundcover layer including *R. ursinus* (trailing blackberry), present at an average cover of 8%, and *Galium* spp. (cleavers or bedstraw), present at an average cover of 7%, among other species (Figure 3-29). The invasive species sampled within the groundcover layer of MZ 9 were *G. robertianum* (herb Robert), *H. helix* (English ivy), *P. arundinacea* (reed canarygrass) and *R. laciniatus* (evergreen blackberry); these were all present in trace amounts. Figure3-29 and Table 3-27 provide additional information about the distribution of groundcover species in MZ 9.

Figure 3-29. Percent cover of species sampled in the groundcover layer of MZ 9



Notes: The graph only shows data for species that were present in the groundcover layer at 1% cover or greater. Species identified that were present at less than 1% cover were *A. rubra* (red alder seedlings), *B. spicant* (deer fern), *E. ciliatum* (purple-leaved willow herb), *G. robertianum** (herb Robert), *G. macrophyllum* (large-leaved avens), *Luzula* spp. (wood rush), O. cerasiformis (Indian plum), *O. sarmentosa* (Pacific water parsley), *P. arundinacea** (reed canarygrass), *P. glycyrrhiza* (licorice fern), *R. repens* (creeping buttercup), *Rumex* spp. (dock) and *V. beccabunga* ssp. *Americana* (American brooklime); information is provided for these species in Table 3-27. The presence of an asterisk (*) indicates an invasive species.

Table 3-27. Number of sampling subplots in MZ 9 in which each groundcover species was identified and the average percent cover of each species within those subplots

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Acer macrophyllum (seedlings)	6	3
Alnus rubra (seedlings)	1	3
Athyrium filix-femina	12	14
Bare ground	6	35
Blechnum spicant	1	3
Circaea alpina	6	3
Dryopteris expansa	4	3
Epilobium ciliatum	1	3
Equisetum arvense	4	3
Galium spp.	11	9

Species	No. of Subplots Where Present	Average Percent Cover for Subplots Where Present
Gaultheria shallon	3	12
*Geranium robertianum**	1	3
Geum macrophyllum	1	5
*Hedera helix**	8	6
Juncus effusus	1	15
Luzula spp.	1	3
Lysichiton americanum	2	4
Mahonia nervosa	5	9
Oemleria cerasiformis	2	3
Oenanthe sarmentosa	1	3
*Phalaris arundinacea**	1	3
Polypodium glycyrrhiza	1	3
Polystichum munitum	20	19
Ranunculus repens	1	3
*Rubus laciniatus**	1	30
Rubus ursinus	15	8
Rumex spp.	2	3
Smilacina racemosa	3	3
Tellima grandiflora	5	3
Tolmiea menziesii	3	16
Unidentified sedge	1	10
Urtica dioica	15	11
Veronica americana	1	3

Note: Species present at an average percent cover of 3% are considered to be present in "trace" amounts.
* - indicates an invasive species

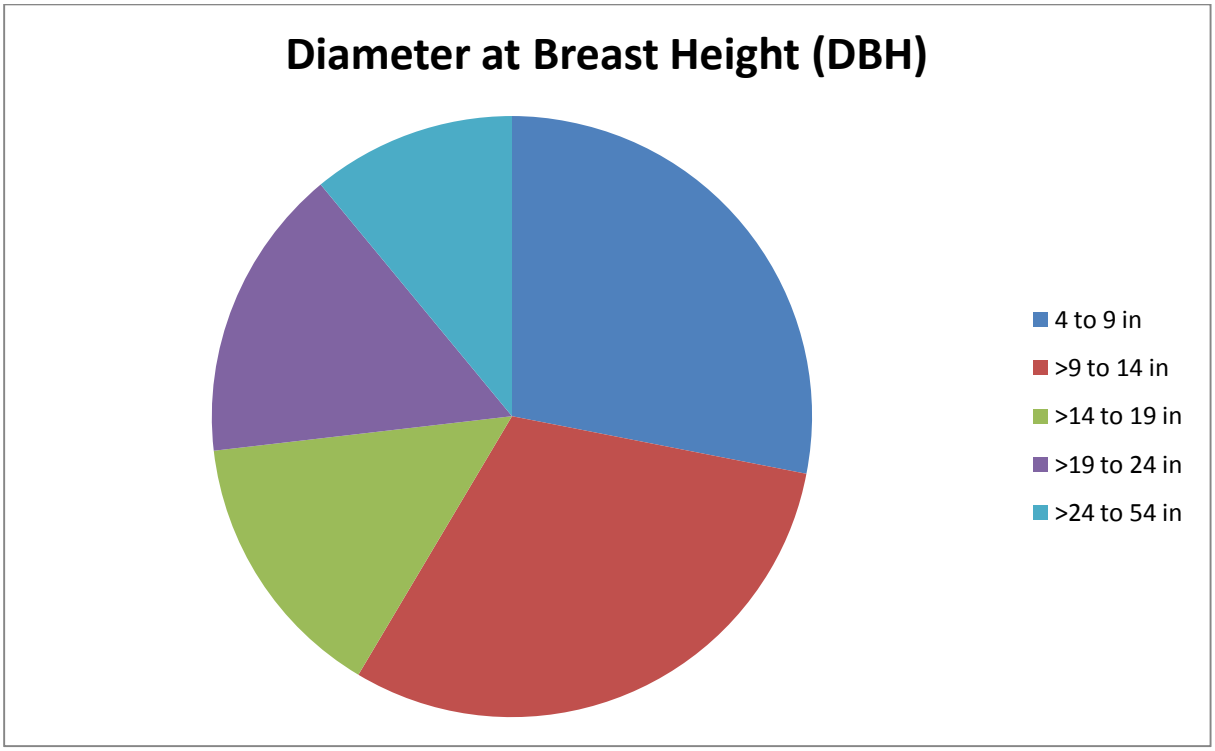
3.3 Large Woody Debris and Snags

Large woody debris (LWD) is an important habitat feature because it provides habitat for small mammals, birds, soil invertebrates, certain plant species (such as *V. ovatum* and *T. heterophylla* which tend to grow on nurse logs), and many other species. LWD also contributes organic material to the environment as it decomposes. Pieces of dead wood greater than 4 in. (10 cm) in diameter and greater than 6.6 ft (2 m) long are generally considered LWD (Slaney and Zaldokas 1997). For the purposes of this report, any length of dead wood (logs or stumps) greater than or equal to 4-in. in diameter was considered LWD.

In total, there was an average density of 58 pieces of LWD per acre in Salmon Creek Ravine. The average length of LWD pieces was approximately 25 ft, and the average DBH was approximately 16 in. In terms of LWD volume, there was an average of 1,270 ft^3 per acre. The average values for density and volume of LWD per ac are likely biased low because in some subplots information about LWD was not recorded in the field. In addition, large accumulations of LWD were observed in the ravine bottoms and in the creek tributary channels; therefore, densities and volumes of LWD are likely much higher in these areas

than on the steep slopes of the ravine walls. An especially large amount of LWD was observed in the stream channel located on the east side of Transects 21 and 22 (Map 5). Figure 3-30 shows the size distribution of LWD sampled. The largest pieces of LWD observed were old growth stumps. A few large logs presumably left over from the historical harvest of old growth trees were also observed.

Figure 3-30. Site-wide LWD size distribution



In addition to LWD DBH, information about the decay class of LWD pieces was also recorded. Decay class can provide information related to the age and habitat value of LWD. The decay class categories used during the Salmon Creek Ravine vegetation assessment are summarized in Table 3-28.

Table 3-28. LWD decay classes

Decay Class	Definition
1	Leaves/needles few or absent, 0-10% of stem covered by moss/lichen, less than 10% decay, 90-100% bark cover on stem
2	Leaves/needles absent, 11-30% of stem covered by moss/lichen, 10-15% showing decay, 60-90% bark cover on stem
3	Leaves/needles absent, greater than 30% of stem covered by moss/lichen, greater than 60% showing decay, less than 60% bark cover on stem

Approximately 50% of the pieces of LWD inventoried during the vegetation assessment were of decay class 3, indicating that they were at least 60% decayed (Figure 3-31). Approximately 25% were of decay class 2 and 25% were of decay class 1. This indicates that either there was a larger accumulation of LWD in the past (most likely prior to the time when Salmon Creek Ravine was logged), or that the pieces of LWD accumulating decay rapidly. This could be the case considering the majority of the trees in Salmon Creek Ravine available to contribute LWD are deciduous species. Many deciduous species decay more rapidly than coniferous species. It is likely that both of these factors have contributed to the trend observed in LWD decay class, where the majority of LWD is in a more advanced stage of decay.

Snags provide habitat for cavity-nesting birds and mammals as well as forage for wildlife species that prey on the insects living on the decaying wood. Only 15 snags were recorded in the transect data for the entire site; it is likely that some snags were missed during the field inventory, but overall it appears that there are few standing snags compared to downed logs and stumps. The average density was 6.5 snags per ac. In comparison, a similar study of Eagle Landing Park conducted in 2009 indicated that there were 30 snags per ac on average in that park (Salisbury and Elman 2009). In Salmon Creek Ravine, the average snag height was approximately 26 ft and the average DBH was approximately 11 in. Several snags were the standing dead wood of *A. menziesii* (Pacific madrone) and several were dead stems of multi-stemmed *A. macrophyllum* (bigleaf maple) trees that still had living stems.

Maintaining a diverse mix of native trees in Salmon Creek Ravine should provide for adequate LWD recruitment in the future. Under-planting conifer trees in the understory would also help maintain sufficient LWD because LWD originating from conifer species, especially *T. plicata* (western red cedar), generally decays much more slowly than LWD originating from deciduous trees. Active restoration of LWD is not recommended at this time; however vegetation management strategies should take into consideration natural recruitment of LWD of various sizes and types.

4 Discussion and Management Recommendations

As discussed in Section 1, Salmon Creek Ravine provides many valuable ecological services and the green space is enjoyed by the neighboring communities for several passive recreational uses. The green space also provides opportunities for environmental education and outreach including hands-on ecological restoration activities, fish release programs and wildlife viewing. Salmon Creek Ravine, along with surrounding undeveloped, privately-owned land and a network of other parks to the north and south (Map 1), represents a large patch of intact lowland forest habitat located within an otherwise densely-developed urban landscape matrix. The habitat provided serves as a refuge for resident and migratory birds and other wildlife. Salmon Creek supports some species of fish and would likely provide limited but high-quality salmonid habitat if fish passage between Puget Sound and the creek could be restored.

Over 50 native plant species were observed in Salmon Creek Ravine and in general, the canopy, understory and groundcover layers of the MZs were dominated by native species. Invasive species were generally present in small, scattered patches. The invasive species with the highest covers site-wide were *R. armeniacus* (12%) and *H. helix* (8%). Other invasive species identified included *I. aquifolium* (English holly), *P. laurocerasus* (English laurel), *P. avium* (sweet cherry), *S. aucuparia* (European

mountain ash), *C. vitalba* (old man's beard), *C. monogyna* (English hawthorne), *S. dulcamara* (bittersweet nightshade), *G. robertianum* (herb Robert) and P. *arundinacea* (reed canarygrass). A few other invasive species were observed although they were not located within the sampling transects. These are discussed in Section 5.1.

The following sections outline vegetation management recommendations for Salmon Creek Ravine based on both the quantitative and qualitative results of the vegetation assessment. Recommendations are separated into three categories: short-term priorities, medium-term priorities, and long-term priorities (following the methods of EarthCorps). Recommended tasks were divided into these categories based on the importance of the task in terms of protecting the native forest community, the amount of time and resources likely needed to achieve the task, and the expected duration of the task (e.g., some tasks will need to be conducted routinely over the long term). While this section simply identifies vegetation management priorities, Section 5 provides more detailed information on how to conduct restoration activities, including invasive species removal and suitable native plants for installation after invasive species removal.

4.1 Short-term Priorities

Short-term priorities are those that should be undertaken as soon as possible in order to prevent significant damage to the native vegetation of Salmon Creek Ravine. The high priority actions are separated into two categories, one assuming primarily volunteer-based resources with limited financial resources, and the other assuming both volunteer resources and significant financial resources.

When primary resources are volunteer labor with minimal additional financial resources, the high priority action recommendations are to:

1) Eradicate the *Polygonum* spp. (knotweed) patch in MZ 8 (near Transect 3). This is the only patch of *Polygonum* spp. that was identified during the vegetation assessment and it should be controlled before it spreads over a larger area. *Polygonum* spp. are very difficult to control, especially when they cover large areas. This work should be conducted by personnel familiar with knotweed control and herbicide application. The presence of this patch has been reported to King County Department of Natural Resources and Parks, which may be able to control this patch at little cost in conjunction with a more extensive *Polygonum* spp. effort in the adjacent Miller/Walker Creeks basin.
2) Cut *H. helix* (English ivy) vines to provide life-rings for trees at the northern end of the ravine in MZ 2 (area surrounding Transect 22). Many of the trees in this area are covered in *H. helix* all the way to their crowns. This could cause tree failure due to the additional weight and wind-sail effect created by *H. helix*. In addition, if *H. helix* reaches the canopy and is exposed to sufficient sunlight it will bear fruit, providing an additional seed source that could result in further spread of *H. helix* throughout other areas of Salmon Creek Ravine. This work will need to be performed by professional restoration crews as the area is difficult to access and located on a steep ravine slope.
3) Continue restoration at the entrance near the WWTP and at the entrance from 16th Avenue Southwest. There are large invasive species patches in these areas and restoration efforts have

already been initiated by volunteers. These areas will provide highly visible examples of restoration at work to further educational and outreach opportunities and perhaps to recruit additional volunteers. If funding is available, interpretive signs should be placed in these areas. Much of this work can be performed by volunteers.

When more significant financial resources are available, the additional high-priority action recommendations are to:

1) Replace the steep social trail in MZ 1 with a new switchback trail. The current trail is causing loss of vegetation and soil erosion. It continues to widen as it is used (primarily by kids from the surrounding neighborhoods) because they traverse the edges of the trail as the majority of it is slick and treacherous. If a suitable public trail access area cannot be identified on the northeast end of Salmon Creek Ravine, this trail could be designed to make a loop contained within the site boundaries. While the majority of this work would need to be performed by professionals, volunteers from the neighborhood (particularly the kids who currently use this trail) could be recruited to help work on the less-steep portions of a new trail. This would provide an educational opportunity regarding the damage that social trails can cause and might reinforce proper trail use in the future.
2) Control additional invasive species (including *H. helix, I. aquifolium* and *P. laurocerasus*) in the area surrounding Transects 2 and 3 in MZ 8. This is currently a high-quality habitat area with relatively small patches of invasive species present. However, there is an opening in the canopy (possibly due to the presence of a root rot pocket) and several invasive species are present. Without control, invasive species will likely exploit the canopy opening and spread over a much larger area. If additional native species are to be installed in this area after removing invasive species, woody species resistant to root rot should be selected due to the presence of the potential root rot pocket (recommendations for suitable plant species are included in Section 5.2).
3) Remove *H. helix* from the groundcover layer in the northern end of the ravine in MZ 2 (area surrounding Transect 22) and install native plants. This work would need to be conducted by professionals due to the inaccessibility of the area and steep topography.

4.2 Medium-term Priorities

Medium-term priorities are those that should be undertaken over the next few years as resources are available. The short-term priorities outlined in the previous section should be undertaken before the medium-priority actions as much as possible. Medium-priority actions are separated into two categories, one assuming primarily volunteer-based resources with limited financial resources, and the other assuming both volunteer resources and significant financial resources.

When primary resources are volunteer labor with minimal additional financial resources, the medium-term priority action recommendations are to:

1. Plant native groundcover and shrub species in the landslide area on the north side of the gravel access road near Transect 17. This area is located in the riparian zone of the main branch of

Salmon Creek. This work could probably be performed by volunteers but some professional assistance may be required to install jute matting or another erosion control mechanism. Installing plants in this area will help prevent additional erosion from taking place and will help stabilize the adjacent gravel access road bed.

2. Remove invasive species from the riparian zone in MZ 3. This work could also be performed by volunteers as this area is relatively easy to access from the gravel access road. Small groups of volunteers are recommended to do the work in order to avoid trampling native vegetation and potentially sensitive soils.
3. Control invasive species (including *R. armeniacus, S. aucuparia, I. aquifolium* and *P. laurocerasus*) at the eastern end of the gravel access road in MZ 4 (area surrounding Transect 28) and at the entrance from Shorewood Drive (in MZs 8 and 9). These areas are also highly visible to site visitors and could provide demonstrations of restoration activities at work. The majority of this work could be done by volunteers but some areas, such as the northern side of the upper pedestrian trail entering the site from Shorewood Drive, are quite steep and work here would need to be conducted by professional restoration crews.
4. Control invasive species (primarily *P. laurocerasus*) in the portion of MZs 8 and 9 near Transect 5. This area is relatively easy to access from the upper pedestrian trail and much of this work could be performed by volunteers.
5. Plant conifer seedlings in the understory. This activity could be conducted anywhere in Salmon Creek Ravine but the areas to be prioritized are riparian areas and areas with few conifers in either the canopy or understory. While conifer regeneration was observed throughout much of the site, overall the dominant tree species in both the canopy and understory are deciduous species (*A. rubra* and *A. macrophyllum*). Appropriate species would include *P. sitchensis* and *T. plicata* in moister riparian areas and *T. heterophylla*, *Abies grandis* (grand fir) and *T. plicata* in drier upland areas (see Section 5.2 for more information on plant selection). *P. menziesii* can also be planted in drier areas where there is sufficient sunlight (such as areas with larger openings in the canopy). Volunteers could install conifers along the trails and in the accessible areas of the riparian zone surrounding the main branch of Salmon Creek. Professional restoration crews would likely be required to install conifers in the more remote portions of Salmon Creek Ravine.

When more significant financial resources are available, the additional medium-priority action recommendations are to:

1. Control other invasive species (besides *H. helix*) in MZ 2. The other invasive species observed include *P. laurocerasus* (English laurel), *P. avium* (sweet cherry), *I. aquifolium* (English holly) and *R. armeniacus* (Himalayan blackberry). This work will need to be conducted by professional restoration crews and may be able to be combined with *H. helix* control in the zone if sufficient financial resources are available at that time.
2. Control invasive species (including *P. laurocerasus, H. helix* and *I. aquifolium*) in MZ 1 (most invasive plants in this zone were observed at the western end of Transect 17 and surrounding Transect 19). The majority of this zone is difficult to access as there are no trails

on the eastern or northern portions of the zone and as the topography is very steep. Except for the portions of this zone accessible from the gravel access road, this work will need to be performed by professional restoration crews.

3. Re-route the lower portion of the upper pedestrian trail (near where this trail intersects the gravel access road). This portion of the trail is generally very muddy and steep making it quite slippery and difficult to use. It is also causing damage to surrounding soils and vegetation as people skirt the outer edges of the trail when it is muddy. Much of the surrounding area consists of riparian wetland habitat. This portion of the trail should be re-routed to a less steep path, and if possible, an elevated boardwalk could be constructed to help alleviate damage to surrounding soils and plants and make the trail easier to use during the wetter times of the year.
4. Control invasive species in MZ 7. Currently there are just a few relatively small patches of invasive species in this zone, including *S. aucuparia* (European mountain ash)*, I. aquifolium, H. helix* and *R. armeniacus*. Invasive plants should be controlled while the infestations are still small. This area is relatively easy to access from the upper pedestrian trail but it is hard to navigate due to swampy, muddy conditions. Work in this zone will need to be conducted by professionals who know how to traverse sensitive wetland areas without damaging soils and vegetation, and without becoming stuck in deep mud.

4.3 Long-term Priorities

Long-term priorities are those that should be undertaken over the next several years as resources are available. The short- and medium-term priorities outlined in the previous sections should be undertaken before the long-term priority actions as much as possible. Long-term priority actions are separated into two categories, one assuming primarily volunteer-based resources with limited financial resources, and the other assuming both volunteer resources and significant financial resources. Many of the long-term priorities should be conducted routinely into the future to maintain the health of the native vegetation community in Salmon Creek Ravine.

When primary resources are volunteer labor with minimal additional financial resources, the long-term priority action recommendations are to:

- Control patches of *R. armeniacus* (Himalayan blackberry) and *R. laciniatus* (evergreen blackberry) in MZ 4 in areas that are easy to access from the gravel road.
- Control scattered patches of invasive species (including *I. aquifolium* [English holly]*, P. laurocerasus* [English laurel]*, R. armeniacus, S. aucuparia* [European mountain ash] and *H. helix* [English ivy]) in areas of MZs 5 and 6 that can be accessed from the trails and gravel access road.
- Continue to monitor trail corridors, site entrances and the riparian zone of the main branch of Salmon Creek for invasive species. Control patches of invasive species, prioritizing areas with small infestations then moving to areas with larger infestations.

When more significant financial resources are available, the additional long-term priority action recommendations are to:

1. Control *P. avium* (sweet cherry) in MZ4; *P. avium* was observed in all three vegetation layers in this MZ.
2. Control invasive species in riparian areas of MZ 3, including *P. laurocerasus, I. aquifolium, R. armeniacus, H. helix, G. robertianum* (herb Robert) and possibly *P. avium* in the vicinity of Transect 26.
3. Control invasive species patches scattered throughout MZs 5 and 6, and around Transect 4 of MZ 8.
4. Remove the large patch of *R. armeniacus* in and around Transect 27 in MZ 4. This area will likely need to be replanted with native species and mulched to prevent it from being re-colonized by invasive species. Woody species resistant to root rot should be selected as a potential root rot pocket was observed in this location (recommendations for suitable plant species are included in Section 5.2).

5 Restoration Practices and Ongoing Monitoring

The purpose of the following sections is to provide basic guidance for conducting restoration activities in Salmon Creek Ravine, including recommendations for invasive species control methods and suitable native species selection for replanting cleared areas. City of Burien staff, restoration professionals employed to help carry out vegetation management activities and others contributing to stewardship efforts will no doubt contribute additional ideas and be able to tailor practices to specific areas within Salmon Creek Ravine. The following sections are intended only to provide a starting point for carrying out the priority actions recommended in Section 4.

5.1 Invasive Species Control

Several invasive species were identified within the vegetation sampling transects (Section 4 and Appendix A). Invasive species were also observed in other areas of Salmon Creek Ravine (i.e., areas not included within the sampling transects), usually when hiking through the site from one transect to another. Map 8 shows specific site-wide locations where invasive species were observed by EarthCorps in 2009 and during this vegetation assessment in 2010. In addition, GPS coordinates for the invasive species locations observed during this assessment are included in Appendix D.

Table 5-1 provides information on the regulatory classification, potential ecological impacts and methods of control for each of the invasive species identified in Salmon Creek Ravine. The methods suggested in Table 5-1 are based on King County Noxious Weed Control Program (KCNWCP) guidance. Additional detail on KCNWCP's recommended best management practices for controlling invasive species is contained in Appendix E. In general, KCNWCP recommends an integrated pest management (IPM) approach to controlling invasive weeds. IPM involves using a multi-faceted program to control the spread of invasive weeds, including manual and mechanical removal, use of herbicide and biological control (when available). IPM programs are tailored to the specific conditions of a site, taking into consideration the size and location of the weed infestations, the resources available to help control invasive species and several other factors. Table 5-1 provides several options for invasive species control that can be selected from when developing an IPM program. As invasive species control methods are

continually evolving based on new research and other information, the KCNWCP website[17] should be consulted periodically to check for control method updates. In addition, other organizations can provide useful information on invasive species control. For example, Earth Corps is currently researching the effectiveness of various control methods for *I. aquifolium* (English holly).

[17] URL: http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds.aspx

Table 5-1. Ecological impacts of the invasive species observed in Salmon Creek Ravine and control methods for those species

Ecological Impacts	Control Methods	Time of Year for Control
Buddleia davidii (butterfly bush): non-regulated noxious weed		
Grows in dense thickets on riverbanks; interferes with natural forest regeneration processes; does not provide suitable habitat or food for native butterfly species.	Seedlings can be hand-pulled. For larger plants, the most effective method of control is to cut the trunk at ground level and then immediately apply a glyphosate or triclopyr herbicide directly to the cut surface. Do not dispose of any cut parts on-site as they can re-sprout when in contact with the soil. Dispose of cut stems in the garbage. To prevent further spread of this plant, remove flower heads in late summer or fall before seeds are disbursed; dispose of flower heads in garbage.	Manual removal of seedlings will be easiest in the spring, winter or fall when the soil is moist. Herbicide application is generally most effective during the summer growing season.
Clematis vitalba (old man's beard): Class C noxious weed; control recommended but not required		
Grows very quickly and climbs, weakens and smothers trees; can even cause trees to collapse. Out-competes native understory species and tree seedlings.	Seedlings do not grow well in shade so maintaining a full canopy (particularly evergreen) and dense native understory can help prevent establishment of new plants. Small plants can be removed manually when the soil is moist. For climbing vines, cut at waist height and remove the lower portion of cut vines and dig out roots. The upper portion of the climbing vines can be left as long as no part of the vine is touching the ground (where it could re-root). Dig up and remove vines growing along the ground. Taproots can extend several yards underground making them very difficult to remove manually. Application of herbicide after manual control will often be required to prevent re-growth. Herbicide can be painted on fresh cuts or applied to the leaves and stems of actively growing plants. Additional options for mechanical and chemical control are contained in Appendix E. Cut stems can be disposed of by hanging them or placing them on tarps to dry as long as there are no flowers on the stems (which could spread seed) and as long as no part of the stem touches the ground (where it could re-root). Dried out stems can then be disposed of on-site. Stems can also be chipped or burned and disposed of on-site. After removal, areas that were infested with *C. vitalba* should be monitored for re-growth for at least 5 years.	Control before fall when seeds are produced. For foliar herbicide control, apply in spring when plant is actively growing but before stem elongation. If applying herbicide later in the growing season after stem elongation, cut vines back, wait for re-growth and then spray.
Convolvulus arvensis[a] (field bindweed or morning glory): Non-designated Noxious Weed; control recommended but not required		
Out-competes native species, especially new plantings, and climbs	Hand-weeding may be successful in controlling seedlings but should not be conducted once seeds form. Do not dig or till the soil around mature plants because roots and rhizomes can be spread and will re-sprout. Herbicide application will likely be the best	Control methods must be implemented over many consecutive growing seasons.

Ecological Impacts	Control Methods	Time of Year for Control
surrounding vegetation; very difficult to eradicate once established	way to control established patches. Glyphosate, triclopyr and 2,4-D are all options for *C. arvensis*. See Appendix E for more information on chemical control options.	Hand-weed seedlings in spring. Apply herbicide in the summer or fall when foliage still green.
Geranium robertianum (herb Robert): Class C noxious weed; control recommended but not required		
Displaces native understory vegetation by forming dense monocultures and releasing allelopathic chemicals that suppress the growth of native species.	For smaller infestations or isolated plants, manually pull plants out. Grasp at the base and pull gently (the root systems are shallow and generally easy to pull). Place pulled plants in bags if they are in flower or show signs of maturing seed. If seeds are ripe, consider postponing *G. robertianum* removal until the following year (seeds will be dispersed in the process of removing *G. robertianum*). For larger infestations consider use of herbicide or sheet mulching. Take precautions including cleaning shoes, boots and vehicles to prevent spread of seed from infested areas to non-infested areas. Plants with seeds or mature flowers should be thrown in the garbage. Plants without seeds or flowers can be put in yard waste containers.	Manually remove *G. robertianum* prior to seed formation later in the growing season. For best results, apply herbicide to plants that are actively growing but have not yet flowered.
Hedera helix (English ivy)[b]: Class C noxious weed; control recommended but not required		
Grows well in sun or shade and can out-compete native plants in the groundcover, shrub and canopy vegetation layers. It can shade out and suppress growth of native plants in the understory and alter natural forest succession processes. Mature trees covered in ivy are more likely to be blown down due to the added weight. The mat-like root system of ivy can cause erosion problems on steep	Manual removal is the most effective control method for *H. helix*. Cut or mow above-ground vines if they impede access to the root systems, then hand-pull or dig out roots using a shovel, claw mattock, or other hand tool. Prioritize removal of climbing vines, especially when they cover desirable native vegetation. A "life ring" can be cut around the entire tree trunk to sever the climbing vines from the root system (in this case, climbing vines above the cut area do not need to be removed from tree canopies, etc.). Removing these vines will reduce fruit production and spread of seed. When clearing ground-covering ivy from slopes and stream banks, erosion control will likely be required until native plants can become established. To dispose of *H. helix* vines, wrap them into bundles and allow them to dry out and decompose. Either place the bundles on a tarp or periodically turn the piles so that all rootlets are exposed to the air and dry out. The piles can also be covered with black plastic to speed the desiccation and decomposition process. After ivy removal, plant native plants if needed and cover the cleared area with 8 in. of mulch. In areas with flat topography, sheet mulching with cardboard overlain by an 8-in.-thick layer of mulch can be applied on top of H. helix roots and/or vines as a method of control. King County generally does not recommend use of herbicide for *H. helix* control	Manual control is usually easiest in fall, winter or spring when the ground is moist and roots are easier to pull. For chemical control, the best time is late summer to early spring. Applying herbicide in winter can reduce damage to dormant native plants. Herbicide application to new leaf growth in early spring can increase effectiveness.

Ecological Impacts	Control Methods	Time of Year for Control
slopes.	because chemicals often do not effectively penetrate the plant's waxy leaves; however, an herbicide with an effective surfactant can be used. Apply to the leaves (especially when young) or cut stems or roots and apply herbicide to the cut area. National *H. helix* control guidance provided by the Plant Conservation Alliance suggests the use of herbicides over manual control for large infestations; their fact sheet is also included in Appendix E.	
***Lamiastrum galeobdolon*[a]** (yellow archangel): non-designated Class C noxious weed; control recommended but not required		
Forms dense ground-cover patches and outcompetes native species; provides poor-quality forage and shelter for native wildlife.	Plants can be manually removed as the root systems are shallow; however, new plants will sprout readily from residual stem or root fragments so chemical control is often combined with manual removal to achieve control. Spot-spraying herbicide is recommended for this species.	Manual removal is easiest in fall, winter or spring when soil is moist.
Ilex aquifolium (English holly): Weed of Concern; control recommended but not required		
Tolerates sun and shade and it can form dense thickets that produce deep shade and dominate the forest understory, suppressing the growth of native species.	Small plants can be pulled manually when the soil is moist. For larger plants the most effective control method is to cut or frill the trunk and apply herbicide to the fresh cuts. Frilling involves making many smaller cuts/notches all the way around the trunk rather than cutting straight through. Foliar application of herbicide is not recommended for *I. aquifolium* because the chemicals do not adequately penetrate its waxy leaves.	Manual removal is easiest in fall, winter or spring when soil is moist.
***Polygonum* spp.** (knotweed): Class B Noxious Weed; control recommended but not required		
Outcompetes native plants and degrades riparian habitat. Can cause problems with erosion along stream banks when it displaces native riparian species. Dense stands can clog waterways.	*Polygonum* spp. are very difficult to control and control can required long-term planning. Although manual control methods are outlined in the KCNWCP fact sheet (Appendix E) for *Polygonum* spp., control using herbicides is the recommended approach because manual control is extremely time consuming and relatively ineffective (personal communication from Dennis Clark 2011). Herbicide can be applied by injecting glyphosate directly into the stems. Several other herbicide application methods are discussed in the fact sheet for *Polygonum* spp. The wick wiper and spot spray methods are recommended for smaller infestations such as the one identified in Salmon Creek Ravine.	The appropriate time of year for herbicide application will depend on the product selected (see Appendix E for more information).

Ecological Impacts	Control Methods	Time of Year for Control
	For disposal, dead canes should be isolated from the surrounding environment and allowed to dry out completely on a tarp or other type of barrier . Dried stems chipped to lengths of one inch or less can be composted on site but they should not be placed in wetland or riparian areas. Root crowns, rhizomes and stems with seeds should be removed from the site and disposed of in the garbage. Take precautions such as washing boots, tools and vehicles that have been in contact with *Polygonum* spp. patches to prevent the spread of seeds, stems and root fragments. It is especially important to keep these from entering waterways.	
Prunus laurocerasus (English or cherry laurel): Weed of Concern; control recommended in natural areas and forestlands but not required		
Grows quickly in sun or shade and outcompetes native shrub and tree species in the understory. It can replace native trees in the forest canopy over time.	When plants are small remove manually by pulling or digging out roots. For large plants, use a saw to cut stems as low to the ground as possible. Stumps are likely to re-sprout so apply mulch over the stump and also monitor for and remove any new growth. Alternatively, glyphosate or triclopyr herbicide can be applied to the cut surface immediately after cutting. Another control method is to frill (make many small cuts/notches all the way around the trunk rather than cutting completely through it), and then apply herbicide to the freshly cut areas. Removed stems can be chipped and then used as mulch or disposed of.	Specific recommendations for timing of *P. laurocerasus* control were not provided by King County; it is assumed that control can be conducted at any time of year but that herbicides should be used during dry periods to avoid runoff.
Rubus armeniacus and ***Rubus laciniatus*** (Himalayan and evergreen blackberry); Class C noxious weed; control recommended but not required		
Outcompetes native understory plants and can hinder establishment of shade intolerant native tree species	KCNWB recommends starting at the least infested areas and working to more heavily infested areas. Cut canes back leaving enough of the cane to help locate the root ball. Dig out root ball using a shovel, claw mattock, or other hand tool. Roots, crowns and stems with berries should be disposed of in the trash; stems can be disposed of on-site but must first be completely dried out to prevent them from re-rooting. Revisit cleared areas periodically to check for re-growth of blackberry; conduct additional follow-up control as needed. When using herbicides, use the cut-and-paste method (cut the stem and then apply herbicide to the cut portion of the remaining plant).For large infestations where there are few desirable native species (such as the one near Transect 27), herbicide use is often more economical than manual control.	Do not remove large patches during bird breeding season (March through June). Manual control is often easiest in the spring or fall when soil has been loosened by rain. Glyphosate-containing herbicides are most effectively used for the control of blackberry in September-October.
Senecio jacobaea[c] (tansy ragwort): Class B noxious weed designated for control; control is required		

Ecological Impacts	Control Methods	Time of Year for Control
The plant is toxic to livestock and deer.	Small infestations can be removed manually by hand or with hand-held weeding tools. Be careful not to spread seed if removing plants after seeds have formed. Bag pulled plants and dispose of in the garbage (seeds can still develop on pulled plants). Herbicides can be used for control of larger infestations but large infestations are not expected in Salmon Creek Ravine. Take precautions such as washing boots, tools and vehicles that have been in contact with *S. jacobaea* patches to prevent the spread of seeds. In the spring and summer following removal, monitor areas where *S. jacobaea* was removed for new plants sprouting from residual seed.	Pull *S. jacobaea* after it bolts but before it flowers, usually from May through June. It is easiest to identify for removal in June or July when in flower.
Solanum dulcamara (bittersweet nightshade): Weed of Concern; control recommended but not required		
Can form thicket along the ground and climb trees; can become dominant along stream banks, crowding out native vegetation and causing channel disruption; toxic to animals and people	Small infestations can be removed manually. Hold stem close to the ground and gently pull to remove all roots; use weeding tools such as cultivators or mattocks to assist in removing below ground growth; cut back above-ground growth to allow access to the root systems when necessary. Roots and crowns should be disposed of in the trash; stems can be disposed of on-site but must first be completely dried out to prevent them from re-rooting. When *S. dulcamara* is located in an area that cannot be cleared or tilled (due to the presence of rocks, dense desirable native vegetation, etc.) other methods such as repeatedly cutting the vines back to starve the roots, cutting back and then covering with a weed barrier, or the use of an herbicide can be employed.	Manual control can be done at any time of year but is often easiest in the spring or fall when soil has been loosened by rain. Herbicides are most effective when used during dry, warm weather periods (e.g., August – October). If using herbicide in an area where native herbaceous plants are also present, apply when native species are dormant. Different lengths of time will need to pass prior to replanting areas treated with herbicide depending on the product used (see Appendix E for specifications).

[a] *L. galeobdolon* and *C. arvensis* were observed in only one location during the vegetation assessment. Both of these species were growing near the southern entrance to the Salmon Creek Ravine off 16th Ave SW (Map 8).

[b] Much of the ivy observed may actual be *Hedera hibernica*; however, the control methods for *H. hibernica* and *H. helix* are the same.

[c] Scattered individual *S. jacobaeac* plants were observed growing along the gravel access road in late summer. All *S. jacobaeac* observed during the vegetation assessment was removed and disposed of in the garbage. The gravel access road should be monitored for this species each summer. *S. jacobaeac* was not identified anywhere else in Salmon Creek Ravine.

KCNWCP – King County Noxious Weed Control Program

Noxious Weed Classes
B – Non-native species not designated for control but control recommended; transporting, buying, selling or otherwise distributing the species is prohibited
C – Non-native species that can be designated for control based on local priorities (control recommended but not required in King County)
Weed of Concern - control recommended in natural areas and protected forest lands; new plantings discouraged especially where species could escape to forest lands

In addition to the species listed in Table 5-1, *P. arundinacea* (reed canarygrass) was observed within several of the sampling transects during the vegetation assessment; however, it is not specified for control as part of this plan because it was present only in small patches growing beneath the forest canopy. It is expected that these infestations will remain small as long as they are shaded, and targeted control should not be necessary.

With invasive species control, it is generally most effective to work from the least heavily-infested areas to the most heavily-infested areas. When large patches of invasive plants are cleared, the area should be replanted with suitable native vegetation (see Section 5.2) to reduce the risk of erosion and recolonization by invasive species. Follow-up monitoring for invasive plants that may have been missed or that may have regrown should be conducted routinely. Many of the invasive species in Salmon Creek Ravine contain toxic compounds that some individuals may be sensitive to (KCNWCP 2011). When working with invasive species, personal protective equipment including gloves, long sleeves, long pants and closed-toe shoes should be worn. Protective eyewear may also be needed in some cases (see Appendix E).

Permits may be required or other regulations may apply when work is to be conducted in riparian, wetland or other critical areas. The Noxious Weed Regulatory Guidelines included in Appendix E provide additional information regarding these requirements. Erosion control may be required when clearing large patches of invasive species. This should be determined on a site-by-site basis. If a professional restoration group such as EarthCorps is employed to conduct invasive species removal, they should be able to provide recommendations for areas in need of erosion control and the type of control to use. The King County Surface Water Design Manual (available online) also provides information on erosion control methods.

5.2 Recommended Native Plant Species

When restoration activities call for the installation of native plants, either to replant areas where invasive species have been cleared or simply to increase biodiversity, Table 5-2 can be used to help guide species selection. This table provides lists of species that should be well-adapted to conditions within three different habitat types within Salmon Creek Ravine: higher elevation areas and ravine ridges that are drier and receive more direct light; areas along the ravine walls that are dry to moist and typically shaded by a forest canopy; and the wetland and riparian areas. The majority of these species were selected using existing vegetation in Salmon Creek Ravine as a guide; however, additional species have been included to increase biodiversity and visual interest. The additional species proposed are also widely available from native plant nurseries.

Table 5-2 Native species recommended for Salmon Creek Ravine

Habitat Type	Trees	Shrubs and Vines	Groundcover
Higher elevation upland (drier, more sun, ravine ridges)	***A. grandis****, A. macrophyllum, A. rubra, C. nuttallii,* ***Pinus monticola*** **(western white pine),** *P. emarginata, P. menziesii, T. plicata, T. heterophylla*	*C. cornuta, H. discolor, L. ciliosa, O. cerasiformis, P. lewisii,* ***Ribes sanguineum*** **(red flowering currant),** *R. gymnocarpa, R. parviflorus, S. racemosa, S. albus, V. ovatum*	*G. shallon, M. nervosa, P. munitum, P. aquilinum, R. ursinus, T. grandiflora, U. dioica*
Lower elevation upland (moister, more shade, ravine slopes)	*A. macrophyllum, A. rubra, C. nuttallii, P. sitchensis, P. emarginata, P. menziesii, T. brevifolia, T. plicata, T. heterophylla*	***Acer circinatum*** **(vine maple),** *C. cornuta, H. discolor, L. ciliosa, O. cerasiformis, P. lewisii,* ***Physocarpus capitatus*** **(Pacific ninebark),** ***Rhamnus purshiana*** **(cascara),** ***Rhododendron macrophyllum*** **(Pacific rhododendron),** *R. gymnocarpa, R. parviflorus, R. spectabilis, S. racemosa, S. albus, V. ovatum*	*A. triphylla, A. filix-femina, C. alpina, D. expansa, G. shallon, G. macrophyllum, M. nervosa, P. munitum, P. aquilinum, R. ursinus, S. racemosa, T. menziesii, T. grandiflora, T. ovatum*
Riparian and wetland (areas along creek channels)	*A. macrophyllum, A. rubra,* ***Fraxinus latifolia (Oregon ash),*** *P. sitchensis, P. trichocarpa, T. plicata, T. heterophylla*	***Acer circinatum*** **(vine maple),** ***Cornus stolonifera*** **(red osier dogwood),** ***Lonicera involucrata*** **(black twinberry),** *O. cerasiformis,* ***Oplopanax horridus*** **(devil's club),** ***Physocarpus capitatus*** **(Pacific ninebark),** *R. spectabilis, R. bracteosum, S. racemosa*	*A. pedatum, A. filix-femina, B. spicant, C. occidentalis, C. alpina, D. expansa, Luzula* spp.*, O. sarmentosa, P. munitum, T. menziesii*

Note: Species listed in **bold** were not identified in Salmon Creek Ravine during the vegetation assessment but could be planted to increase biodiversity.

If replanting an area suspected of being affected by root rot, woody species resistant to root rot fungi should be selected for planting. For example, *T. plicata* (western red cedar), *A. rubra* (red alder) and *Pinus monticola* (western white pine) are resistant to some root rot fungi. Plants should be installed in the fall or winter after the wet season begins. In wetland and riparian areas, plants may be able to be installed in the early spring but this is not recommended for the drier upland areas. As it will likely be difficult to irrigate plants post-installation, planting during the dry season is not recommended. After plants are installed, coarse woody mulch should be placed around the plants to help suppress weeds and retain soil moisture (this can help newly-installed plants survive the dry season while they become established). Arborist chips are a good option for mulch and are often available free of charge. Mulch should be applied in a layer three to four inches thick in a ring around the plant. Leave the area directly around the trunk or stem of the plant un-mulched to avoid rot.

5.3 Ongoing Monitoring and Photopoint Documentation

Monitoring changes in the vegetation of Salmon Creek Ravine could take many different forms depending on the resources available for a monitoring program. If adequate funding were available, the vegetation transects established in this study may be revisited in the future to collect additional monitoring data for Salmon Creek Ravine (using the GPS coordinates provided in Appendix D and the rebar markers if they could be relocated). A comparison of the data presented in this report (collected summer 2010) to data collected in the future would provide information about changes in the plant community over time and could help identify additional management priorities for the future. Qualitative monitoring could be conducted by periodically scouting the MZs for invasive weeds (this type of monitoring could also be conducted as part of an invasive species control program).

Photo documentation can also be an important tool for monitoring changes at a site, particularly when resources for conducting monitoring are limited. A set of photos was taken from 12 designated photopoint locations in May 2011 and is included as Appendix F. All of the photopoint locations are easily accessible from the borders and trails of Salmon Creek Ravine. A map showing the locations of each photopoint, as well as a general description of each location, is provided in Appendix F. These photopoint locations can be revisited periodically to document changes through time and to help monitor the health of the forest community.

6 Next Steps

In order to implement the recommendations laid out in Section 4, the City of Burien and the Shorewood on the Sound Community Club should work together to estimate both the volunteer and financial resources that will be available to implement short-term priorities over the year of two. If possible, forecasting the resources that will be available over the next several years should also be conducted to identify medium-term and long-term priority actions that might be able to be implemented over the next several years. Based on the resources available, City staff and community members should identify which of the short-term, medium-term and long-term priorities can be feasibly achieved.

As laid out in Section 4, important short-term action items that could be conducted primarily through volunteer efforts would include invasive plant removal and native plant installation at the site entrances

and along the main trails. The restoration project at the southwestern end of the green space, adjacent to WWTP is largely complete except for ongoing monitoring and maintenance. An interpretive sign placed in this area could help share information about the importance of ecological restoration with the surrounding community and other visitors of Salmon Creek Ravine. Several different species of invasive plants are growing at the southern entrance off 16th Ave SW- this would be a good candidate for the next focused restoration effort. In addition, many invasive species are growing along the upper pedestrian trail, gravel access road, and the trail that connects these two paths. Invasive plant removal and underplanting of native conifer trees along the pathways would be another important next step that could be achieved primarily by volunteers. Controlling invasive species along the pathways would help reduce their spread into the interior portions of Salmon Creek Ravine.

Important next steps to be conducted by City of Burien staff or other professional work crews include controlling the *Polygonum spp.* (knotweed) patch in MZ 8. This is the only patch of *Polygonum* spp. that was identified during the vegetation assessment and it should be controlled before it spreads over a larger area. The presence of this patch has been reported to King County Department of Natural Resources and Parks, which may be able to control it at little cost in conjunction with a more extensive *Polygonum* spp. effort in the adjacent Miller/Walker Creeks basin. The City of Burien could also work to secure additional funding for Salmon Creek Ravine so that professional restoration crews could be hired to carry out priority action items that cannot be achieved by volunteers.

Finally, in addition to the vegetation management plan, a baseline stream habitat survey would also provide useful information for the management of Salmon Creek Ravine. The main branch of Salmon Creek should be the priority for such a survey. A stream habitat survey should provide baseline information on the quality of habitat in the stream relative to the requirements of salmonids and other indigenous fish species reported to have historically inhabited the creek. Although there is currently thought to be no anadromous salmonid production in the creek due to migratory blockages downstream, some resident fish are expected to be present in the creek and juvenile coho salmon are outplanted in the creek by Trout Unlimited each winter. It is expected that Salmon Creek could provide limited but high quality salmon habitat in the future if migratory blockages were removed or modified. Understanding the potential habitat value of the creek and its riparian corridor would no doubt be useful for future planning.

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Maps

Appendices