Gaddis Park

Forest Analysis & Management Plan

For:

City of White Salmon

Submitted by:

Peninsula Urban Forestry LLC

PENINSULA URBAN FORESTRY

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Prepared For:	City of White Salmon
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Cover Photo:	Old growth Douglas-fir, Gaddis Park, October 2018.

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1 Executive Summary

This Forest Stewardship Plan (the "Plan") provides the City of White Salmon city staff and the community with objective analyses and expert management recommendations on the natural resources within the Park. This Plan addresses the community's concerns over recent tree failures, after ice storms and heavy wind events, forest health resiliency, forest biodiversity and public accessibility and engagement.

Gaddis Park is approximately 6.5 acres in size, with 5.5 acres currently accessible and 1.0 acres in a generally inaccessible area. The Park is a natural, native forest with multi-storied forest types. The Park has three primary different forest types, including a riparian forest, a mixed coniferous forest, and an upland forest. Elevation and distance to Jewett Creek and Little Jewett Creek are determining factors in the forest type and expressed plant community. Soils, influenced by the geography and geology of the site, also influence the tree species occupying a site.

Evidence of *red ring rot* wood decay fungi was found on Douglas-fir trees examined within the Park. Sap streams down Douglas-fir trees and entrance/exit boring holes with sap exudations are also evident throughout the Park, indicating Douglas-fir bark beetle attack (likely the Douglas-fir bark beetle, *Dendroctonus pseudotsugae*). The ongoing outbreak is significant, and treatment of unaffected, notable trees is recommended. While the forest pathogens expressed on-site are native, and their functions are crucial in native forest ecosystems, these forest pathogens are threatening more stands of trees as warm climates and summer droughts cause stress in our native trees and forests.

Within Gaddis Park, both diseased and standing dead trees that pose low levels of risk should be allowed to remain and decay naturally. This natural process of decay regenerates complex soil ecosystems, replenishes sol nutrients, and creates habitat for wildlife to explore, feed, and nest. While in the park, we noted considerable presence of wildlife, including red breasted nuthatch, red-tailed hawk, and tree frogs. Beyond the wildlife species we identified, numerous habitat snags, ground nesting dens, and other habitat opportunities were identified.

Peninsula Urban Forestry ecologists stratified the management of the park's ecosystems into three *Management Units*[1]. These units are discussed throughout the Forest Management Plan to identify distinct opportunities to increase forest resiliency, opportunities for forest restoration, wildlife enhancement, and other recommendations.

Stratification of these management units was accomplished through biological surveys of forested plots randomly generated through ESRI's ArcGIS software. Each forested plot captured 1/10th of an acre, or 4,356 square feet. Within these plots we installed a long-term monitoring stake with metallic plot center label, which we recommend engaging a long-term monitoring project with local citizen scientists, the Stream Keepers, or another non-profit or academia.

[1] Table 1

From the center plot stakes to 37.2 feet outwards in all directions, we tallied trees, shrubs, ground cover species, identified & measured *crop trees*[2], dug soil samples, and measured species diversity. A detailed study design can be located in Appendix F.

Trees and associated plant communities who favor limited water availability and tolerate drought-like conditions should be favored when implementing forest stewardship plantings and restoration within the Park. Oregon white oak and ponderosa pine are suitable candidates for the ecosystem and White Salmon's goals. Legacy restoration through the replanting of Douglas-fir should be avoided due to the high Douglas-fir bark beetle pressure within the Park and a changing weather and fire pattern. Adaptability in times of change is crucial in long-term management of natural resources.

Our executive recommendations are as follows:

- Strengthen forest resiliency through volunteer planting and restoration projects focused on increasing biodiversity and old-growth forest development. We recommend facilitating growth of Oregon white oak in the upland management unit and ponderosa pine is the mixed coniferous management unit.

- Park managers should implement anti-aggregation pheromone treatment on select old-growth Douglas-firs within the park. Treating all trees actively attacked by native bark beetles is an unattainable goal, so treatment should be directed towards trees of importance.

- Increase community engagement and stewardship of Gaddis Park through the following:
    - New or enhanced interpretative signage for the Park,
    - Organize Arbor Day plantings within the Park to supplement natural forest regeneration,
    - Enable community-wide Citizen Scientists to continue monitoring and sampling the forest plots installed by Peninsula Urban Forestry.

[2] A crop tree is the dominant or codominant representative tree species within a plot.

2 Introduction

2.1 Background

The White Salmon Tree Board, representing the City of White Salmon, asked the Consultant to develop a forest management plan for the forested natural area known as, Mamie and Francis Gaddis Park.

Gaddis Park (the "Park") is a publicly owned, forested park, that sits in the northeast corner of White Salmon along Jewett Creek. Peninsula Urban Forestry LLC (the "Consultant") conducted a forest evaluation and assessment after visiting the natural area on October 22nd, 23rd, and 24th, 2018.

Gaddis Park is a total of 6.49 acres, including a nearly inaccessible 1-acre boot shaped portion of the parcel, which extends south and is surrounded by residential private property on the northwest, and managed forests. Of the eight properties bordering Gaddis Park's parcel, only the three on the western border are private residential. The remaining parcels all appear to be privately owned and managed forest land.

A specific list of the scope of this project:

- Assess and evaluate trees & associated vegetation, forest soils, hydrological and environmental conditions, related to the forest within 6.49 acres of Gaddis Park in the City of White Salmon.
- Outline findings, discussions and recommendations in a comprehensive and holistic report to aid in the management of the forested natural area.
- Provide a map indicating management units, and other valuable forest information.
- An individual tree-by-tree inventory is not part of this scope. Instead we will stratify trees and landscapes into Management Units (MU) to be managed collectively as a whole.
- Deliverables include: Comprehensive report, GIS database in an ArcGIS file geodatabase.

Peninsula Urban Forestry, LLC consultants visited the property on October 22nd, 23rd, and 24th 2018. This report summarizes the data collected during our site reconnaissance and assessment, our conversations regarding the project, and our professional opinions and recommendations. The results and recommendations of this report represent our professional opinion compiled from on-site forensics, information provided to us, referenced material and our experience. Our recommendations are compiled with industry standards, best-available-science and currently accepted best management practices. This report is intended for the exclusive use of our Client and its agent and for specific application to the referenced property. Use this report to assist in future management decisions of subject plants and properties.

2.2 Management Units

We stratified Gaddis Park into three separate Management Units ("MU"). These MUs are stratified by forest composition & diversity, hydrology, topography and other distinct management recommendations.

As dynamic and complex ecosystems, individual MUs should be managed independently from each other. While many similarities exist across the forest system, other qualities are different and require other management methods.

Both the riparian forest and upland forest are comprised of two forested study plots, while mixed coniferous was given five due to its size and diversity.

The Plans following discussions and recommendations refer to individual MUs rather than the entire park, unless specified. A map of Management Units, and their forest plot composition, is located in Maps of Gaddis Park.

Table 1: Management Units

MU	Unit Description	Acreage	Elevation Range (ft)	Forested Plots
MU1	Riparian forest	2.0	560-610	62, 68
MU2	Mixed coniferous forest	3.4	610-690	58, 59, 61, 63, 69
MU3	Upland forest	1.1	690-750	57, 60

Figure 1: Center of Forested Plot 63.

3 Baseline Forest Conditions

3.1 Recent Park History

Gaddis Park is a mature, fully forested park located in the northeast corner of White Salmon in southcentral Washington State. The Park is within walking distance of downtown and contains trails, enabling community downtown-to-green space connectivity. Several years ago, the Jewett Creek Stream Keepers formally adopted the Park. The Stream Keepers installed a native plant interpretive trail with labelled signs corresponding to trees and plants. According to the City website, the trail has fallen into disrepair, especially due to the ice storm of 2012 (City of White Salmon, 2018). The 2012 ice storm caused downed trees and woody debris accumulation. The same City website notes a lot of work still needs to be done to "bring the park up to its potential glory."

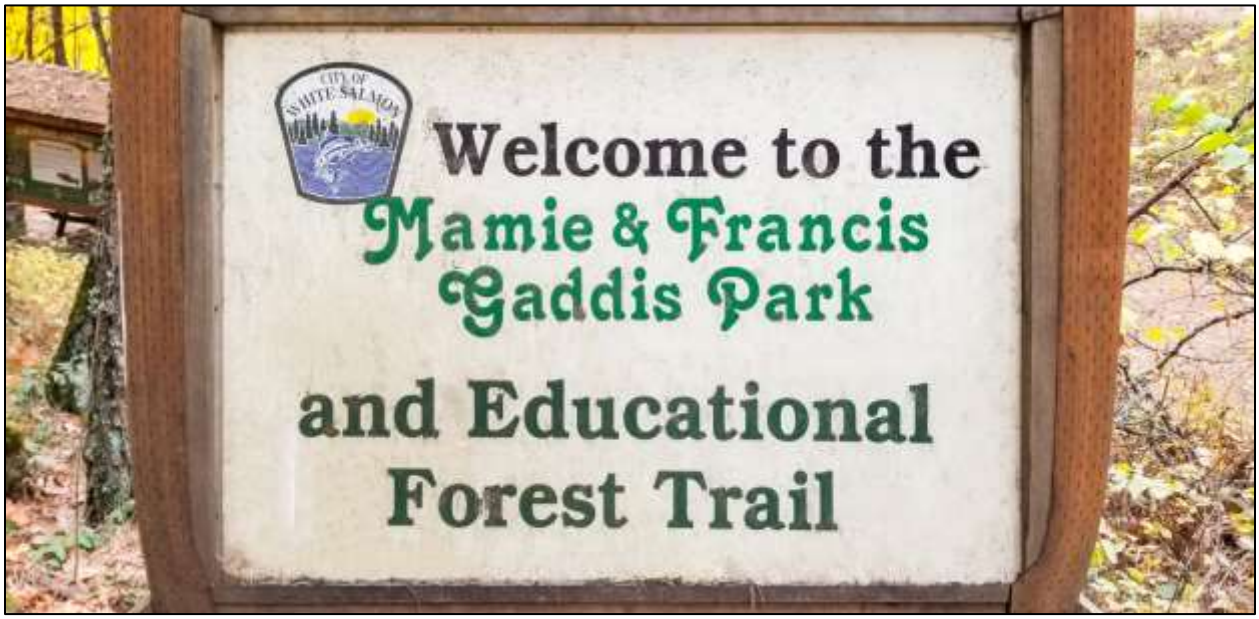


Figure 2: Entrance to Gaddis Park

3.2 Soils

A broad overview of the soils present at Gaddis Park can be found in the Soil Conservation Service publication for Klickitat County Area (2009), and the Natural Resources Conservation Service (NRCS) Web Soil Survey (2018).

Gaddis Park is underlain by four main soil types:

- Jebe gravelly loam, 30 to 75 percent slopes;
- Underwood ashy loam, 8 to 15 percent slopes;
- Underwood ashy loam, 15 to 30 percent slopes;
- Underwood gravelly ashy loam, 30 to 50 percent slopes.

The Jebe gravelly loam, 30 to 75 percent slopes are described in the NRCS survey as very deep soils formed on canyon sides in colluvium from basalt with loess and minor amounts of volcanic ash. A typical profile is 0 to 5in of gravelly loam; 5 to 31in of very gravelly loam; and 31 to 60in of extremely gravelly clay loam.

The primary soil types that underlay Gaddis Park are part of the Underwood soil series. The Underwood soils are very deep. The Underwood soil series are derived from basalt with the impact of volcanic ash in the upper portion of the soils. The soils are found on the plateaus, footslopes, and backslopes of mountains. This soil type's primary use is characterized by timber production, wildlife habitat, and crop production.

We noted forest floor characteristics in 9 sections of the Park and dug pits to ~20-30cm, depending on cobbles in the soils. Overall, we noted the soils were more cobbly than gravelly, and included large boulders throughout the Park. Some areas had limited forest floor build-up (<1cm) with rocky cobbles, while others had 8cm of O horizon, or duff, build up above the loam horizons. Throughout the loam horizons, the cobbles in the soil were significant at all sites except the sites by the riparian area.

Figure 3: Fine plant roots in upper layers of forest soils.

Slopes across the sites varied from ~10% to ~60% and slopes were measured at 9 separate, randomly selected points, corresponding to plot centers. See Table 1 for slope and aspect of randomly chosen plots throughout the Park.

Table 2: Forest types by plot number with descriptions.

Forest Type	Plot Number	Aspect (Degrees)	Aspect (Direction)	Slope (%)	Substrate Type
Riparian	62	120°	ESE	23	Next to stream and trail, berm
	68	195°	SSW	11	Floodplain, rocky streambed runs through plot
Mixed Coniferous	58	140°	SE	28	Forest floor with rock outcroppings
	59	82°	E	26	Forest floor with cobbles and large stones
	61	98°	E	59	Cobbly with heavy Oi (duff)
	63	120°	ESE	61	Split- Rock shelf, escarpment; rock outcropping
	69	142°	SE	58	Rocky with thick duff and boulders
Upland	57	180°	S	31	Rocky with limited duff
	60	94°	E	48	Rock outcropping

Figure 4: Forest soils sampling.

3.3 Hydrology

The total precipitation for the three months preceding our site visit was 0 inches, with September having missing data, according to the Dallesport Airport Station (NRCS, NWCC 2018). October 2018's rainfall was within the 30-year average. Given this data, it is possible hydrologic characteristics from precipitation were subdued compared to normal conditions. The Park is located within Water Resource Inventory Area (WRIA) 29 Wind - White Salmon, and more specifically within the 12-digit Hydrologic Unit 170701051105. Hydrologic inputs to the site are primarily through surface water flow from the surrounding landscape, with secondary inputs through precipitation and some subsurface flow. The primary hydrologic outputs are through surface water flow off the site to the south, and secondarily evaporation, evapotranspiration, and groundwater recharge in areas of non-flowing inundation (ponding).

Jewett Creek is the main hydrologic feature within the Park and originates approximately 2.25mi to the north of Gaddis Park, near Locke Hill. It then travels due south to White Salmon, where it cuts through the southeast portion of Gaddis Park, and continues to outlet at the Columbia River. The majority of the Park has a southwestern aspect that sends surface water toward the creek. At the mouth of Jewett Creek, the Columbia River has been assessed as having highly impacted water quality, with a Category 5 rating for temperature on the WA Dept. of Ecology's 303(d) list.

There are no wetland delineations available for the site, but the wetlands in the Park have been estimated by the National Wetland Inventory. Jewett Creek is the only known wetland, and the section in the park is considered a palustrine, broad-leaved deciduous forested wetland with temporary flooding. This classification is the result of the deciduous forest along the riparian flood plain, that likely experiences flooding during higher flow events. A tributary for Jewett Creek cuts through a small portion of the southern protrusion of the parcel and is considered a riverine wetland with intermittent flow over a streambed substrate, with temporary flooding.

Figure 5: Surface water and inundated soils near Little Jewett Creek.

During the Gaddis Park assessment, the stream was in a low velocity state, with an

approximate width of 12ft and approximately 1-2in of water above the surface. The streambed substrate is cobbly with scattered and sparse aquatic vegetation. The size of the cobbles indicates that the creek experiences high velocity flow events that have scoured smaller sediment sizes from the bed. Further evidence of this is shown by the cut banks on either side of the creek, which indicate erosion caused by the water. The floodplain can be seen on the contours of the site, and shows an approximately 120ft wide floodplain, where water can be expected to inundate during high flow events and may pool as it spills over from the creek. There were no obvious signs of erosion in the upland areas of the park, likely due to ample vegetation and few soil disturbances.

Jewett Creek is designated as a fish bearing stream by the WA Dept. of Natural Resources. The cobble substrate that dominates the streambed is not ideal for most anadromous fish spawning, but areas of lower velocity where gravel sized sediment has accumulated could be suitable. The well vegetated nature of Jewett Creek also benefits fish habitat by providing shade for the creek, which can help reduce the water temperature. This in turn helps combat Columbia River's temperature issue.

Figure 6: Historic well from Little Jewett Creek and spring water services era.

3.4 Forest Composition & Structure

Figure 7: Bigleaf maples, river birch and cherry understory trees.

Gaddis Park is a multi-structured natural area with several different forest types located within. The Park can be separated into three distinct forest types, a riparian forest, a mixed coniferous forest, and an upland forest. Each forest type is characterized by different tree and plant diversity as well as forest structure. Elevation as well as the distance to the stream are determining factors in the forest type and locale. Soils, influenced by the geography and geology of the site, also influence the tree species found in a specific locale.

The **riparian forest** surrounds Jewett Creek and Little Jewett Creek. Bigleaf maple (*Acer macrophyllum*), Douglas-fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), river birch (*Betula nigra*), and cherry (*Prunus spp.*) are the tree species found in the riparian forest. The dominant and codominant species are bigleaf maple, Douglas-fir, and red alder. The mid-story of the canopy is composed of river birch and cherry.

The **mixed coniferous forest**, a transitional zone, composes most of the Park area. Bigleaf maple, Douglas-fir, Oregon white oak (*Quercus garryana*), ponderosa pine (*Pinus ponderosa*), bitter cherry (*Prunus emarginata*), grand fir (*Abies grandis*), incense cedar (*Calocedrus decurrens*), Pacific dogwood (*Cornus nuttallii*), river birch, Oregon ash (*Fraxinus latifolia*), and western redcedar (*Thuja plicata*) trees were observed in this area. The dominant and codominant species are Douglas-fir, bigleaf maple, and Oregon white oak.

The **upland forest** occurs in the rocky outcroppings of the Park. Bigleaf maple, Douglas-fir, Oregon white oak, and cascara (*Rhamnus purshiana*) are the main tree species in this community. Douglas-fir and Oregon white oak are the dominant and co-dominant trees in the upland system.

Table 3 defines management units per forest structure, their management unit size, dominant and codominant trees, estimated age classes, tree stocking and elevation.

Figure 9, 10 & 11 provide a graphical representation of the structure of the management units via their tree diameter distribution and the extrapolated trees per acre within each diameter class.

A complete plant species list was compiled for each sample plot. The plots were stratified by forest composition based on dominant and co-dominant species. A summary of the species and which forest community they were found associated with can be found in Appendix C.

In addition, dominant and co-dominant trees were selected per plot and assigned "crop tree" status. These trees had heights and diameters at breast height (diameter at 4.5ft above grade) measured. Crop tree data is summarized in Table 4.

Figure 8: Upland forest system.

Table 3: Forest composition and structure summary

Mgmt. Unit (MU)	Forest Type	Stand Size (Acres)	Dominant & Co-dominant Trees	Estimated Age with Notes	Stocking (Trees per Acre)	Plots Numbers	Elevation Range of Plots	Elevation Range of MU's
MU1	Riparian	2.0	Bigleaf maple Douglas-fir Red alder	1 – 100. ~50+ 1 – 70.	~235	62, 68	600 – 605 feet	560 – 610 feet
MU2	Mixed Coniferous (Transitional)	3.4	Douglas-fir Bigleaf maple Oregon white oak	50 – 300+ – Remnant old growth is a component of this forest type. 1 – 100. 1 – 200.	~225 – with diverse diameter classes	58, 59, 61, 63, 69	630 – 660 feet	610 – 690 feet
MU3	Upland	1.1	Douglas-fir Oregon white oak	40 – 50+ 1 – 80	~395 – Bigleaf maple contributes to high stocking in small diameter class	57, 60	720 – 710 feet	690 – 750 feet

Table 4: Crop tree by forest type and plot number

Forest Type	Plot Number	Crop Tree Species	DBH (in)	Height (ft)
Riparian	62	Douglas-fir	11.7	91
		Bigleaf maple	15	68
	68	Douglas-fir	32.2	138
Mixed Coniferous	58	Bigleaf maple	8.7	68
		Oregon white oak	15.3	62
		Ponderosa pine	25.7	105
		Douglas-fir	18.2	106
	59	Douglas-fir	20.6	125
	61	Douglas-fir	27.1	97
	63	Ponderosa pine	19.9	80
		Douglas-fir	32.2	122
	69	Douglas-fir	11.8	67
Upland	57	Douglas-fir	20.2	99
	60	Douglas-fir	17.3	84
		Oregon white oak	21.7	78

Figure 9: Thimble berry (Rubus parvaflorus) in mixed canopy plot.

Figure 10: Riparian Forest – Diameter Distribution

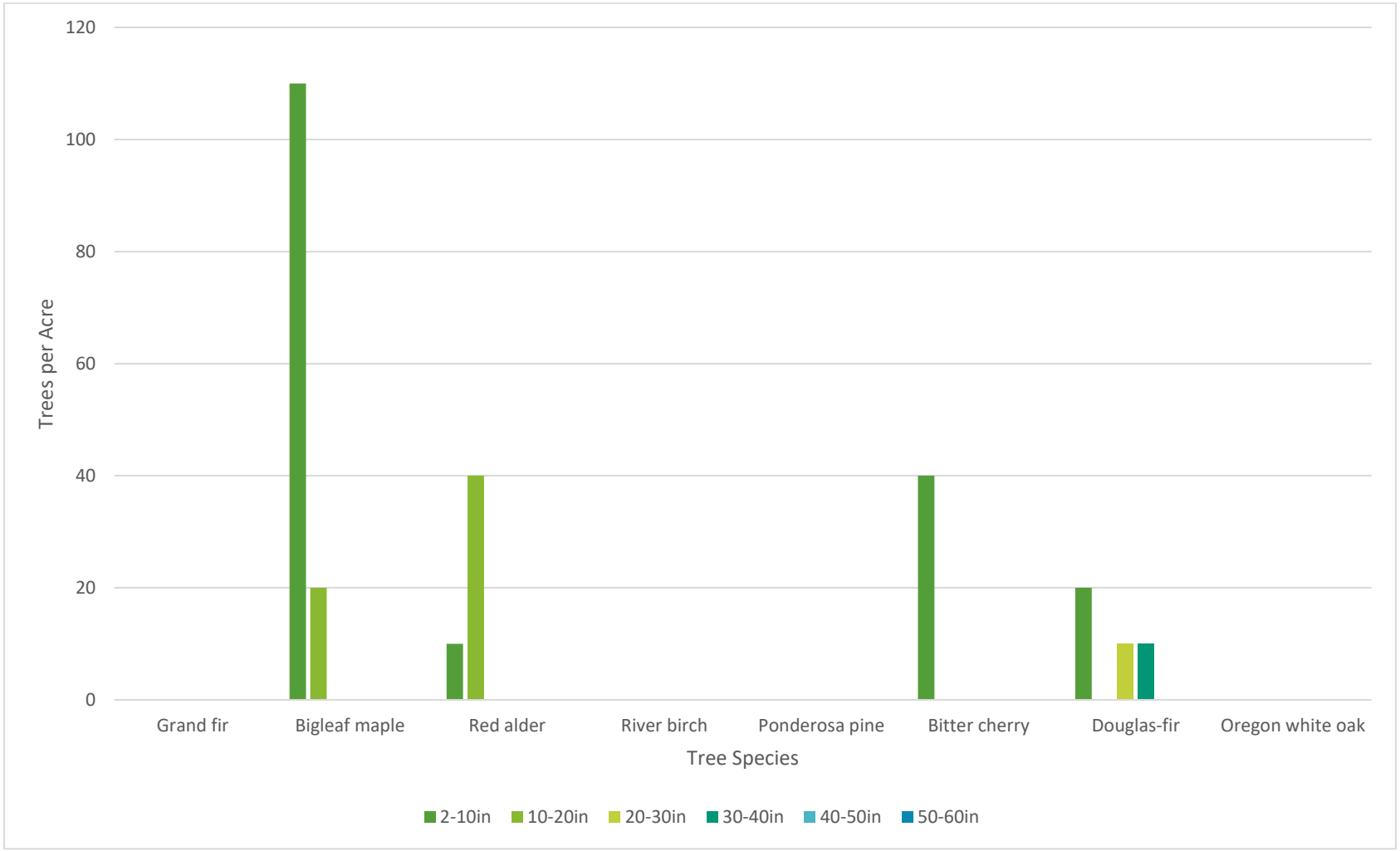


Figure 11: Mixed Coniferous Forest – Diameter Distribution

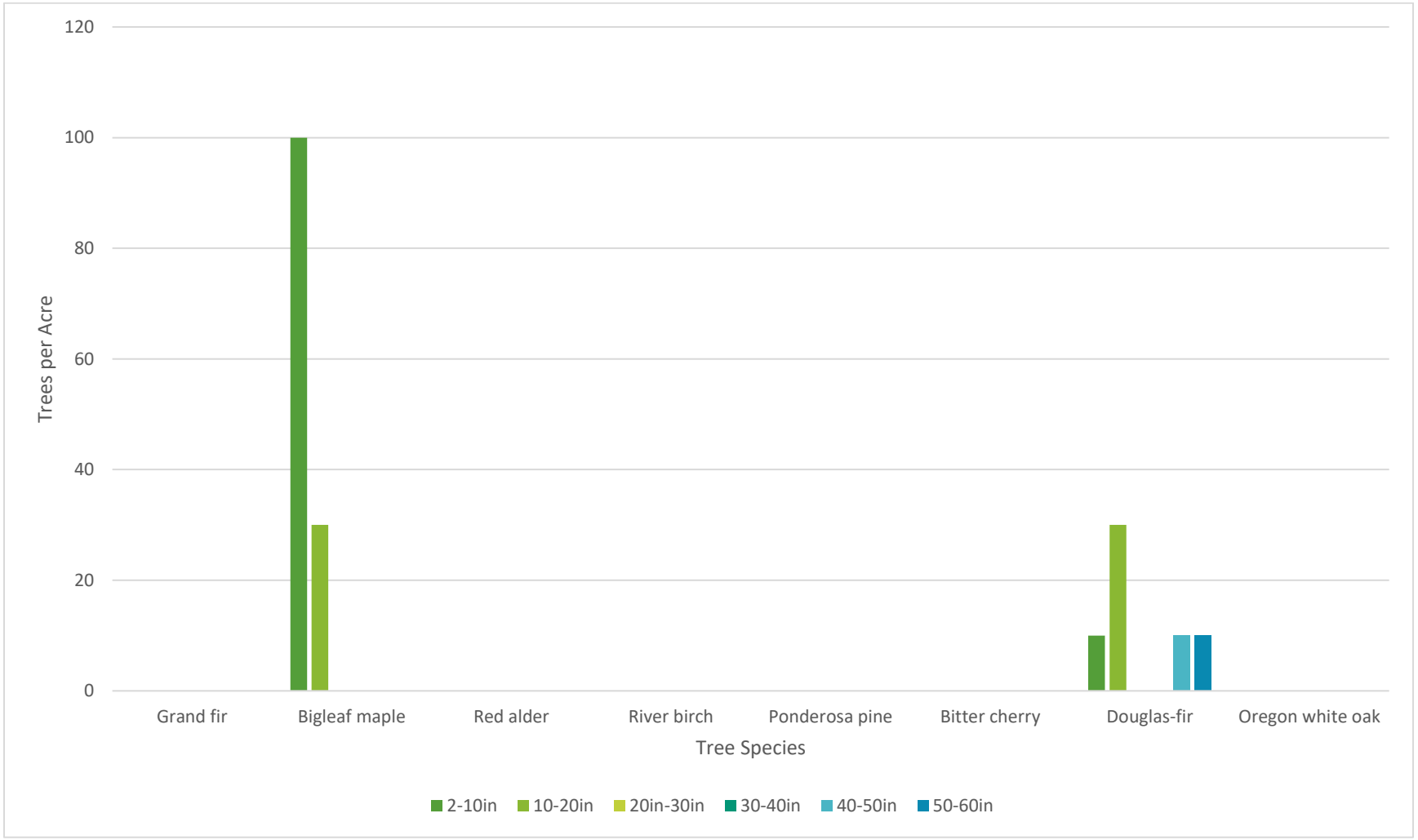
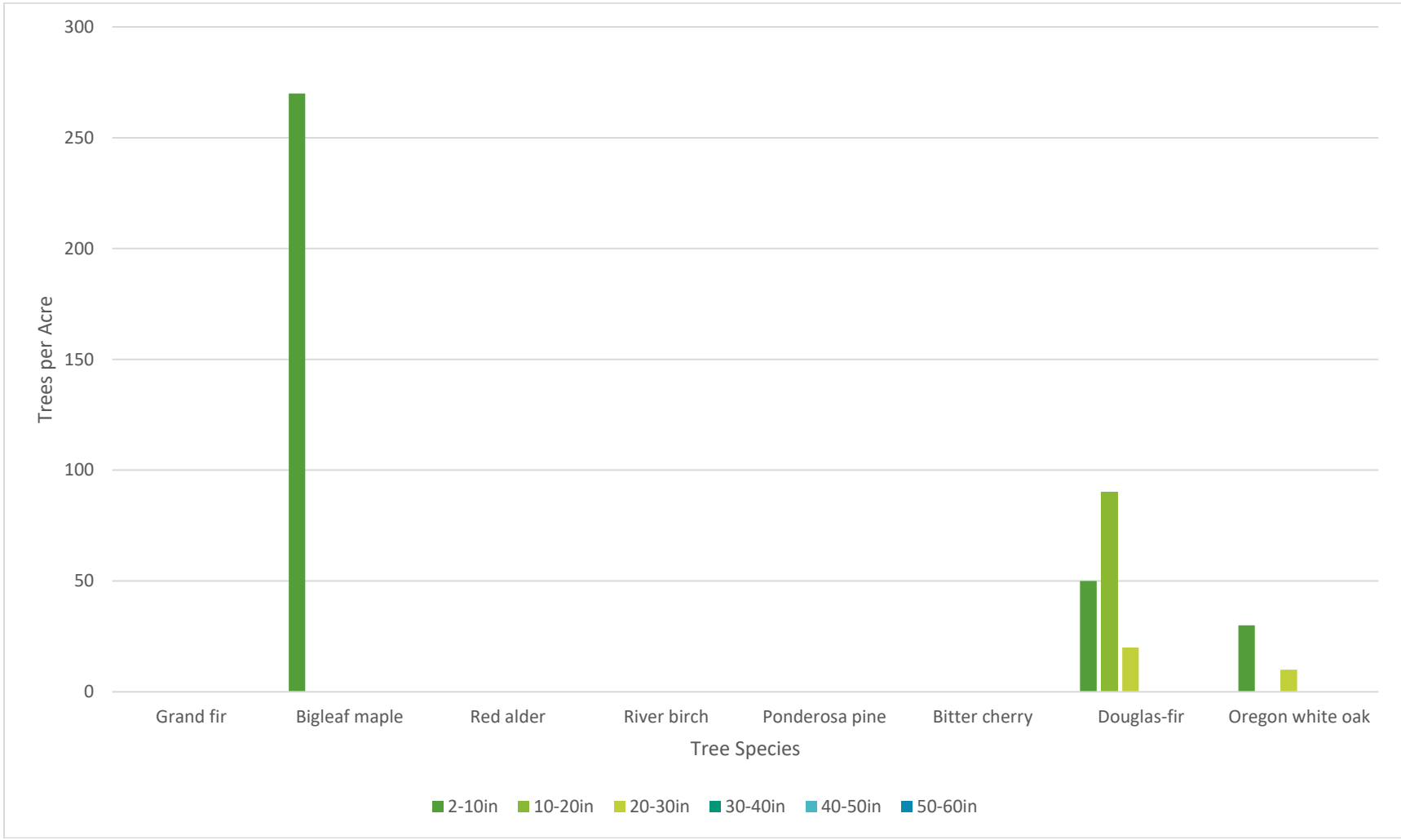


Figure 12: Upland Forest – Diameter Distribution



3.5 Forest Pathology

We observed a single pathogen and single pest in our assessment of the Park, noted below.

Porodaedalea pini

We observed *Pordodaedelea pini* conk growing on a mature, standing live Douglas-fir tree. This tree was not within a surveyed forest plot but its presence was noted while surveying the forest in general. Only a single expression of *P. pini* was observed.

Figure 14: Porodaedalea pini conk on living Douglas-fir tree.

Douglas-fir bark beetle (likely, *Dendroctonus pseudotsugae*)

Sap streams down Douglas-fir trees and entrance/exit boring holes with sap exudations are evident throughout the Park, indicating Douglas-fir bark beetle attack (likely, *Dendroctonus pseudotsugae*).

Figure 13: Dendroctonus pseudotsugae beetle galleries.

3.6 Wildlife

Habitat for wildlife is abundant in Gaddis Park. We observed the presence of habitat trees and snags, including cavities sizeable enough for owls and wood ducks. Snag (vertical deadwood) components in all forested stands are present in mixed tree ages and tree diameters. Fallen deadwood is present across the site in diameters ranging from 1-36 inches, and in various decay classes.

Large, old-growth trees used by predatory birds and migratory shorebirds are limited across the forest. Only a few old-growth Douglas-fir trees currently exist onsite, with a relatively recent old-growth ponderosa pine tree having fallen across the trail.

Priority Habitat listed by the Washington Department of Fish and Wildlife Priority Habitat Database are provided in Table 5, and the wildlife and habitat occurrences that we noted during sampling are provided in Table 6.

Figure 15: Bore holes on Douglas-fir tree indicating woodpecker feeding/nesting.

Figure 16: Ground nesting habitat.

Table 5: Priority Habitat listed by WA Fish & Wildlife.

Common Name	Scientific Name	Priority Area Occurrence Type	Status
California mountain king snake	*Lampropeltis zonata*	Occurrence	PHS Listed
Coho salmon	*Oncorhynchus kisutch*	Occurrence/ Migration	PHS Listed
Mule and black tailed deer	*Odocoileus hemionus*	Regular Concentration	PHS Listed
Northern spotted owl	*Strix occidentalis*	Management Buffer	PHS Listed
Oak/Pine forest (25 to 75% canopy)	N/A	Terrestrial Habitat	PHS Listed
Oak/Pine forest (75% - 100% canopy)	N/A	Terrestrial Habitat	PHS Listed
Rainbow trout	*Oncohynchus mykiss*	Occurrence/ Migration	PHS Listed
Resident coastal cutthroat	*Oncorhynchus clarki*	Occurrence/ Migration	PHS Listed
Summer steelhead	*Oncorhynchus mykiss*	Occurrence/ Migration	PHS Listed
Western gray squirrel	*Sciurus griseus*	Regular concentration	PHS Listed
Winter steelhead	*Oncohynchus mykiss*	Occurrence/ Migration	PHS Listed

Table 6: Wildlife sightings and indicators by forest plot.

Forest Classification	Plot Number	Snags (>4in, & 6ft)	Wildlife Sightings & Indicators
Riparian	62	11	Multiple species of birds, indicated by call
	68	9	Multiple species of birds, indicated by call
Mixed Coniferous	58	9	Gray squirrel, red-tailed hawk
	59	4	Multiple species of birds, indicated by call
	61	6	Multiple species of birds, indicated by call
	63	4	Multiple species of birds, indicated by call; Gall wasps on Oregon white oaks
	69	4	Turkeys, tree frog, Gray squirrel; Multiple species of birds, indicated by call
Upland	57	4	Multiple species of birds, indicated by call
	60	9	Red breasted nuthatch, stellar jays, red-tailed hawk, deer scraping of tree

4 Further Understanding

4.1 Forest Function

The forest at Gaddis park is a complex ecosystem providing benefits to the White Salmon community through the functions it provides. The park includes a portion of and borders a dynamic stream, identified as active Coho breeding habitat. Forests like Gaddis Park assist in the recharging of belowground aquifers to maintain long-term water availability. This protection of water resources is considerable given the changes in climate and precipitation our region is facing the next century. Through different processes, tree leaves reduce erosion and stabilize soils, maintaining adequate levels of top soil for new forest regeneration. In both the long-term and short-term, trees facilitate biotic habitat in soil ecology and regenerate forest soils. Trees reduce local climate by both shade and the process of adding water to the atmosphere (transpiration).

Community forests like Gaddis park also provide values to the community-at-large. Parks like Gaddis are a resource for improving human health and social wellbeing.[3] Forests provide passive physical benefits like air quality improvement, reducing air pollution in our surrounding community and subsequently reducing air quality related diseases and hospital trips. Forests also provide an outlet to actively improve human health through recreation: hiking and walking.

FOREST STRUCTURE & COMPOSITION

Forest structure is the horizontal and vertical spread of tree, shrub, and groundcover layers in the forest, and is a determining factor in what wildlife species and forest pathogens will inhabit a site. Tree diameter distributions, examined in classes, yields an analysis of the forest stand structure. Tree & plant diversity represent the number of different species and their abundance that are contained within each community, or forest type. Forest heterogeneity also plays an essential role in determining wildlife species presence, as well as forest pathogen presence.

Forest composition is shaped by events called 'disturbances.' A disturbance is a natural or human-caused event that causes an alteration in the structure and composition of a forest ecosystem. Disturbances test a forest's *resiliency*, or how quickly an ecosystem and adapt or recover after those disturbances.

Native forest pathogens and insects in the landscape, like *Porodaedalea pini*, kill trees and create gaps in the canopy. This is known as gap dynamics, when openings in the canopy happen and free up resources for new growth to occur. New cohorts of trees can grow, and this creates structural complexity in the forest. As forest succession is ongoing, native pathogens play a role in creating gaps for new trees and plants to grow. Furthermore, native forest insects and

[3] Wolf 2018

pathogens are naturally occurring constituents of the forest ecosystem and play an essential role in the dynamics of successional processes.

FOREST BIODIVERSITY[4]

Biodiversity is the spatial and genetic diversity of plant and animal species. Biodiversity includes spatial diversity of ecosystems that support both flora and fauna and the interactive processes they engage in.

Washington State has 3,100 vascular plant species, 140 mammals, 470 freshwater and marine fishes, 341 birds, 25 amphibian 21 reptiles, an estimate of thousands of mosses, lichens, liverworts and fungi and an estimated 20,000 invertebrates (including more than 2,000 moths and butterflies). Increased biodiversity (both spatial and genetic) and resiliency directly correlate with each other. Greater biodiversity enhances a forest's resiliency to withstand adverse effects from a variety of sources.

CLIMATE CHANGE & FOREST CARBON SEQUESTRATION[5]

Within the next 100 years average annual temperatures in Washington are projected to rise at a rate of 0.1 to 0.6 °C. Precipitation forecasts are generally more uncertain, though, in general, winters are projected to be wetter and summers are projected to be drier.

These changes in our environment will affect forest resilience, regeneration, diversity and spatial distribution over time. Changes are expected in the length of growing season, plant and animal composition and distribution, water availability and duration and an increase in drought conditions during summer and fall. The single greatest forest management action to help sequester carbon is to manage stands for density, regeneration and resiliency to keep trees healthy and foster vigorous growth.

Figure 17: Photo of field surveys.

[4] LandScope 2018

[5] Lawler 2007

4.2 Forest Pathology & Pests

Porodaedalea pini

The woody bracket conk, *Porodaedalea pini*, is a white rot decay fungus often referred to as "red ring rot." This fungus most commonly occurs on older trees. The decay is a naturally occurring fungi. When this fungus affects old growth trees, it creates an excellent source of habitat as wildlife trees.

Douglas-Fir Bark Beetles

Douglas-fir bark beetle (*Dendoctonus pseudotsugae*) outbreaks are usually prompted by disturbance. The beetles burrow into the tree bark, leaving 'frass' on the outside of the tree. Pitch-tubes and/or pitch streaming may occur, running down the tree from the beetles' bored holes. The beetles lay their eggs inside 'galleries' and the larvae feed underneath the bark. With 1-year life cycles, the Douglas-fir bark beetles usually emerge when the temperature is 60 degrees (in the spring normally). Most Douglas-fir bark beetles make a single attack, but about 20% of the population make a second attack (Kegley, 2011). Insect outbreaks last 2-4 years (Kegley, 2011).

The Douglas-fir bark beetles favor trees that are wounded by fire, defoliation, windthrow, root disease, or other pathogens. Stand density and weather conditions can also affect beetle populations. For example, the denser the stand, the more vulnerable the forest is to a Douglas-fir bark beetle attack (Negron et al., 1999). Additionally, larger diameter trees are more likely to be affected than intermediate or suppressed trees (Negron et al., 1999). Furthermore, there is a relationship between root-diseased Douglas-fir and native populations of beetles (Wright and Lauterbach, 1958).

Figure 18: Exuding sap on Douglas-fir, a sign of bark beetle attacks.

Douglas-fir bark beetle associated mortality was observed on ~30,600 acres statewide in 2016, the highest since 2009, when wind storms battered the coast (WA DNR, 2017). Washington State DNR believes the 2016 increase may be due to the drought and defoliation by the western spruce budworm (*Choristoneura occidentalis*) in some areas (WA DNR, 2017).

Outbreaks last longer on the Eastside than the Westside of the Cascades, sometimes continuing as long eight years, instead of two to four years. This is especially true during droughty years. Triggering events include wind, snow, drought, prolonged defoliation, and wildfire. In this region, stand vulnerability to attack by Douglas-fir beetle increases with increasing stand density, percentage of large Douglas-fir, and age of Douglas-fir

4.3 Habitat Functionality - Dead Standing Trees

Structural habitat features are important to avian habitat, both ground nesters and tree nesters. Large birds like the American bald eagle and red-tailed hawk only use bare, old branches to perch. Large dead-wood and dead branches make up a complex network of available habitat for aerial avian roosting and nesting. Small dead-wood and dead fine twigs too little for tree nesting birds. Ground litter and fallen twigs do offer structural material for bird nests.

Vertical dead wood, or habitat trees, are another source of avian habitat if the vertical dead wood is above 8 inches in diameter. Horizontal dead wood (perching wood) should be at least 5 feet long and over 4 inches in diameter. Perching wood remaining in this fashion (short and stout) has low risk of failure, and the risk of damaging property is also low. Recall that our homes and structures are made of dead wood. The vertical dead wood supporting avian habitat can have more structural integrity than dimensional 4x4 lumber used in construction.

Coarse woody debris located on the ground is another structural habitat avenue for birds, plants and the forest in general. Laying large branches or large sections of tree on top of each other (securely) allows for the gradual decay and usage of the log for the forest community.

4.4 Wildlife

Western Gray Squirrel[6]

The western gray squirrel was added to Washington's list of state threatened species in 1993 when surveys indicated a decline in its geographical distribution. The species was once common at low to mid-elevations in dry forests where oak, pine, and Douglas-fir mix, and could be found in the south Puget Trough and Columbia River gorge and on the east slope of the Cascades north to Okanogan County.

Its range is now limited to three isolated populations, each of which faces serious

6 https://wdfw.wa.gov/conservation/gray_squirrel Accessed 11/1/18

threats. These threats include (1) habitat loss and degradation from human development, catastrophic wild fires, logging, fire suppression, and invasion by weeds; (2) highway mortality; (3) disease (e.g., mange, tularemia); (4) possible competition with eastern gray, eastern fox, and California ground squirrels, and wild turkeys; and (5) potential loss of genetic diversity and inbreeding resulting from the small sizes and isolation of populations. State law RCW 77.15.130 protects nest trees used by western gray squirrels.

Coho Salmon[7]

Coho salmon (*Oncorhynchus kisutch*) of the Lower Columbia/SW WA are federally threatened but have no state status currently. Salmon are anadromous, meaning that they spawn in freshwater, but reside in both freshwater (including lakes, rivers, streams, as well as wetlands) and saltwater (including estuary and open ocean) environments for at least some portion of their lifetime. Migrating salmon that rely on freshwater and saltwater environments are important because these fish combine high value to people via food, recreation, cultural importance. They provide high value to ecosystems via support to a vast array of species in fresh and salt water from orca whales, sea lions, and seabirds to otters, eagles, herons, and insects. Salmon are also important due to their environmental sensitivity to ecosystem attributes like water quality, water quantity, food sources, habitat structure and access.

Forest lands have the potential to preserve important habitat and watershed processes for salmon, if managed with care. Forest practices can harm salmon habitat if best management practices are not implemented. Forest practices can also impact salmon habitat in freshwater tributaries where streams can become clogged with sediment. Additionally, if fish are unable to access natal streams or important spawning areas due to poorly installed culverts at forest road crossings. Voluntary restoration and protection projects are a key element of regional recovery plans.

Salmon spawning and egg incubation occurs in freshwater where females construct a nest, or redd. Redd site selection is influenced by physical variables, such as stream depth, velocity, and substrate size (sand, gravel, etc.). The shallow downstream ends of pools leading to riffles contain loose gravels the product of size-dependent sediment transport and deposition following erosion upstream. Habitat structure such as large woody debris found in many streams increases the habitat complexity by creating areas with different depths, velocities, substrate types and amounts of cover, and adds stability to the redd during winter floods . In general, spawning salmon avoid the slowest water with fine sand and silt; avoid the fastest water; and prefer water about 30-60 cm deep, flowing about 30-100 cm per second over coarse sand and small to medium gravel (2-10 cm in diameter). These conditions allow a high flow of oxygenated water through the interstitial spaces in the streambed, bringing cool, well-oxygenated water to the redd and carrying away metabolic waste.

[7] Knight 2009

4.5 Forest Ecology

A diversity index is a quantitative measure that reflects the number of different species while simultaneously accounting for species evenness within an ecosystem. The Shannon Diversity Index and the Simpson Diversity Index are diversity indexes used to measure plant diversity within an ecosystem.

Simpsons Diversity Index

Simpson's index provides another way of quickly assessing biodiversity. It places a heavier emphasis on dominant, or more common, species. The value presented is 1 – D, where D = Simpson's Index, and is the common form to present the value. The higher the value, the higher the diversity. At zero the index represents a theoretical monoculture, and at one the index represents a theoretically complete diversity. Gaddis Park's value can be used with subsequent assessments to determine a general increase or decline in biodiversity.

Management Unit	Simpson Diversity Index
Upland	0.65
Mixed coniferous	0.68
Riparian	0.58

Table 7: Simpson Diversity Index

Plant Species Richness

Species richness simply quantifies how many different species exist in a population. In total, 243 plants were identified and counted in all 9 forested plots. Out of these 243 plants, a total of 67 species were identified.

The table below outlines species richness within each management unit and forested plot.

Management Unit	Plot Number	Total Species Identified
Riparian	62	21
	68	29
Mixed coniferous	59	39
	61	24
	58	29
	63	27
	69	30
Upland	57	22
	60	22

Table 8: Species richness

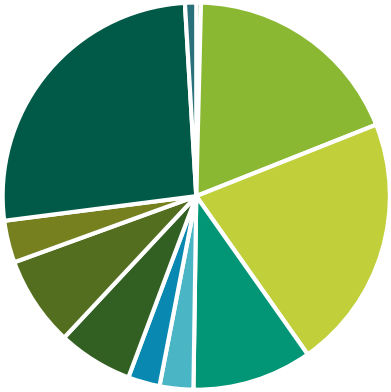
Riparian Forest Understory Composition

- Vine Maple (4.05%)
- Bigleaf Maple (7.35%)
- River Birch (8.44%)
- Beaked Hazelnut (8.03%)
- Oceanspray (12.98%)
- Dull Oregon Grape (1.03%)
- Licorice Fern (0.62%)
- Sword Fern (2.99%)
- Bracken Fern (17.78%)
- Trailing Blackberry (19.36%)
- Snowberry (17.37%)

Mixed Coniferous Understory Composition

- Vine Maple (6.81%)
- Bigleaf Maple (2.39%)
- Pacific Serviceberry (2.75%)
- Yerba Buena (10.45%)
- Beaked Hazelnut (7.82%)
- Oceanspray (7.5%)
- Western Trumpet Honeysuckle (0.97%)
- Tall Oregon Grape (0.7%)
- Dull Oregon Grape (16.21%)
- Licorice Fern (2.18%)
- Sword Fern (6.7%)
- Oregon White Oak (0.2%)
- Baldhip Rose (0.76%)

Upland Forest Understory Composition



- Bigleaf Maple (0.39%)
- Beaked Hazelnut (18.59%)
- Oceanspray (21.25%)
- Dull Oregon Grape (10%)
- Poison Oak (2.81%)
- Licorice Fern (2.66%)
- Sword Fern (6.25%)
- Oregon White Oak (7.5%)
- Baldhip Rose (3.52%)
- Trailing Blackberry (26.09%)
- Snowberry (0.94%)

5 Stewardship Strategies

5.1 Forest Ecology

Tree disease decline is usually a slow, progressive deterioration in tree health and vigor caused by many interacting factors. This process is complex and involves both abiotic (physical, chemical, hydrologic) and biotic (biological, ecological) processes. Predisposing factors of tree disease decline within this site are identified as a wind and ice storms in the area, droughty soils, and extended periods without precipitation.

Inciting factors of tree susceptibility to both colonization of Douglas-fir trees by *Porodaedalea pini* and the outbreak of Douglas-fir bark beetle attacks are the abiotic factors noted earlier as well as the age of the stand, the stocking, and the size of the Douglas-fir trees.

Forest disturbances such as tree failure and gaps in otherwise contiguous forest canopy, are onset by and often a consequence of forest pathogens (Cobb and Metz, 2017). The interaction of forest pathology and the landscape can be visualized in the disease triangle: the interaction of pathogen, environment, and hosts (trees). The type of the pathogen or pest, the environmental conditions, and the host spatial distribution all play a major role in determining tree mortality. This disease triangle drives the potential extent for a forest pathogen to cause disease and mortality within a stand of trees. Forest stress at Gaddis Park begins with abiotic factors (storms, drought, soils). Described abiotic stress increases forest pathogen and pest susceptibility, leading to the tree decline.

Many (>50%) Douglas-fir trees show signs of remnant and active sap loss via 'pitch streams' down the sides of the trees. This is a sign of a bark beetle (*Dendroctonus pseudotsugae*) attack, although this should not be used as the sole indication of bark beetle presence. Other indications of bark beetle presence include: pitch tubes and/or bore holes, boring dust, woodpecker feeding, fading foliage in the tree crowns, and gallery patterns under bark (Ross et al., 2015).

We observed bore holes, woodpecker feeding indications, and pitch streams. This is significant evidence to support the conclusion of an ongoing and extensive bark beetle attack. Outbreaks of Douglas-fir bark beetle normally occur in Douglas-fir trees that are injured, stressed, or have recently died (Ross et al., 2015). Therefore, disturbances (natural or anthropogenic) like windstorms, fire, logging, or nutrient or water stress can create circumstances favorable for the bark beetle to breed, thereby increasing their population density significantly. If the density becomes too high, they begin attacking healthy, living trees to support the population and its growth. Actively reducing beetle habitat and reducing Douglas-fir competition are responsive treatment methods to control beetle outbreaks.

It is important to note that there is little to no regeneration of coniferous or deciduous trees in Gaddis Park, except for Oregon white oaks in a limited area of the Upland

Management Unit. This lack of regenerative tree species is exasperated by the dense understory and closed canopy in most areas of the Park. We recommend the manual installation of flora rather than anticipating self-regeneration of the current tree community.

Maintaining Gaddis Park as part of the Oregon white oak, Douglas-fir, ponderosa pine ecosystem is important since it has a limited range and it is part of White Salmon's natural landscape.

The reinstallation of additional Douglas-fir trees within Gaddis Park isn't ideal. We recommend the installation of tree species which are:

1) Resistant or non-susceptible to pathogens and pests within Park
2) Tolerant to drought-like conditions

Figure 19: Mixed conifer and deciduous forest canopy.

5.2 Natural Area Education Techniques

Engaging the Public

Opportunities exist to incorporate citizen scientists, or other non-profit, and community citizenry in natural resource stewardship. A positive direction in urban forest management has been the incorporation of volunteer activities specifically managed by volunteers. This invites a level of ownership that produces urban forest *champions.*[8] Through these champions and a productive management guide, urban forest stewardship is accomplished with reduced input from city staff and city financial input.

A *Gaddis Park Stewardship Program* would outline and direct brief public training in native plant & tree identification, ecological monitoring, and restoration practices. *Volunteer Forest Stewards* would be trained to conduct Arbor Day plantings for restoration and habitat enhancement. Residents, neighbors, and community groups should be invited to participate in Arbor Day work parties as well as biennial forested plot monitoring activities. Outreach attempts should be made to engage school groups and local community groups, such as Scouting groups.

Engaging neighbors and White Salmon residents can be done in an assortment of ways, including flyers, announcements at public meetings, on the City's website and other social media outlets. Social media and in-person outreach at community events has proven to increase urban forest stewardship activities and performance.

By educating and engaging the community that utilizes Gaddis Park and cultivating the principle of environmental stewardship through volunteer project ownership, forest sustainability and resiliency will strengthen, and the public use of the Park will flourish.

Interpretative Signs

Public signage is an important act of public engagement and public education. New signage would incorporate Gaddis Park natural area functions & values and notify park users of ongoing natural processes occurring within the Park, and the importance of wildlife habitat via dead and dying trees. Signage would include planned future restoration and rehabilitation of the Park. Below is sample verbiage detailing habitat trees and ecosystem function at Gaddis Park:

"Trees within Gaddis Park are allowed to age and deteriorate naturally. By mimicking the natural processes of forests, we encourage wildlife habitat, increase biodiversity and foster native soil production.

Natural tree failure is a part of this process, as such, the use of Gaddis Park should be limited to days with typical weather conditions.

Please be aware of the forest around you when visiting the park during heavy rain, snow, ice, or strong winds as these weather patterns increase likelihood of tree and branch failure."

[8] Local volunteer who performs above and beyond the normal volunteer duty spectrum.

Simpler signs, like Figure 19 below, can also be used.

Figure 20: Tree failure warning.

Furthermore, future restoration efforts, Park history, existing wildlife, and other information included on the current educational signs could be reincorporated in future educational signage. The walking path should continue to be maintained as an interpretative trail. Pamphlets identifying tree species with pictures and a trail map as well as signs marking plant and tree species along the trail would provide an ideal experience for the community and visitors.

Forest Plot Monitoring

Forest monitoring is the significant step in maintaining a forested greenspace as it provides ongoing information on the condition and actions needed to ensure long-term management success. Peninsula Urban Forestry installed nine permanent forest plots at Gaddis Park, all staked, labeled and GPS coordinates. Scientific monitoring is a quantitative methodology that is a more rigorous data collection approach. Permanent plots allow volunteers to evaluate site conditions in greater depth.

The Consultants encourage city staff to assist the public in continuing these nine forest monitoring plots as a student project, citizen science engagement, or other Arbor Day event.

Tools needed for permanent forest plot monitoring include, forestry diameter tape, native plant identification manual, measuring tape, densiomiter (if available), compass, clinometer or range finder.

For detailed information on the forest plot studies, and to recreate the Consultant's study, see Appendix F.

5.3 Wildlife Stewardship

Wildlife Habitat Enhancement Principles

Wildlife trees are both dead trees (snags), dying trees and living trees with dead parts. These trees can contain nesting cavities and bird feeding holes. Standing and decaying trees should be protected as decay provides additional cavity habitats, while replenishing soils. Retain both trees with broken tops and trees with multiple tops as these large perches act as large avian habitat. Downed logs should be retained especially those in advanced levels of decay.

Wildlife snags can be created to mitigate for identified and assessed hazard trees within the Park. Allowing a Certified Arborist or other tree professional to convert hazard trees into habitat trees will increase wildlife availability. Habitat trees should be between 15-30 feet tall, depending on species and decay class. Tree risk is associated through different tree parts (i.e. tree branches, canopy, tree trunk, roots). When a tree's canopy or branches are the only hazard, habitat conversion is a good mitigation technique. Owls, bats, wood ducks, woodpeckers and other animals use these habitat trees as their nests and for breeding.

Stacks of branches and stems "jackstrawed" or crisscrossed over themselves act as excellent ground habitat. Branches can be any size, but generally are over 4" in size. Incorporate this technique into trail cleanup: when a tree falls onto the trail, throw branch material off the trail but retain it in a pile.

Understory shrubs and low trees act as preferred habitat and foraging for some bird and mammalian species. Retain shrub species such as wild rose, cascara, red and blue Huckleberry, elderberry, blueberry. Restoration plantings should emphasize plants that bear fruit for wildlife.

In addition to fruit bearing shrubs and ground cover, both flowering schedules, and flower persistence should be planned during stewardship activities. Choose plants whose flowering schedules overlap and where the plant community offers pollinators a variety of flowers throughout the season. Not all plants offer foraging for pollinators all season long. A strong and resilient plant community will offer foraging opportunities throughout the season though plants with overlapping flower timing.

Manually installed nest boxes can provide cavity habitat for nesting birds and small mammals (such as gray squirrels and chipmunks). Birds such as chickadees and wrens will use boxes installed within the forest canopy. Bluebirds and swallows will use boxes around the edges of openings. The Washington Department of Fish & Wildlife has woodworking diagrams for a variety of nest box construction projects.[9]

[9] https://wdfw.wa.gov/living/projects/

6 Forest Actions

6.1 Park Preventative Care and Restoration:

1. Follow Integrated Pest Management Plan (Appendix A). Treat healthy Douglas-firs within the park with anti-aggregation pheromone to reduce successful Douglas-fir bark beetle attacks.
    a. Treatment should occur in Spring prior to beetle emergence. Continue treatment until beetle pressure subsides.
    b. Peninsula Urban Forestry staff is available for pheromone treatment.

2. Use Arbor Day 2019 and future Arbor Day volunteer events to install tree species outlined in Appendix B with local community groups, like the Stream Keepers.
    a. Many municipalities in Washington and Oregon are now celebrating Arbor Day in October and November, rather than April, to facilitate more sustainable tree planting practices.

3. Incorporate Wildlife Habitat Enhancement Principles (Page 30) into Park restoration.
    a. Install fruit bearing shrubs and ground cover.
    b. Install plants with a wide range of blooming periods.

4. For forest restoration and regeneration concepts, see Appendix B.

6.2 Wildlife Enhancements

1. Retain all standing dead wood (habitat snags) *when* trees do not pose a threat to public park users, vehicles, or structures.
    a. For additional information, visit: https://wdfw.wa.gov/living/snags/snags.pdf

2. When a hazard tree is identified within the Park, encourage the retention of that tree trunk as a habitat tree.

3. Enhance salmon habitat by prioritizing noxious weed control in and near the riparian forest and stream corridors.
    a. Promote overhanging vegetation, and ample leaf litter within and nearby.

4. Retain fallen trees (downed woody debris) to encourage ground nesting and facilitate regeneration of native plant species.

5. Install bat, owl, flicker and woodpecker habitat through nest boxes attached to trees. Use Washington Department of Fish & Wildlife Specifications.

6. Retain smaller woody debris in piles on the forest floor. When clearing trails, do not heavily disperse branch material.

6.3 Park Maintenance and Education Opportunities

1. Maintenance of current Park trails by clearing downed logs and debris that fall across trails. Leave woody debris on site to decay naturally.

2. Install or enhance educational signage as outlined in Natural Area Education Techniques.
    a. Educational signage to notify park users to not engage the Park during elevated episodes of tree failure, such as high precipitation and high wind weather events.
    b. Educational signage to describe how wildlife lives, nests, forages, and hibernates in both standing and fallen dead trees.
    c. Prioritize funding to enhance current signage to revitalize the native tree and shrub vegetation identification through the walking trail.

3. Maintenance of current native plant interpretative trail to include:
    a. Correction of signage for missing plants and trees as well as missing signs
    b. Correction of unclear placement of signs
        i. Example: Placement of maple signage beside two maple species
    c. Pamphlet with plant images and locations along trail map

4. Encourage and facilitate future biennial monitoring of Consultant installed permanent forest plots by volunteer organization(s):
    a. Wooden stakes were installed at the center of all permanent forest plots. Each stake is tagged with numerical metallic tag which represents that specific forest plot number. Volunteers can revisit these plots to monitor forest composition and structure changes within Gaddis Park.
    b. This opportunity provides useful information on how the natural area changes through time and brings community involvement and engagement with their greenspace.
    c. See Appendix F for study details and standards for recreation.

7 Closing

Work for this project was performed and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. No warranty, expressed or implied, is made. Neither I, nor Peninsula Urban Forestry, has any current or prospective interest in the plants or properties discussed. Acceptance of this report acknowledges receipt and agreement with Peninsula Urban Forestry's attached Assumptions & Limiting Conditions.

Thank you for the opportunity to evaluate the landscape in Gaddis Park. We appreciate your business and look forward to working with you in the future. If you have questions now, or in the future, do not hesitate to contact us. Peninsula Urban Forestry appreciates answering any questions you may have.

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8 Maps of Gaddis Park

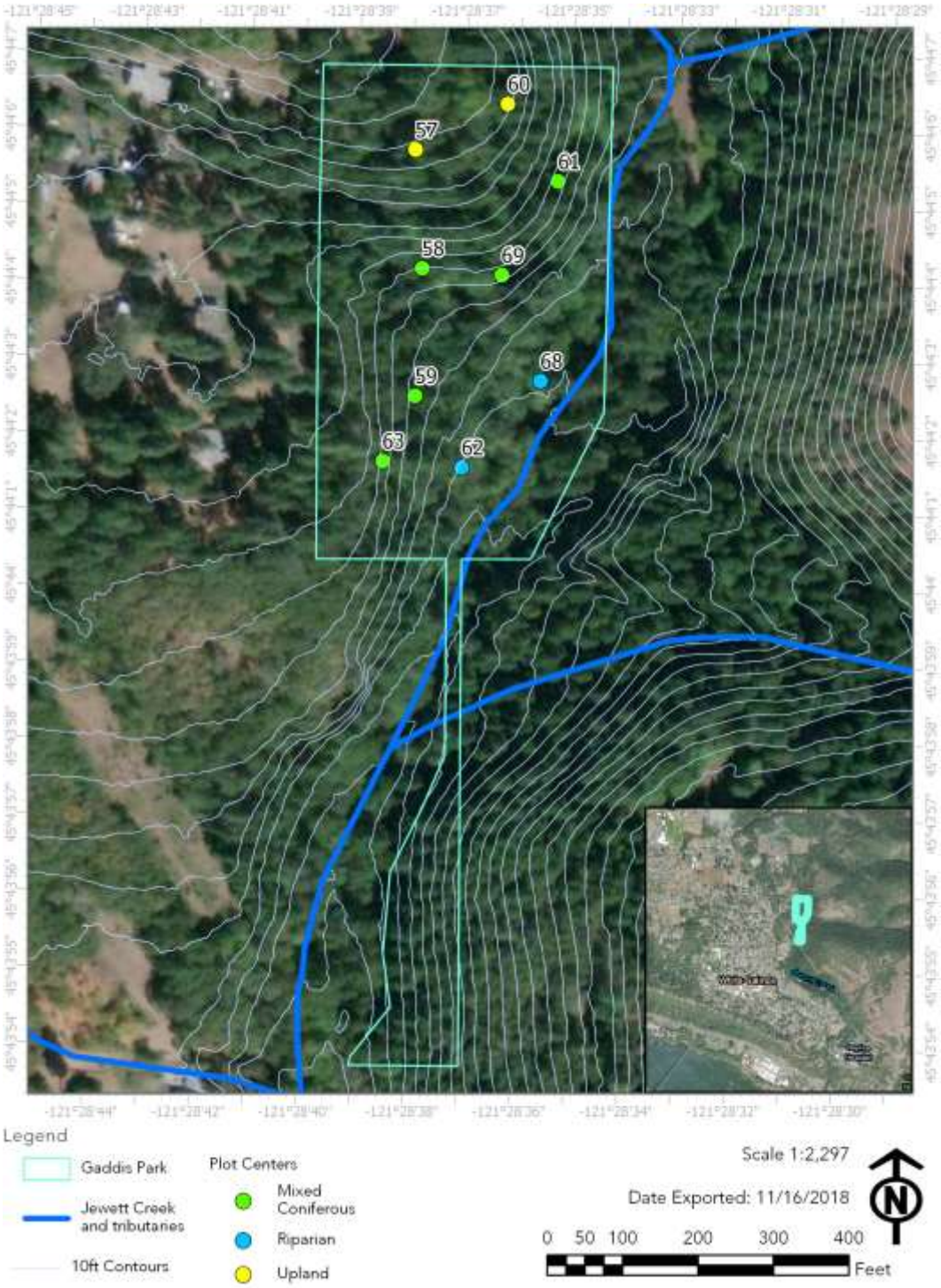


Figure 21: Overall image of Gaddis Park parcel, the study area, and landscape.

Figure 22: Gaddis Park sampling plots and management units.

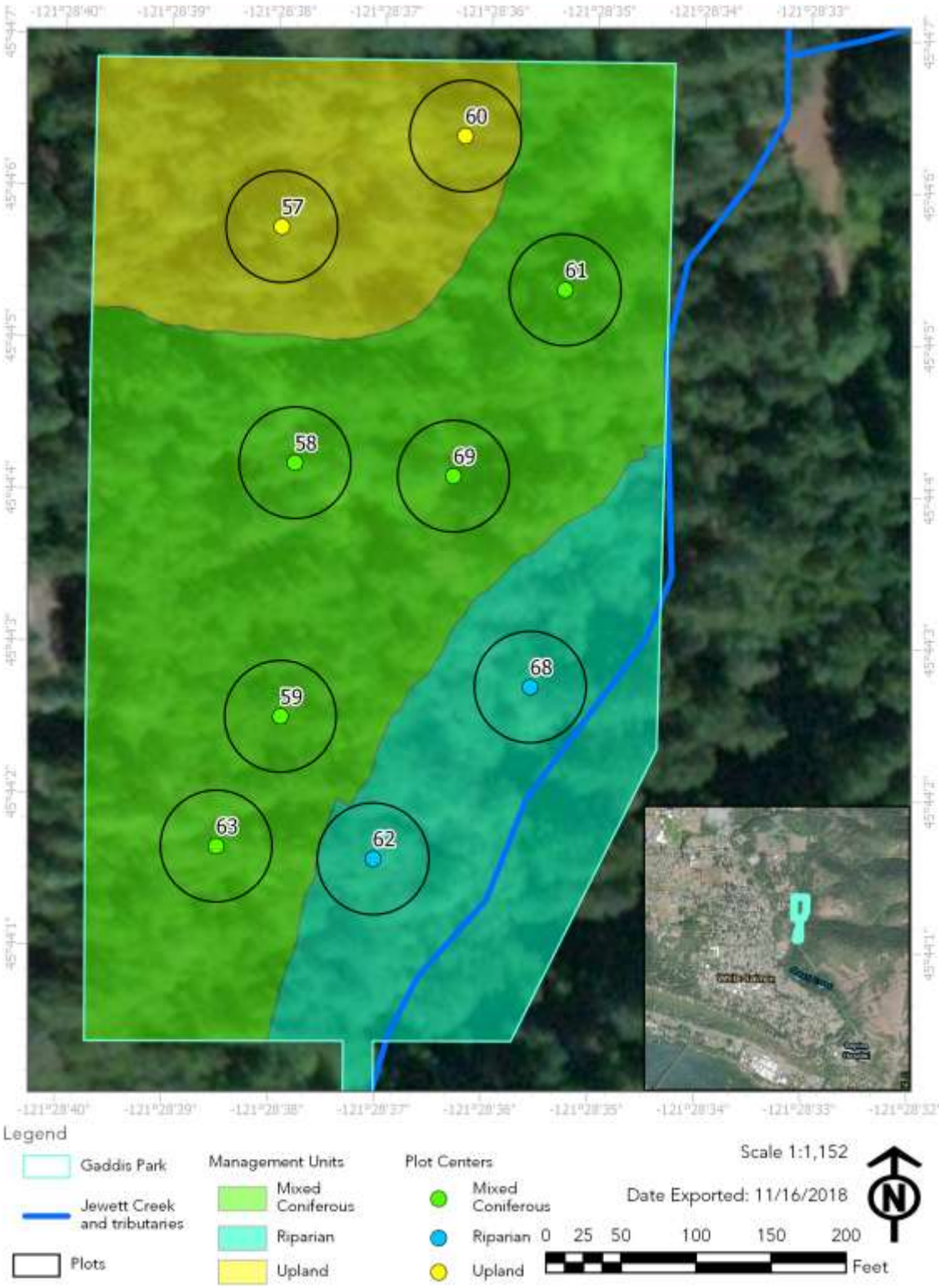
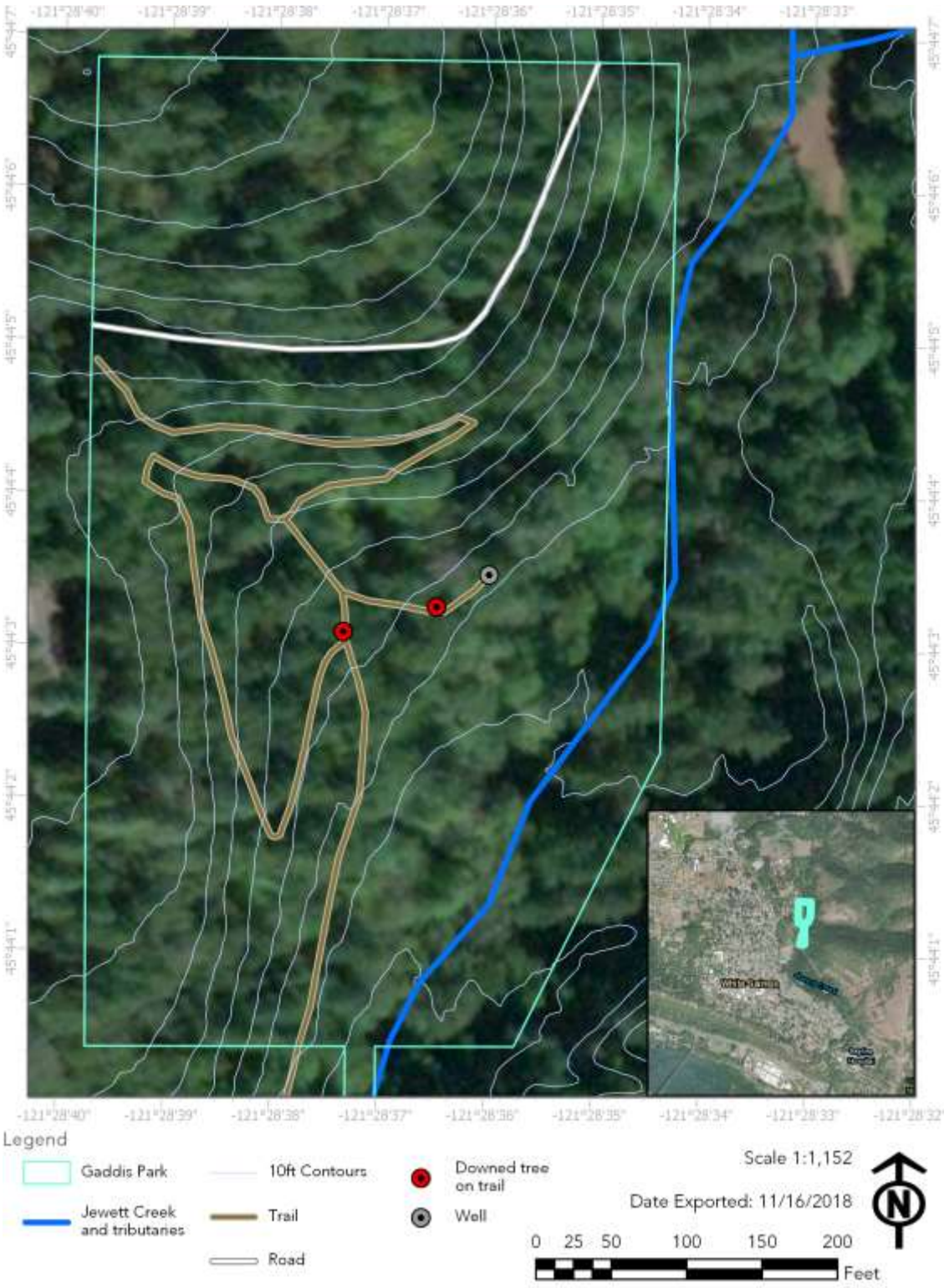


Figure 23: Gaddis Park trails and road map.



9 References and Bibliography

Allen, E., Morrison, D. & Wallis G. (1996). Common Tree Diseases of British Columbia, Natural Resources Canada, Canadian Forest Service. Victoria, BC.

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Tree Risk Assessment a. Tree Structure Assessment) (A300, Part 9) 2017. Tree Care Industry Association, Manchester, NH. 14pp.

Burns, Russell M., and Barbara H. Honkala, tech. coords. 1990. Silvics of North America: 1. Conifers; 2. Hardwoods. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC. vol.2, 877 p.

City of White Salmon. 2018. https://www.white-salmon.net/parksrec/page/gaddis-park. Accessed October 31, 2018.

Cobb, Richard C. & Margaret. R. Metz. 2017. Tree Diseases as a Cause and Consequence of Interacting Forest Disturbances. Forests: 8, 147.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. (1979). Classification of wetlands and deepwater habitats of the United States, U.S. Department of Interior, Fish and Wildlife Service, Washington, DC. 131 pp.

Dept. of Ecology. (2016). Washington State Water Quality Atlas. DOE Washington. https://fortress.wa.gov/ecy/waterqualityatlas/map.aspx?CustomMap=y&RT=0&Layers23,29&Filters=n,n,n,n

Dept. of Natural Resources. (2018). Forest Practices Application Mapping Tool. DNR Washington. https://fpamt.dnr.wa.gov/default.aspx

Devine, Warren D.; Harrington, Constance A. 2010. Planting native oak in the Pacific Northwest. Gen. Tech. Rep. PNW-GTR-804. Portland, OR: US. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 25p

Franklin, J.F., Shugart, H.H. and Mark E. Harmon. 1987. Tree Death as an ecological Process. BioScience Vol 37. No. 8.

Kegley, Sandra. 2011. Douglas-fir Beetle Management. Forest Health Protection and State Forestry Organizations. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5187396.pdf

Knight, K. 2009. Land Use Planning for Salmon, Steelhead and Trout. Washington Department of Fish and Wildlife. Olympia, Washington.

LandsScope, Washington Plant & Animals. http://www.landscope.org/washington/plants-animals/ Accessed 11/1/2018

Larson, Andrew J., James A. Lutz, Rolf E. Gersonde, Jerry F. Franklin, & Forest F. Hietpas. 2008. "Potential Site Productivity Influences the Rate of Forest Structural Development". Ecological Applications. 18(4): 899-910.

Lawler J.J. and M. Mathias. 2007. Climate Change and the Future of Biodiversity in Washington. Report prepared for the Washington Biodiversity Council.

Manion, P.D. (1981) Tree Disease Concepts. Prentice Hall, Englewood Cliffs, New Jersey.

Mattheck C & Breloer H, 1994, The Body Language of Trees: A handbook for failure analysis. The Stationary Office. London, UK.

National Wetland Inventory (NWI). 2018. Wetland Mapper. U.S. Fish and Wildlife Service. https://www.fws.gov/wetlands/data/Mapper.html

Natural Resource Conservation Service. 2009. Soil Survey of Klickitat County Area, Washington. U.S. Dept. of Agriculture. Washington, D.C.

Natural Resources Conservation Service, National Water and Climate Center. (2018). Retrieving Climate Data and Summary Reports from AgACIS. United States Dept. of Agriculture. https://www.wcc.nrcs.usda.gov/climate/navigate_wets.html

Natural Resources Conservation Service. (2018). Web Soil Survey. United States Department of Agriculture, USA. http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Negron, J.F., W.C. Schaupp, Jr., K.E. Gibson, J. Anhold, D. Hansen, R. Thier, and P. Mocettini. 1999. Estimating extent of mortality associated with the Douglas-fir beetle in the central and northern Rockies. W.J. App. For. Vol. 14, No. 3, p. 121-127.

Ross, Darrell W. K. Gibson, and Gary E. Daterman. 2015. Using MCH to Protect Trees and Stands from Douglas-fir Beetle Infestation. USDA Forest Service. Morgantown, WV.

Schwarze, Francis W. M. R. Diagnosis and Prognosis of the Development of Wood Decay in Urban Trees. Rowville: ENSPEC, 2008. Print.

Washington State Department of Natural Resources. 2017. Forest Health Highlights-2016. USDA.

Wright K. H Lauterbach P. G . Ten year study of mortality in a Douglas-fir saw-timber stand in Coos and Douglas Counties, Oregon. Research Paper PNW-RP-27. Portland, OR, USDA Forest Service, Pacific Northwest and Range Experiment Station , 1958.

Wolf, Kathleen, Ph.D., http://naturewithin.info/; accessed October 31, 2018

10 Assumptions & Limitations

1. Any legal description provided to Consultant is assumed to be correct. Any titles and ownerships to any property are assumed to be good and marketable. Consultant assumes no responsibly for verification of ownership or locations of property lines, or for results of any actions or recommendations based on inaccurate information. It is assumed that any property is not in violation of any applicable codes, ordinances, statutes or other governmental regulations, unless explicitly stated otherwise.
2. Consultant assumes no responsibilities for legal matters in character. Consultant assumes all property appraised or evaluated is free and clear, and is under responsible ownership and competent management.
3. Any evaluation or assessment carried out was restricted to the property and the plants or landscapes within the Scope of Assignment. No assessment of any other plants or landscapes has been undertaken by Consultant. The conclusions of this report do not apply to any zones, landscapes, trees, plants, or any other property not explicitly covered in the Scope of Assignment.
4. The total monetary amount of all claims or causes of action the Client may have as against Consultant, including but not limited to claims for negligence, negligent misrepresentation, and breach of contract, shall be strictly limited to solely the total amount of fees paid by the Client to Consultant pursuant to the Agreement for Services as dated for which this Assignment was carried out. Further, under no circumstance may any claims be initiated or commenced by the Client against Consultant. or any of its directors, officers, employees, contractors, agents, or Assessors, in contract or in tort, more than 12 months after the date of this Assignment.
5. Although Consultant has taken care to obtain all information from reliable sources and to verify the data insofar as possible, Consultant does not guarantee and is not responsible for the accuracy of information provided by others
6. Consultant shall not be required to testify or attend court due to any report unless mutually satisfactory contractual arrangements are made, including payment of an additional fee for such Services as described in a Consulting Arborist Agreement.
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8. Neither all or any part of the contents of this report, nor copy thereof, shall be conveyed to anyone, including the client, to the public through advertising, public relations, news, sales or other media, without prior expressed written consent of Consultant. Particularly as to value conclusions, identify of Consultant., or any reference to any professional society or to any initialed designation conferred upon Consultant as stated in its qualifications.
9. This report and any values expressed herein represent the opinion of the Consultant, and the Consultant's fee is in no way contingent upon the reporting of a specific value, a stipulated result, the occurrence of a subsequent event or upon any finding to be reported.
10. All photographs included in this report were taken by Consultant during the documented site visit, unless otherwise noted.
11. Sketches, drawings and photographs in this report, being intended as visual aids, are not necessarily to scale and should not be construed as engineering or architectural reports or surveys. The reproduction of any information generated by architects, engineers or other Consultants and any sketches, drawings or photographs is for the express purpose of coordination and ease of reference only. Inclusion of such information on any drawings or other documents does not constitute a representation by Consultant as to the sufficiency or accuracy of the information.
12. Unless otherwise agreed, (1) information contained in this report covers only the items examined and reflects the condition of those items at the time of inspection; and (2) the inspection is limited to visual examination of accessible items without dissection, excavation, probing, climbing, or coring. Consultant makes no warranty or guarantee, express or implied, that the problems or deficiencies of the plans or property in question may not arise in the future.
13. This report is based on the condition of the trees, landscape, or plants at the time of inspection.
14. Loss or alteration of any part of this report invalidates the entire report. This report is only valid if reproduced from a digital file.

11 Appendix A: Integrated Pest Management Plan

Integrated Pest Management, as defined by RCW 17.15, is a coordinated decision-making and action process that uses the most appropriate pest control methods and strategy in an environmental and economically sound manner to meet programmatic pest control objectives. The goal is to prevent pest problems, monitor pest damage, establish the density of the pest population, treat the pest problems to reducethe damage and reduce the pest populations, and evaluate the effects of pest treatments (RCW 17.15). In Washington state, there are three classes of Noxious weeds. Class A noxious weeds are non-native species whose distribution in Washington State is still limited. Class B noxious weeds are nonnative species whose distribution is limited to portions of Washington State. Class C noxious weeds are widespread in Washington or are of special interest to the agricultural industry. Under RCW 17.10 and WAC 16-750, all landowners are required to eradicate all Class A, control and prevent the spread of any Class B designate, and selected Class B or C species on their property. Prevention and eradication is the goal for Class A species. Containment and eventual reduction is the goal or Class B designates and selected weeds. It is up to the landowner to determine the method of control, but one should consider the life cycle of the weed, its extent, and its location.

This IPM program acknowledges the undesired usage of herbicides in our landscape, and clearly measuring the effectiveness of non-herbicide control with herbicide control. If manual control methods are appropriate and effective, we should use those methods to control the plants. Otherwise, we should use an appropriate and effective herbicide solution. If herbicide is the method of control, as required by Federal and State law, all herbicide application of controlled herbicide should be conducted by a licensed Washington State Pesticide Operator or Applicator.

References:

Integrated Pest Management. 1997. Chapter 17.15 RCW. Washington State Legislation. USA. https://app.leg.wa.gov/rcw/default.aspx?cite=17.15&full=true#17.15.005

Klickitat County Noxious Weed List. 2017. Klickitat County Noxious Weed Control Board. https://www.klickitatcounty.org/575/Klickitat-County-Weed-List-PDF

Noxious Weed-Control Boards. 1975, 1997. Chapter 17.10 RCW. Washington State Legislation. USA. http://app.leg.wa.gov/rcw/default.aspx?cite=17.10

State Noxious Weed List and Schedule of Monetary Penalties. Chapter 16-750 WAC. Washington State Legislation. USA. http://apps.leg.wa.gov/WAC/default.aspx?cite=16-750

Table 9: Noxious plant management

Invasive Species	Image	IPM, (Recommendation Control Methods)
Common St Johnswort *Hypericum perforatum* Klickitat County Weed of Local Concern	 Photo credit: Jolie Dollar, USDA NRCS, https://plants.usda.gov/plantguide/pdf/pg_hype.pdf	St. Johnswort was isolated to a single forested plot, though, it could be present in additional unobserved plots. St Johnswort spreads by underground rhizomes, seeds, and aboveground stems. A single plant can produce 100,000 seeds per year. Seeds can remain viable for between 10 and 30 years. • Manual: For manual removal, repeated pulls are necessary to remove all parts of the plant. The plant remnants must be removed from the site to prevent vegetative growth. • Mechanical: Mow before maturation. Cover with grass litter to reduce germination and shoot extension. • Chemical: Chemical control can be achieved by spot treating. Multiple treatments are necessary. • Biological: Biological control agents exist but are not recommended for small infestations.

Dwarf periwinkle

Vinca minor

Klickitat County Weed of Local Concern

Photo credit:
Peninsula Urban Forestry

Dwarf periwinkle is growing on the road corridor of Gaddis Park. While this plant is not a listed noxious weed, its invasive behavior is a cause for concern. Allowed to grow, the plant can quickly overtake native flora.

Drawf periwinkle is a highly shade tolerant prostate vine-like plant. It spreads via both seed dispersion and rhizomatously.

- Manual: For manual removal, repeated pulls are necessary to remove all parts of the plant.
- Mechanical: Not recommended.
- Chemical: Chemical control can be achieved by spot treating. Multiple treatments are necessary.
- Biological: None available.

Table 10: Bark beetle management

Species	Image	IPM, (Recommendation Control Methods)
Douglas-fir bark beetles *Dendroctonus pseudotsugae*	 Photo credit: USDA Forest Service – Region 4 – Intermountain, USDA Forest Service, Bugwood.org	Douglas-fir bark beetles favor trees that are wounded by fire, defoliation, windthrow, root disease, or other pathogens. Stand density and weather conditions can also affect beetle populations (Negron et al., 1999). Larger diameter trees are more likely to be affected than intermediate or suppressed trees (Negron et al., 1999). • Cultural control: Select trees to plant that are unlikely to be attacked by bark beetles in the future. • Chemical control: Beetles use to pheromones to naturally interrupt their aggregation. Therefore, beetles' attacks can be prevented by using capsules filled with the pheromone to prevent beetle aggregation on certain trees. This can avert the attacks on high value trees (Ross et al., 2015). The anti-aggregation pheromone is regulated by the EPA and must be applied by licensed Pesticide Applicators. We recommend continued application until beetle pressure subsides, normally 4-6 years in central Washington forests.

12 Appendix B: Regeneration Planting Plan

Ecological Restoration Principles

Ecosystem success is not defined by historical (legacy) plant occupancy but defined by seed sources, disturbance, and micro-climatic conditions. By examining disturbances, soils, hydrology, and other environmental conditions, we can make assumptions and draw conclusions about pairing a plant with a suitable environment to achieve optimal growth and fill an ecological niche. Following these principals, we recommend planting a mixed variety of trees which tolerate drought conditions and are resistant or unsusceptible to the pest and pathogens witnessed on site. Trees can be planted over a period of several years, until the site is at capacity.

Suitable Tree Regeneration Planting

- Garry oak, or Oregon white oak, (*Quercus garryana*) is a suitable native species for Gaddis Park's soils, droughty conditions, and rock outcroppings. Oregon white oak is a notable tree species within the White Salmon region. Oregon white oak is highly susceptible to sunlight exclusion and requires full sun to retain its health. Oregon white oak could successfully be installed in the Upland Management Unit. The non-profit organization Garry Oak Ecosystems Recovery Team (goert.ca) has successfully restored Oregon white oak ecosystems and is a useful resource for information for Oregon white oak restoration efforts.

- Ponderosa pine (*Pinus ponderosa*), although susceptible to some of the same diseases and pests as Douglas-fir, is a suitable candidate for restoration planting at Gaddis Park. This is due to the hardiness of the species with regional climatic conditions as well as the suitability to the soils in the White Salmon region. Additionally, ponderosa pine's historical occurrence within the mixed-transitional forests found throughout the Park is evident, as determined by the estimated age (100+ years) of the trees found within the Park. Furthermore, ponderosa pine is found on the fringes of Oregon white oak communities or intermixed as a mixed coniferous forest with Oregon white oak. Ponderosa pine can be planted both in the Mixed Coniferous Management Unit and in the Upland Management Unit where there are gaps in the canopy and in the understory.

13 Appendix C: Plant Species List and Associated Forest Type

Table 11: Complete surveyed plant list.

Plant Form	Common Name	Scientific Name	Riparian	Mixed Coniferous	Upland
Fern	Bracken Fern	*Pteridium aquilinum*	Y	Y	N
	Licorice Fern	*Polypodium glycyrrhiza*	Y	Y	Y
	Sword Fern	*Polystichum munitum*	Y	Y	Y
Forb	American Brooklime	*Veronica americana*	Y	N	N
	Big-leaved Sandwort	*Moehringia macrophylla*	N	Y	Y
	Bull Thistle	*Cirsium vulgare*	N	Y	N
	Cleavers	*Galium aparine*	Y	N	N
	Common Mullein	*Verbascum thapsus*	N	Y	N
	Common St. Johnswort	*Hypericum perforatum*	N	N	Y
	Cooley's Hedge Nettle	*Stachys cooleyae*	Y	N	N
	European Bittersweet	*Solanum dulcamara*	Y	N	N
	Greater Periwinkle	*Vinca major*	N	Y	N
	Hooker's Fairybells	*Prosartes hookeri*	Y	Y	N
	Large-leaved Avens	*Geum macrophyllum*	Y	N	N
	Lemon Balm	*Melissa officinalis*	Y	N	N
	Mountain Sweet-Cicely	*Osmorhiza berteroi*	Y	Y	Y
	Pacific Water Parsley	*Oenanthe sarmentosa*	Y	N	N
	Pathfinder	*Adenocaulon bicolor*	Y	Y	Y
	Red Columbine	*Aquilegia canadensis*	N	Y	N

	Self-Heal	*Prunella vulgaris*	N	Y	N
	Starflower	*Trientalis borealis*	N	Y	Y
	Stream Violet	*Viola glabella*	Y	Y	N
	Sweet-Scented Bedstraw	*Galium triflorum*	N	Y	N
	Unknown Hawkweed	*Hieracium spp.*	N	Y	N
	Unknown Saxifrage1	*Saxifraga spp.*	N	Y	N
	Unknown Forb1	Forb	Y	Y	N
	Unknown Pea	*Fabaceae* family	N	Y	N
	Unknown Saxifrage2	*Saxifraga spp.*	N	N	Y
	Vanilla Leaf	*Achlys triphylla*	Y	Y	N
	Wall Lettuce	*Lactuca muralis*	Y	Y	Y
	Wild Ginger	*Asarum caudatum*	Y	N	N
	Woodland Strawberry	*Fragaria vesca*	N	Y	N
Graminoid	Blue Wildrye	*Elymus glaucus*	Y	Y	N
	Brome Species	*Bromus spp.*	Y	Y	Y
	Dewey's Sedge	*Carex deweyana*	Y	Y	Y
	Idaho Fescue	*Festuca idahoensis*	N	Y	Y
	Unknown Scirpus	*Scirpus spp.*	Y	N	N
	Unknown Carex	*Carex spp.*	N	Y	N
Shrub	Baldhip Rose	*Rosa gymnocarpa*	Y	Y	Y
	Beaked Hazelnut	*Corylus cornuta*	Y	Y	Y
	Black Hawthorn	*Crataegus douglasii*	N	N	Y
	Dull Oregon Grape	*Mahonia nervosa*	Y	Y	Y
	Himalayan Blackberry	*Rubus armeniacus*	Y	N	Y
	Mock Orange	*Philadelphus lewisii*	N	Y	N
	Mountain Sweet-Cicely	*Osmorhiza berteroi*	N	Y	N
	Oceanspray	*Holodiscus discolor*	Y	Y	Y
	Saskatoon	*Amelanchier alnifolia*	N	Y	Y
	Snowberry	*Symphoricarpos albus*	Y	Y	Y

	Tall Oregon Grape	*Mahonia aquifolium*	Y	Y	Y
	Thimbleberry	*Rubus parviflorus*	Y	Y	N
	Vine Maple	*Acer circinatum*	Y	Y	N
	White Bark raspberry	*Rubus leucodermis*	N	Y	N
Tree	Bigleaf Maple	*Acer macrophyllum*	Y	Y	Y
	Bitter Cherry	*Prunus emarginata*	N	Y	N
	Cascara	*Frangula purshiana*	N	N	Y
	Douglas-fir	*Pseudotsuga menziesii*	Y	Y	Y
	Oregon White Oak	*Quercus garryana*	N	Y	Y
	Grand Fir	*Abies grandis*	N	Y	N
	Incense Cedar	*Calocedrus decurrens*	N	Y	N
	Pacific Dogwood	*Cornus nuttallii*	N	Y	N
	Ponderosa Pine	*Pinus ponderosa*	N	Y	N
	Red Alder	*Alnus rubra*	Y	N	N
	River Birch	*Betula nigra*	Y	Y	N
	Oregon Ash	*Fraxinus latifolia*	N	Y	N
	Western Redcedar	*Thuja plicata*	N	Y	N
Vines	Trailing Blackberry	*Rubus ursinus*	Y	Y	Y
	Western Trumpet Honeysuckle	*Lonicera ciliosa*	Y	Y	Y
	Yerba Buena	*Clinopodium douglasii*	N	Y	Y

14 Appendix D: Supporting Photos

Figure 24: Photo panoramas of riparian understory.

Figure 25: Photo of mixed coniferous plot 69; two old growth Douglas-fir trees.

Figure 26: Photo of mixed coniferous forest stand. Note bigleaf maple & Douglas-firs.

Figure 27: Photo of upland forest stand; Oregon white oaks & Douglas-firs.

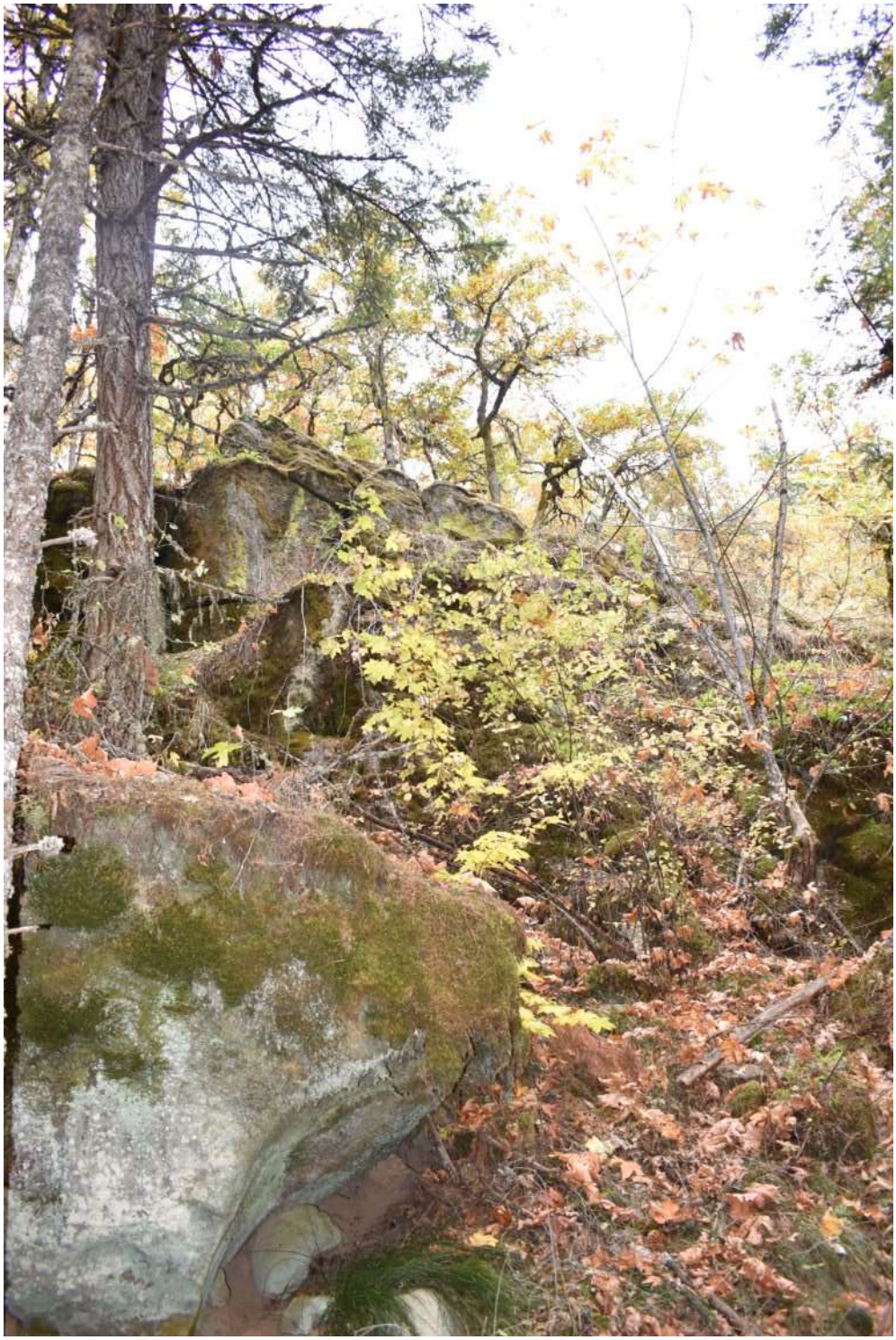

Figure 28: Photo of gall wasp galls on Oregon white oak in the upland forest

Figure 29: Photo of small woody debris across walking trails.

15 Appendix F: Study Design

The graphic below is an example of the 1/10-acre sampling plots used during the Gaddis Park assessment. 1/10th-acre plots are a standard forest plot measurement totaling 4,356 square feet. The black dot is the center point of the plot, representing the location of the wooden stakes and tags installed at Gaddis Park. Each plot has a 37.2ft radius from center plot. Densiometer readings were taken from the plot center, and all unique species of plants within the entire plot were identified and recorded. All trees over 20 feet were identified and their DBH was measured. Trees <20 feet were counted as shrub layer. Snags were counted in plots. Shrub and groundcover sampling were performed along three transects in each plot, as indicated by the lines at 120°, 240°, and 360° degrees. Start and stop positions of foliage or brush were recorded, with a null value representing bare-ground.