Mitchell Hill -- Preston Ridge -- Raging River Forest Stewardship Plan

September 2015

Report produced by Advanced Forest Ecology & Management Class Spring 2015

King County PARKS Your Big Backyard

School of Environmental and Forest Sciences

UNIVERSITY of WASHINGTON

College of the Environment

Acknowledgements

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David Kimmett, King County Department of Natural Resources and Parks
Greg Ettl, University of Washington - SEFS
Derek Churchill, University of Washington - SEFS & Stewardship Forestry
Paul Fischer, University of Washington - SEFS & Stewardship Forestry
Doug McClelland, Washington State Department of Natural Resources
Kristi McClelland, King County Department of Natural Resources and Parks

Advanced Forest Ecology & Management Class Spring 2015

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I. Property Location

- Mitchell Hill Connector Forest is 444 acres north of SE 58th Street and southwest of 298th Ave. SE, adjacent to Grand Ridge.
- Preston Ridge Forest is 215 acres north of Interstate 5 and SE High Point Way, south of 289th Ave SE.
- Raging River Natural Area is 53 acres east of Preston Fall City Rd SE and south of SE 68th St.

Parcel Number	Zoning	Acres	Parcel Number	Zoning	Acres
Mitchell Hill Connector Forest			*Preston Ridge Forest*		
1924079077	RA-5-P	20.5	3024079003	RA-10	35
1924079093	RA-5-P	20.5	3024079021	RA-10	45.3
1924079073	RA-5-P	20.8	3024079023	RA-10	0.7
1924079096	RA-5-P	20.8	3024079094	RA-10	22
1924079097	RA-5-P	20.8	3024079004	RA-10	0.8
1924079098	RA-5-P	20.8	3024079111	RA-10	12.4
1924079099	RA-5-P	20.8	2924079061	RA-5-SO	20
1924079080	RA-5-P	20.5	2924079007	RA-5-SO	20
1924079087	RA-5-P	20.5	2924079030	RA-5-SO	9.8
1924079083	RA-5-P	20.3	2924079010	RA-10	28.6
1924079095	RA-5-P	20.3	2924079028	RA-10	1
1924079085	RA-5-P	21.7	2924079009	I-P	21.9
1924079094	RA-5-P	20.4			
1924079091	RA-5-P	4.4	*Raging River Natural Area*		
1924079092	RA-5-P	23.4	2824079025	RA-10	1
1924079004	RA-5-P	8.7	2824079032	RA-10	44.9
1924079035	RA-5-P	4.4	2724079024	RA-10	6.5
1924079003	RA-5-P	21.8	2724079028	RA-10	0.7
2024079075	RA-5-SO	112.4			

Legal Description

- Mitchell Hill Connector Forest: Portions of NE ¼, NW ¼ and NW ¼ SW ¼ of Sec. 19, T24N, R07E, WM, King County, WA
- Preston Ridge Forest: Portions of SW 1/4 NW 1/4, portions of NW 1/4 SW 1/4 of Sec. 29, and portions of SE 1/4 NE 1/4, portions of N 1/2 SE 1/4of Sec. 30, T24N, R07E, WM, King County, WA
- Raging River Natural Area: Portions of NW1/2 Sec. 27, T24N, R7E and portion E1/2 Sec. 28 T24N, R7E, WM, King County, WA

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II. Executive Summary

The Preston Ridge-Mitchell Hill-Raging River Forest Stewardship Plan provides an analysis of forest health, forest resources and recommendations for management to guide the long-term stewardship of these forested properties. This stewardship plan covers the management of 721 acres of forested land included in Preston Ridge, the Mitchell Hill Connector Forest and the Raging River Natural Area (collectively known in this plan as the 'project site' or 'project area'). The plan evaluates forest stewardship options to provide continually for social, ecological and economic objectives.

Preston Ridge Forest, Mitchell Hill Connector Forest and Raging River Natural Area are each broken into management units. Preston Ridge, primarily mixed-conifer hardwood ecotypes, contains eight units, P01 to P08. Mitchell Hill Connector Forest is predominately mixed-conifer hardwoods with interspersed hardwood patches and contains four primary management units, MH01 to MH04. Included with MH01 and MH03 are hardwood patches, that when inventoried were delineated into MH01-HWD and MH04-HWD. The Raging River Natural Area is one management unit which was divided into two units for inventorying purposes, RR and RR-HWD.

Multi-age and mixed species stands are classified by 3 distinct ecotypes: mixed conifer-hardwood, hardwood, and young forest. These ecotypes best characterize the project area's forest cover. The mixed conifer-hardwood ecotype covers the majority of the project area, broken up by various sized hardwood patches. 75 acres are past clear cuts and were previously planted with conifer seedlings to various degrees of survival. Past plantations should be treated, managing densities and increasing biodiversity to create stands to meet desired future conditions. Stands of mixed conifer-hardwood and hardwood ecotypes can be treated to generate some revenue. This income should fund noncommercial treatments such as dropping and leaving trees onsite, which would be aimed at increasing the forest's resilience and resistance to climate change and disease and enhancing wildlife habitat, while increasing carbon sequestration capabilities.

Treatments aimed at restoring the forest's historic range of variability will require multiple entries of varying intensities. Variable retention harvesting (VRH) and variable density thinning (VDT) create a mosaic of skips, gaps and thinned areas resulting in increased patchiness thereby reallocating resources and restoring ecosystem functions. Management recommendations hinge on notable features including large hardwood patches, the Raging River and neighboring communities. Treating hardwood patches will help guide the management of nearby stands. Many of the current hardwood patches are reaching the upper limits of their lifespan and beginning to decline. These stands will benefit from immediate treatment and should be prioritized. Opportunity to increase shade tree cover, recruit downed wood and enhance habitat along the Raging River, critical for spawning salmon species, should also be given a high priority. Lastly, many homes surround the project areas vicinity. Community outreach and educating neighbors about forest health and operations is critical to effectively restore nearby ecosystems.

III. Introduction

The project area is distributed in three distinctively different management areas, Preston Ridge, Mitchell Hill Connector Forest and Raging River Natural Area. The project area is comprised of three varied ecotypes: the mixed conifer-hardwood forest (Ecotype A), the hardwood forest (Ecotype B) and the young forest (Ecotype C). Located in eastern King County along the I-5 corridor just east of Issaquah and west of Snoqualmie, between Falls City to the north and Preston to the south, the forests have developed over the past century, influenced by a mixture of various harvests and the growth and expansion of nearby neighborhoods. Hydrologic features, including portions of a fish bearing stream in the northeastern region of Mitchell Hill and the Raging River, a tributary of the Snoqualmie River, provide critical habitat for spawning salmon. This unique location encompasses an urban-rural interface coupled with projected growth of urban sprawl in the area thereby calling for special considerations of forest management choices.

IV. Management Objectives

The following stewardship goals guide the management recommendations in this plan.

1) Improve resilience to disturbances and climate change by increasing species diversity, conifer cover and drought tolerant species.
2) Advance the ability of the forest to sequester and store carbon by enhancing and developing old forest characteristics such as large trees with complex crowns.
3) Enhance wildlife and habitat quality by improving conifer cover in riparian areas; supporting a diverse plant community of native species; and addressing variable, patchy canopy, large snags, and downed logs.
4) Protect and restore wetlands, riparian areas and other sensitive or unique habitats.
5) Maintain and improve opportunities for trail-based recreation for the public, while enhancing the surrounding forest aesthetic.
6) Generate revenue to support stewardship of the site.

V. General Property Information

A. General description of environmental setting

The Mitchell Hill, Preston Ridge and Raging River Natural Area are composed of three distinct ecotypes: mixed conifer-hardwood, hardwood, and young forest. All three ecotypes exhibit high levels of variability. Species composition, age and structure vary widely throughout.

B. Access

Currently there is little useable road infrastructure within the project area's forested areas. These areas have not been actively managed for almost 20 years, and road infrastructure has degraded beyond use. Since future plans include forest management activities, the development of this infrastructure is necessary to efficiently and safely provide access to these areas and transport of timber products out of them.

Access rights have been established by the purchase of properties and right-of-way, and ingress/egress agreements with surrounding ownerships. However, formal infrastructure and access development is necessary. In addition, neighbor relationships need to be a priority to ensure that local communities accept current and future forest management practices.

C. History of the property

1. Mitchell Hill

Mitchell Hill was owned and logged up until the 1930s by Highpoint Mill Company, a local business. The area was left to regenerate naturally and as a result a mix of species seeded and reported around residual trees comprised mostly of large, multi-stem bigleaf maple (*Acer macrophyllum*), and these trees presently dominate much of the forest. Following the 1930s Mitchell Hill was high graded (heavier removal of the highest value trees) and unmarketable trees were left unharvested. A few large (>30" DBH) Douglas-fir (*Pseudotsuga menziesii*) and western red cedar (*Thuja plicata*) legacy trees are dispersed irregularly throughout the western portion of Mitchell Hill. The eastern portion of Mitchell Hill, acquired at a later date and formerly known as the Hooker/McCormick property, was clearcut in 1993 and planted with 300 Douglas-fir seedlings per acre. These conifers received a release cut in the summer of 1999.

2. Preston Ridge (Edge)

The eight management units making up Preston Ridge once had five different owners and were each managed differently. A pending acquisition, a a DNR parcel to be acquired through the state's Trust Land Transfer program, is fully stocked with mature, western hemlock (*Tsuga heteropylla*) and western red cedar, The Friele property was harvested about 1970 and left to reforest naturally. Due to relatively heavy ground disturbance on seasonally saturated soils it seeded-in very unevenly. In this area trees tend to be very widely spaced with vine maple and bigleaf maple dominant. The Finney and Hawhurst properties were partially harvested at about the same time, around 1970. The harvest was heavier in some areas and very light in others resulting in variable spacing and variable species composition. There are some pockets of smaller diameter red alder (*Alnus rubra*), bigleaf maple and cottonwood (*Populus balsamifera trichocarpa*), but the stand is predominantly mixed hardwood and conifer. The Rayonier parcel was harvested in 1996 and reforested with 200 Douglas-fir seedlings per acre. Maple stumps have sprouted heavily since the harvest, are multi-stem and shading out the conifers in patches.

3. Raging River (Leong)

King County based on its ecological value, and the primary objective in managing this property is to develop and enhance habitat along the east side of Raging River. This property has been logged approximately three times in the past 110 years. The initial harvest removed the most economically valuable timber and also the old growth. Hardwood species, western red cedar and western hemlock were not harvested. Subsequent harvests, around the mid-1940s or early 1950s, concentrated on the removal of second growth trees in the central and southern portions of the property. Most recently, in 1975, operations were undertaken to remove most Douglas-fir and some western red cedar, adding to the presently observable network of many old skid trails. Fire scares indicating some fire disturbance, likely pile burning, are present from over 60 years ago.

D. King County acquisition history

King County has a long term acquisition strategy in the Preston and Mitchell Hill area that would connect state and county forest lands. In the late 1990's King County, the Mountains to Sound Greenway Trust and the Washington State Department of Natural Resources (WADNR) identified the Mitchell Hill, Preston Ridge (Edge) and Raging River (Leong) properties as key to maintaining connected forestland in the rapidly urbanizing I-90 corridor. Cooperation between the three agencies led to King County acquiring a USDA Forest Legacy easement on all three sites.

The Mitchell Hill Partnership property was acquired with federal Forest Legacy funds and King County Arts and Natural Resources Initiative bond funds (ANRI). Forest Legacy is a U.S. Department of Agriculture Program that provides funds to conserve privately owned working forest lands that are threatened by development. Lands in the Forest Legacy program are prevented from being converted to non-forest use. ANRI funds were allocated by the King County Council in part to implement the King County Forestry Program and acquire working forestland. King County acquired 112 acres, consisting of approximately 58 reforested acres and 54 acres of mature mixed hardwood and conifer forest. The U.S. Forest Service holds an easement on the 112 acres as part of the Forest Legacy Program, which is administered by Washington Department of Natural Resources.

The Hooker/McCormick property was acquired through a transfer of development rights negotiation involving King County, the Hooker Family Trust, Port Blakely Communities, the Glacier Ridge Partnership, and the Mountains-to-Sound Greenway. King County acquired the land and the timber rights, and the development credits were purchased by Port Blakely with the intention that they be transferred into the Issaquah Highlands Development.

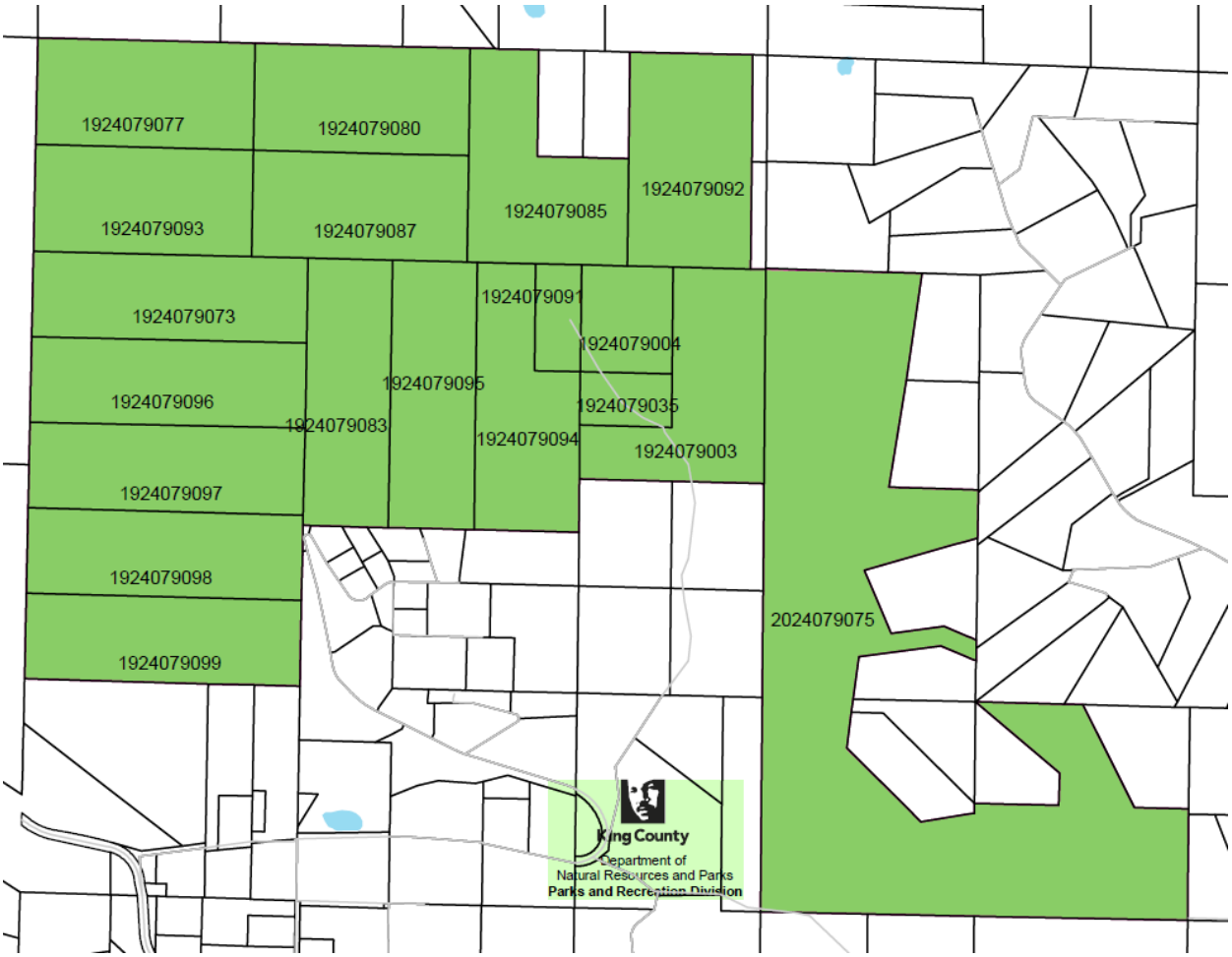
The Forest Legacy conservation easements on both properties prohibit segregation or development but allow for forest practices and passive recreational use.

King County has also used county Conservation Futures Tax (CFT) and Parks Expansion Levy (PEL) funds to acquire critical inholdings at Mitchell Hill Forest. And in 2016, King County will add 35 acres of state forest land to Preston Ridge Forest through the Trust Land Transfer program.

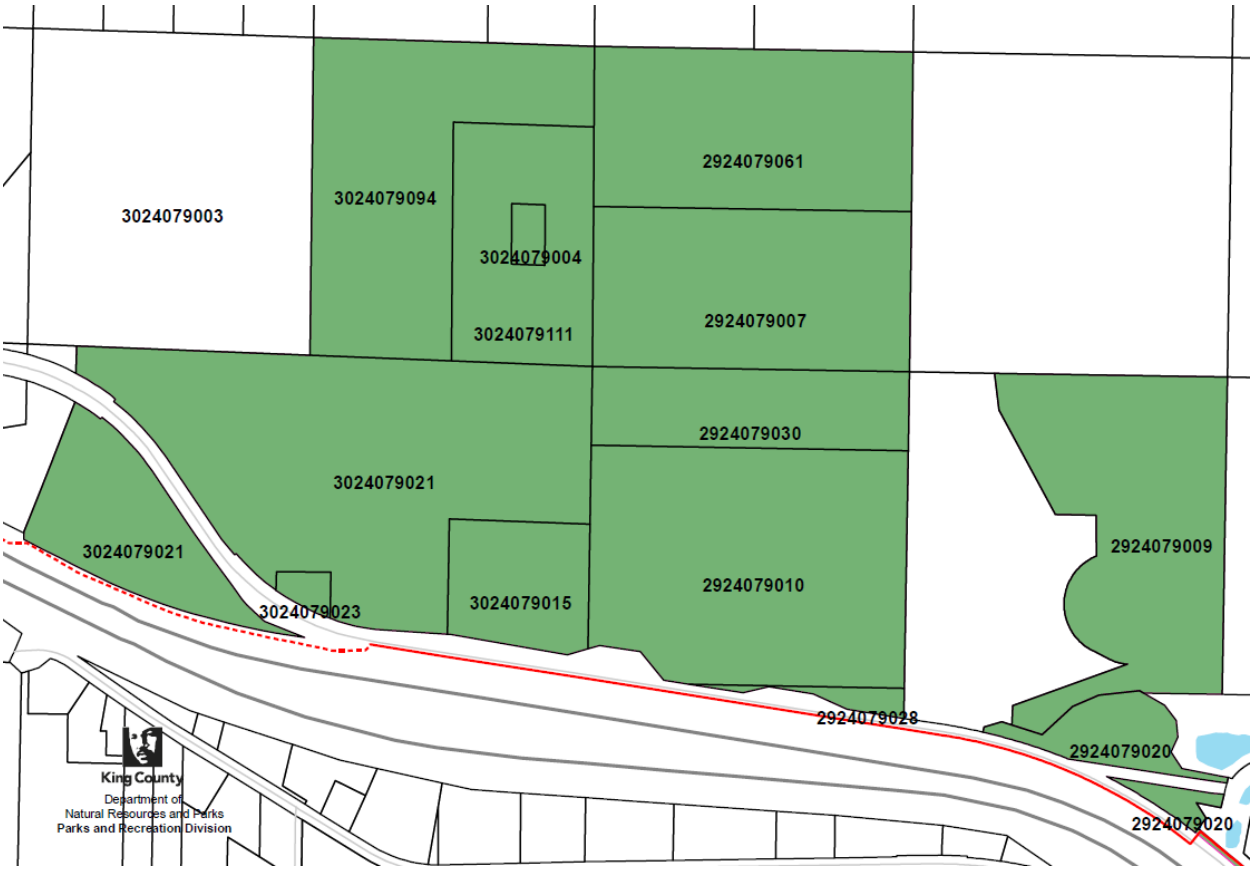
Here is the list of all parcels covered by this forest stewardship plan, including previous ownership names, funding sources, parcel identification numbers, acres and acquisition dates:

Site and parcel sub-name	Parcel number	Acres	Acquisition Date
Mitchell Hill Connector Forest			
Hooker Family Trust - TDR Sending Site	1924079096	20.74	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079099	20.89	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079087	20.25	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079098	20.78	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079077	20.55	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079073	20.72	28-Mar-00

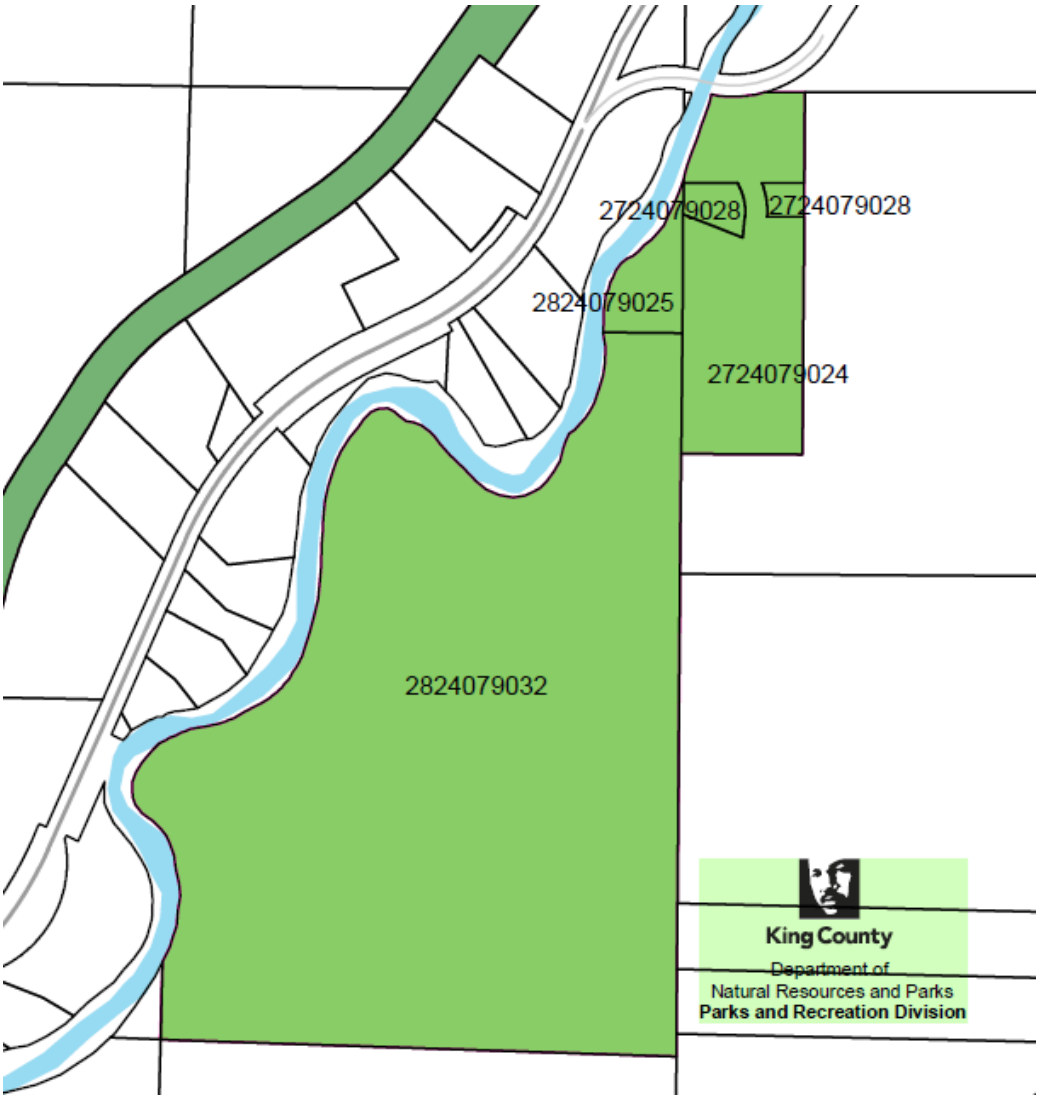
Hooker Family Trust - TDR Sending Site	1924079093	20.55	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079095	20.14	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079092	23.32	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079097	21.06	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079094	20.36	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079085	21.64	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079083	20.09	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079080	20.4	28-Mar-00
Hooker Family Trust - TDR Sending Site	1924079003	21.91	28-Mar-00
Mitchell Hill Partnership - Forest Legacy, ANRI	2024079075	12.69	5-Dec-00
Mitchell Hill Partnership - Forest Legacy, ANRI	2024079075	16.27	5-Dec-00
Mitchell Hill Partnership - Forest Legacy, ANRI	2024079075	9.74	5-Dec-00
Mitchell Hill Partnership - Forest Legacy, ANRI	2024079075	19.73	5-Dec-00
Mitchell Hill Partnership - Forest Legacy, ANRI	2024079075	8.01	5-Dec-00
Mitchell Hill Partnership - Forest Legacy, ANRI	2024079075	14.08	5-Dec-00
Mitchell Hill Partnership - Forest Legacy, ANRI	2024079075	11.92	5-Dec-00
Mitchell Hill Partnership - Forest Legacy, ANRI	2024079075	20.14	5-Dec-00
Woods - CFT, PEL	1924079035	4.37	13-May-11
Bourne - CFT, PEL	1924079004	8.67	28-Sep-12
Woods - PEL	1924079091	4.32	16-Jan-15
Preston Ridge Forest (Edge)			
Parcel B	2924079009	21.94	18-Feb-99
Parcel C - Preston Edge - Hawxhurst	3024079111	12.44	28-Dec-00
Parcel A - Friele	2924079061	20.02	28-Dec-00
Parcel B - Friele	2924079030	9.83	28-Dec-00
Parcel A - Friele	2924079007	19.96	28-Dec-00
Parcel C - Preston Edge - Hawxhurst	3024079004	0.8	28-Dec-00
Parcel C - Preston Edge - Hawxhurst	3024079094	22.06	28-Dec-00
Preston Edge - Rayonier	2924079028	0.98	2-Feb-01
Preston Edge - Rayonier	2924079010	28.64	2-Feb-01
Wickersham - REET, T-21 Grant	3024079015	6.84	13-May-03
Finney Life Estate - T-21 Grant,Forest Legacy	3024079023	0.72	23-Jul-03
Finney Life Estate - T-21 Grant,Forest Legacy	3024079021	45.32	23-Jul-03
WA DNR - Trust Land Transfer	3024079003	35	2016
Raging River Natural Area (Leong)			
Leong Main - Forest Legacy	2824079032	36.34	6-Oct-00
Leong Main -no forest easement	2824079032	10.46	6-Oct-00
Leong Split - Forest Legacy	2724079028	0.66	6-Oct-00
Leong North - Forest Legacy	2724079024	6.48	6-Oct-00
Leong Triangle - Forest Legacy	2824079025	1.19	6-Oct-00



Mitchell Hill Forest Parcels



Preston Ridge Forest Parcels



Raging River Natural Area parcels

VI. Landscape Context

A. Surrounding land use and adjacent ownership

Surrounding ownership includes state, county, and private land. Land use ranges from working forests to ecologic preserves and neighborhoods. Just south of Preston Ridge and Raging River Natural Area and across Interstate 5 is Tiger Mountain State Forest, a working forest managed by Washington Department of Natural Resources (DNR). To the north are privately owned 40-acre parcels managed for forestry or supporting forest cover. To the east and northeast is forestland managed mostly by Plum Creek and the Washington Department of Natural Resource. To the west, KCP's Grand Ridge Open Space, identified as a regional trail, separates the property from the urban densities of Grand Ridge. Homes on 5-acre lots border many of Mitchell Hill's and Raging River's boundaries.

B. Watershed conditions & implications

The project area includes portions of three HUC12 watersheds (Hydrologic Unit Code, sixth level, sub-watersheds). Two Upper Snoqualmie HUC 12 watersheds are, part of the larger Snoqualmie-Skykomish watershed. A Lake Sammamish HUC12 watershed is also within the project area, and is part of the larger Sammamish watershed. Current watershed forest cover conditions may help guide upland forest restoration and management strategies. Although watershed conditions vary greatly by forest cover, forest patch size and aggregation of forest patches, they may inform the ground treatments. In this case, conifer cover and larger patches of conifer trees >20" in diameter are greatly under-represented. Treatments prioritizing conifer retention and enhancement, in combination with planting conifer species resilient to changes in climate, will increase both species representation and forest patch size.

VII. Other Natural Resources

A. Fish & wildlife: threatened & endangered species

The project areas contain high habitat value. Raging River is a salmon spawning tributary of the Snoqualmie River. Parts of Mitchell Hill are included in King County's Wildlife Habitat Network. Large and small birds, frogs and deer were all seen in the stands. Signs of cavity excavating bird, amphibians, coyotes, bear and deer are present. Sites contain mast and forage sources through a variety of native berry bearing plants.

A bald eagle nest in a cottonwood tree.

Our objectives reflect a desire to develop and maintain complex forest structure to provide a habitat for a wide array of wildlife. Ecological goals will be achieved by increasing the quality of both near-stream riparian and in-stream aquatic habitats as well as upland forest structure and composition.

The Project area hosts State and Federally-listed species, including Coho salmon (*Oncorhynchus kisutch*, Federal candidate) and Chinook salmon (*Oncorhynchus tshawytscha***,** Federal species of concern, State monitored) that migrate and breed in the Raging River and its tributaries. Bull trout (*Salvelinus confluentus*, Federally threatened) and steelhead trout (*Oncorhynchus mykiss***,** Federally threatened) may also live in the Raging River. Bald eagles (*Haliaeetus leucocephalus*, Federal species of concern and State sensitive species) also are in the area.

B. Soils & slope stability

1. Mitchell Hill

Mitchell Hill Forest sites range from 680 to 1400 feet in elevation with annual average precipitation of 45 to 65 inches. The property ranges from flat areas to slopes of 60%. Steep slopes may limit the extent of management that is possible on the western half of the property.

Mitchell Hill is made of two primary soil series, Alderwood and Ovall, both with parent material derived from glacial till and glacial drift. Alderwood soils on the eastern half of the site consist of very deep, gravelly, sandy loam underlain with compacted till. The site is moderately well drained with moderately rapid permeability down to the till layer which has very low permeability. This soil can become saturated during the rainy season. The low capacity for available water creates drought potential in the dry months. Alderwood soils are relatively stable with low to moderate surface erosion potential. The main considerations when dealing with this soil type are its intermediate compaction characteristics, puddling potential, and tendency for severe plant competition. There is also potential for wind throw of exposed trees due to the restricted rooting depth resulting from the presence of the till layer.

Rich Ovallsoils dominate the western half of the site, and they share similar characteristics to the Alderwood series. It is well drained with moderately rapid permeability, again lending to drought potential. This soil type is stable with average compaction, puddling and erosion potential.

2. Preston Ridge

Preston Ridge's southern facing aspect ranges in elevation from 500 to 950 feet. Topography varies from flatter plateau in the north and east to moderate to steep slopes of up to 60%. The site receives an annual average precipitation in the range of 50 to 65 inches.

Soil types at Preston Ridge include Alderwood-Kitsap Complex and some Alderwood, both consisting of parent material derived from glacial till and glacial drift. Alderwood-Kitsap Complex covers nearly 80% of Preston Ridge, is moderately well drained with moderately rapid permeability down to the till layer and then very low permeability. This can lead to the soils becoming saturated in the substratum during the rainy season. Water holding capacity is low which can contribute to droughty conditions during the dry months. Alderwood is relatively stable with low to moderate surface erosion potential. The main considerations when dealing with this soil type are its medium to high compaction characteristics, high puddling potential, and the tendency for it to support severe plant competition.

Ten percent of the site is comprised of Beausite where slopes are 0% to 15%. It is well drained with moderately rapid permeability, again lending to drought potential. This soil type is stable with an average potential for compaction, puddling and erosion.

3. Raging River

This site ranges from 260 to 600 feet in elevation and receives between 35" and 65" inches of annual precipitation. Slopes of over 55% are common on most of the southern half and northwestern portions of the site. The higher elevations coincide with the steeper slopes in the southern end on this region. Gentler slopes of less than 30% are found closer to the river.

The Tokul-Pastik Complex covers 93% of the site and includes evidence of volcanic ash combined with evidence of previous burning, possibly wild but most likely from slash burning in the mid-1970s. Parent material varies between glacial till and glacial lake sediments. Tokul-Pastik Complex soils are moderately well drained, but also have moderately high water holding capacity and are fairly resistant to drought during dry summer months. These soils are easily compacted and have high erosion potential.

Aquic Xerofluvents soils occupy the ground along the northwest boundary and the Raging River. This moderately well drained, silty, alluvial soil is sometimes classified as forested wetland. Management should avoid soil compaction in all these areas on the site, but especially along the northwestern boundary where these soils are present. Due to the presence of seeps and steep hillsides draining into the Raging River many of the areas slopes are susceptible to erosion and landslides.

C. Streams and wetlands

Aquatic features, rivers, streams and wetlands are present throughout the planning area. These should be treated as sensitive management areas in an effort to limit their degradation. We propose to follow Washington State Department of Natural Recourses (DNR) forest practices handbook requirements for riparian areas. Fish bearing streams require substantial buffering. Properly buffering riparian management zones (RMZ), implementing appropriate Equipment Limitation Zone (ELZ) and leaving biologically sensitive areas untouched will limit operator's potential negative ecological impacts.

1. Mitchell Hill

One small fish-bearing (type F) stream with a bank full width of approximately 15 feet runs through the northwestern region of MH01 and into MH04. RMZ width for this stream is 140 feet, with inner and outer zones of 55 and 35 feet, respectively. The core zone remains 50 feet wide, as it does for all type F streams in western Washington. Four streams are located in the northeastern region of MH04, either non-fish perennial (Np) or non-fish seasonal (Ns). These areas are to be left untouched unless management activities are deemed worth to undertake. Any management would likely require a 30 foot ELZ along the entire length of these streams. MH04 has three additional Ns streams. Standing water can be seen in places, but no running water at the time of the inventory or later visits (May, 2015) was observed. The streams may run after significant precipitation events. A 30 foot ELZ will be implemented along the entire lengths of these streams. No functioning wetlands are located in the Mitchell Hill project area.

2. Preston Ridge

In unit P03 there are two streams running north to south bisecting the stand. The main stream begins as a Type Np stream, but after traveling about 1,000 feet from the north end of the unit boundary it turns into a Type F stream with an average bank full width of 18.6 feet. The smaller secondary stream that branches off the Np stream is classified as Type Ns. The road that parallels the fish bearing stream should remain far enough away at all points to remain useable and to keep the core area of the RMZ intact. However, erosion may be a concern along the Np stream and a 30ft buffer may be required. The red alder patch in P03 is located in an area that may be a seasonal forested wetland.

3. Raging River

This unit includes several Np and Ns streams and seasonally saturated soils. Hillsides draining into the Raging River are braided with seeps and small seasonal streams. No fish-bearing streams are located within the unit boundaries. These all drain into the Raging River, which makes up much of the unit's western boundary. The Raging River supports many species of fish, including five species of salmon. According to the original King County management plan, there are Type B wetlands present in the stand.

D. Cultural resources

Indigenous tribes in the Issaquah-Snoqualmie area almost certainly moved across this area. Although specific activities are unknown and no cultural artifacts have been recorded in the Project area, it is expected that the landscape facilitated a multitude of events, from hunting and gathering to lodging and leisure. Historic (c. 1900) logging activities may have left debris behind including cables but no known resources are in the area.

E. Agro-forestry & special forest products

Although no current economic activities or resources, excluding timber resources, are present in the project area, some passive, possible revenue generating recreation opportunities (detailed in Aesthetics and Recreation section) have been proposed. Salal, conifer branches and bows for floral bouquets and wreathes can be harvested on site. Seasonally, mushrooms may draw a market locally. Additionally, alternative services, such as developing outdoor classrooms for

delivering environmental science education to King County schools, have been proposed. Less developed concepts discussed for this site include high ropes courses and green burial cemeteries.

F. Aesthetics and recreation

At this time there is not any developed infrastructure to support recreational opportunities on any of the sites other than a small section of the Grand Ridge Trail which is open to hikers and bikers. King County envisions integrating passive recreation activities and networking interior trails with the larger surrounding trail network. The site's gentle topography, existing old logging roads and access from surrounding neighborhoods lends itself well to the construction of both hiking and mountain biking trails that could be developed in a manner that protects natural resources, habitat and water.

The primary management objective is to develop a low-impact, natural trail linking regionally significant trails from the northwest to the south. For example, the Preston area could connect Tiger Mountain State Forest through Grand Ridge Park, Mitchell Hill and Preston Ridge and then back east to Tiger Mountain. The grade would be variable traversing rolling to steep terrain, and the trail would be constructed out of native and onsite materials. The trail location should avoid sensitive areas such as riparian zones and wetlands and seek to mitigate adequately any potential impacts to the wildlife corridor. The development of such a trail offers interpretive opportunities for addressing the interrelated nature of forest resources and adaptive forest management. Forest management activities may take place adjacent to the trail.

The Mitchell Hill acquisition involves developing a new trail that extends through the Preston Ridge Forest and connects with other blocks of forest. These acquisitions are a priority in achieving forest stewardship goals such as maintaining sound forest conditions to promote the greatest biodiversity, habitat preservation and migration pathways for forest inhabitants.

Other passive recreational options might include birding observation sites, wetland interpretation sites, recreational and educational rehabilitation opportunities (eco-tourism volunteers, school projects), and opportunities to enjoy non-timber forest products such as berries and other native plants. A significant esthetic value would accrue to motorists traveling the I-90 corridor as the view of this region would be preserved and ultimately enhanced.

Landowners, recreational advocacy groups, environmental organizations, and other concerned stakeholders should be involvement in planning recreational enhancement projects. Communicating management plans to adjacent landowners allows the community to become effective partners in protecting the valuable assets inherent in the forest.

Aesthetically, the beauty of the forest is the greatest aesthetic resource. The Project area generally lacks scenic vistas, though the Raging River is a scenic resource. Existing homes in different stages of deterioration, old vehicles and machinery remain onsite throughout the project area. One house, proposed for demolition, stands in the south eastern portion of MH01. Another, mostly a ramshackle homestead is centrally located in P02. Rusted out trucks in P03 and the eastern portion of MH01 may pose some operational obstacles.

VIII. Forest Inventory: Current Vegetation Conditions by Forest Type

A. Ecotype A: Mixed Conifer-Hardwood

Mixed Conifer-hardwood forests are the predominate ecotype in the project area. Western hemlock and western red cedar, as well as varying amounts of Douglas-fir and Sitka spruce are distributed unevenly throughout the ecotype. Hardwoods include red alder and bigleaf maple, with black cottonwood and some bitter cherry (*Prunus emarginata*). The understories are dominated by sword fern, Oregon grape and salal. Vine maple, red-flowering current, red elderberry and bed straw are also present. Devil's club is prevalent in the riparian areas along with salmonberry. Invasive species present are Himalayan blackberry, Scot's broom, herb Robert, and tansy ragwort. Long lived conifer species will eventually outcompete hardwood species and dominate the ecotype.

Soils are fairly moist, and there is a thick duff layer throughout the forest. The quantity of snags and down woody debris varies but is significant throughout most of the forest, particularly in the conifer dominated stands.

Current conditions

Past harvest history and the variable degrees to which areas were replanted have resulted in various age classes and diverse structure and composition that vary throughout the ecotype. Mitchell Hill's mixed conifer-hardwood forest is broken up by pure hardwood patches, while much of Preston Ridge is dominated by conifers in clumps with fluctuating proportions of hardwoods. Some stands in Preston Ridge were partially harvested, while some are dense with mature western hemlock and Douglas-fir. In most areas, bigleaf maple, western red cedar and Douglas-fir dominate the overstory, while western hemlock thrives in the midstory and there is red alder throughout disturbed areas where favorable conditions have led to its establishment.

Forest development

Mixed Conifer stands will likely develop into older healthy forest over time, but considering our objectives, opportunities to condition certain stands for the future would be beneficial and could be achieved by treating areas that are too dense or lacking diversity. The changing climate is trending towards hotter, dryer conditions that will affect drought intolerant species including western hemlock and red alder, altering species composition over time. It will be important to take into consideration the decline of such species and plant more drought tolerant species such as Douglas-fir.

Stand density considerations

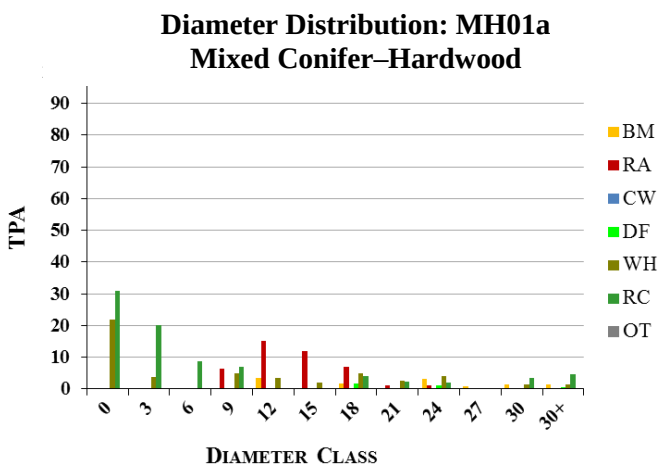
Stand Density Index (SDI) can be a useful measurement to inform the effects of restoration treatments. It is based on the law of self-thinning (Reineke, 1933), which states that plant populations have a density threshold above which mortality occurs. This threshold is typically 60% of the biological maximum density of site. Thinning to different proportions of maximum SDI will result in different growth rates, crown development, levels of canopy closure, and competitive mortality over time. These in turn affect understory development, deadwood levels,

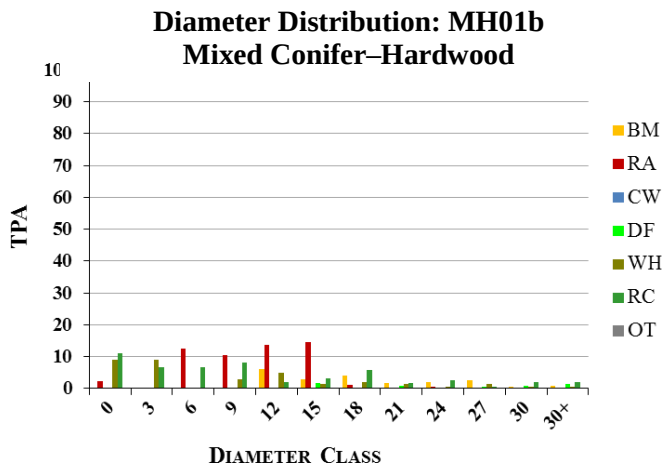
and disturbance processes such as fire and insects fires (Christopher J. Fettig et al., 2007; Long and J. D. Shaw, 2005; Powell, 2010).

For restoration treatments that seek to create heterogeneous stands, SDI can be used to inform how patches of different densities or clumps will achieve different ecological objectives such as growing large trees, promoting forage species, providing for future snags, and managing susceptibility to insect and crown fires.

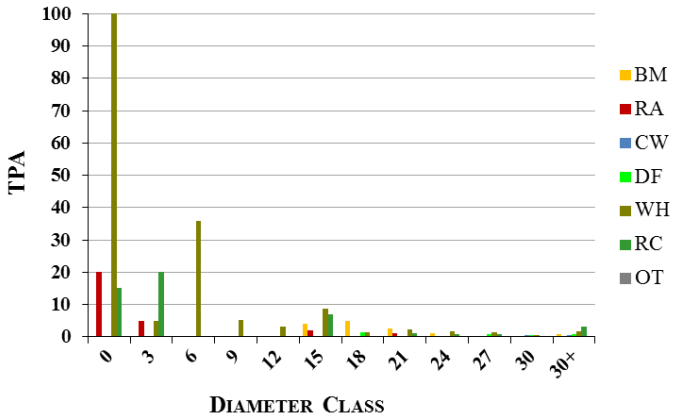
Ecotype A: Mitchell Hill (MH01a, MH01b & MH03)

237 acres of predominantly mature mixed conifer–hardwood forest covers the majority of Mitchell Hill. Due to the large size of the Mitchell Hill block (MH01), it was split into MH01a and MH01b for increased inventory efficiency. The overstory is dominated by 70 to 100+ year old western red cedar, western hemlock and bigleaf maple. Additionally, largely legacy western red cedar (exceeding 30" DBH) and some larger Douglas-fir were retained from previous harvests and are distributed through the area. Currently, this mixed conifer-hardwood forest has 209 TPA (127 TPA >5" DBH) and 228 ft^2 of basal area (225 ft^2 >5" DBH). The average height of trees greater than 5" DBH is 90' with a QMD for the unit of 16" (21" >5" DBH). The midstory is occupied primarily by shade tolerant western hemlock and western red cedar. Red alder advanced regeneration is already established in large and small gaps. Though densities are variable across Mitchell Hill, many areas are too dense. With an average SDI of 310, many parts of the stand are in the Mortality Zone of stand density. The understory community is composed primarily of sword fern and Oregon grape with devil's club occupying saturated sites. Western hemlock with thinning and dead crowns suffers in areas from Annosus root disease.





Diameter Distribution: MH03
Mixed Conifer–Hardwood



Mixed Conifer-Hardwood										
Stand	**TPA**	**TPA >5"***	**Avg DBH**	**QMD**	**QMD >5"**	**BA**	**BA >5"**	**SDI**	**SDI >5"**	**Avg Ht >5"**
MH01a	192	117 (34)	12	16.7	22.6	261	258	347	65	94
MH01b	172	136 (60)	15	17.4	20.2	240	239	330	59	105
MH03	262	107 (46)	9	12.7	19.7	184	178	253	53	71
Average	*209*	*184 (47)*	*12*	*16*	*21*	*228*	*225*	*310*	*59*	*90*

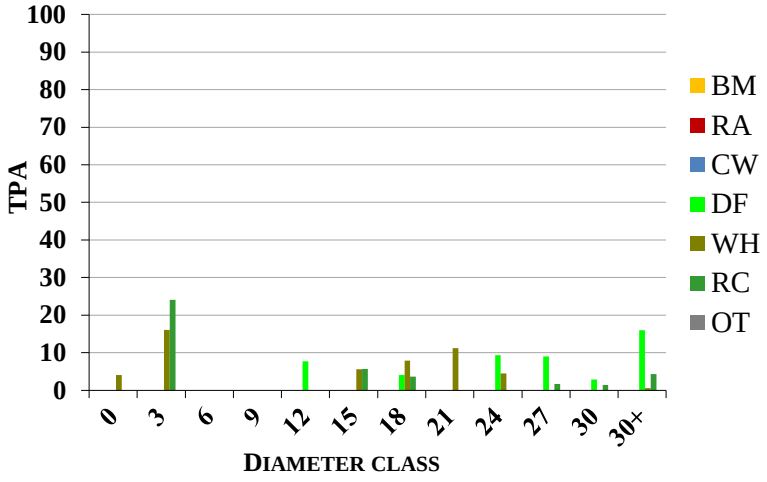
** 95% Confidence Intervals are in ( )*

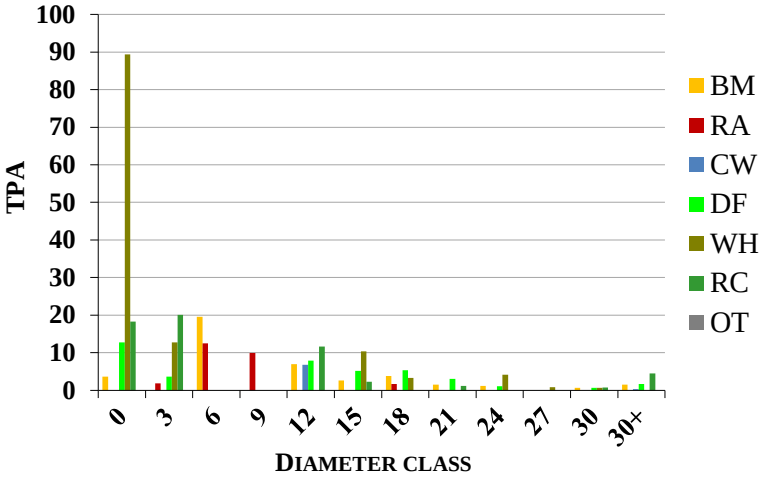
Ecotype A: Preston Ridge (P01, P03, P04 & P05)

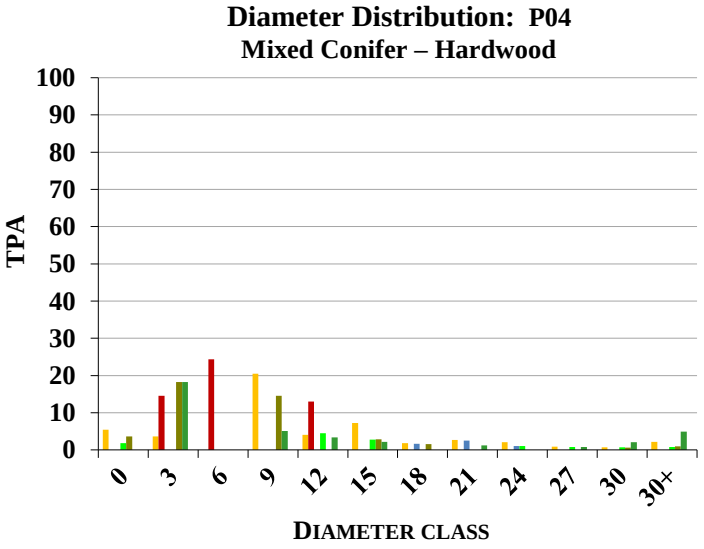
Preston Ridge is dominated by 192 acres of mixed conifer-hardwood forest. Influenced by a history of harvests of varying intensity, this mature, upland mixed conifer – hardwood forest is variable in composition and structure. The northwestern portion (P01 and P02) are dominated by large 80 to 100+ years old, large diameter, Douglas-fir and western hemlock. The midstory is occupied by intermediate western red cedar along with more Douglas-fir. Moving easterly (P04 and P04), hardwoods, mainly large multi-stem bigleaf maple dominate the upper canopy, while lesser amounts of Douglas-fir and western hemlock are co-dominate. P05 is younger with dominate western red cedar, Douglas-fir and bigleaf maple. Bigleaf maple and red alder are intermediates in the midstory. On average the stand carries 290 TPA (159 TPA >5" DBH) and 250 ft^2 of basal area (238 ft^2>5" DBH). The average height of trees greater than 5" DBH is 104' with a QMD for the area of 15" (21" >5" DBH). The SDI is 344. Many parts of the stand are reaching upper limits of the Max Biomass Zone for stand density, but remain largely intact. Stand densities are high, but variable, ranging from 290 to 500, which is within the Mortality Zone for stand density. The stand could benefit from having more natural coarse wood recruitment in place. The understory is diverse, including sword fern, salmonberry, red huckleberry and vine maple. Due to limited field time and its similarity to P01, no inventory data were collected for P02.

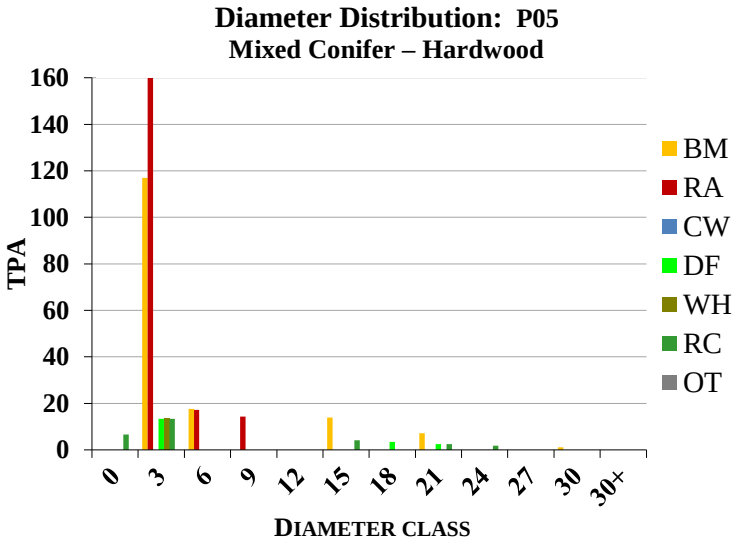
Diameter Distribution: P01
Mixed Conifer – Hardwood

Diameter Distribution: P03
Mixed Conifer – Hardwood







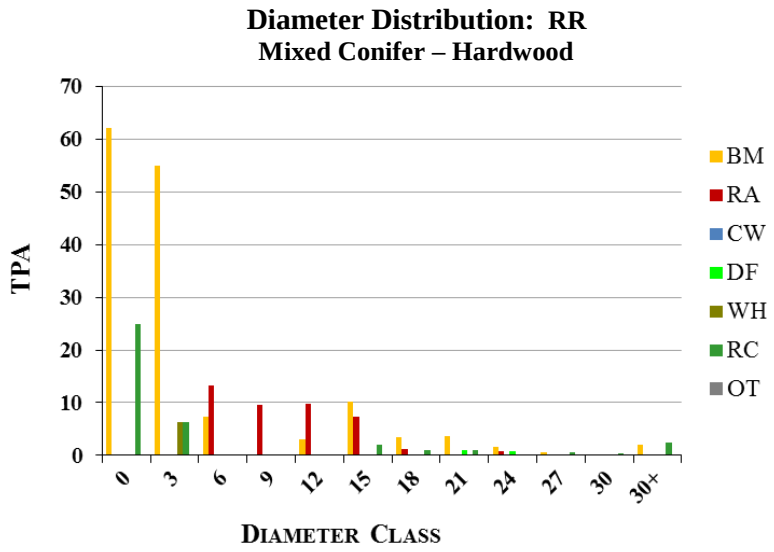


Mixed Conifer-Hardwood										
Stand	**TPA**	**TPA >5"***	**Avg DBH**	**QMD**	**QMD >5"**	**BA**	**BA >5"**	**SDI**	**SDI > 5"**	**Avg Ht >5"**
P01	139	99 (24)	19.3	22.5	26.4	380	376	463	454	136.7
P03	301	133 (77)	10.9	15.5	26.2	241	236	334	319	106.1
P04	208	153 (60)	11.9	15.4	20.1	243	238	332	320	-
P05	513	253 (168)	5.5	7.3	10.8	138	99	247	148	67.9
Average	*290*	*159 (82)*	*12*	*15*	*21*	*250*	*238*	*344*	*310*	*104*

** 95% Confidence Intervals are in ( )*

Ecotype A: Raging River (RR)

Raging River's 30 acres of uneven-aged, multi-cohort, upland mature mixed conifer–hardwood forest is dominated by 80 to 100 years old, large diameter bigleaf maple, western red cedar, and co-dominate red alder. Mature Douglas-fir is also present, but in lesser amounts. Currently the forest has on average 238 TPA (101 TPA >5" DBH) and 148 ft^2 of basal area (143 ft^2 >5" DBH). The average height of trees greater than 5" DBH is 81' with a QMD for the unit of 14.7" (19.2" >5" DBH. The SDI is 254. A second cohort of advanced regeneration bigleaf maple, younger western hemlock and western red cedar occupy the midstory. The forest is dense and reaching the upper limits of the Max Biomass Zone of stand density, beginning to enter the Mortality Zone. The understory is comprised of sword fern, salmonberry and Oregon grape.



Mixed Conifer-Hardwood										
Stand	**TPA**	**TPA >5"***	**Avg DBH**	**QMD**	**QMD >5"**	**BA**	**BA >5"**	**SDI**	**SDI GT 5"**	**Avg Ht >5"**
RR	238	101 (55)	12.3	14.7	19.2	148	143	211	196	81.4

** 95% Confidence Intervals are in ( )*

B. Ecotype B: Hardwood

Hardwood species tend to be the first tree species to naturally emerge following disturbances and clearcuts. Red alder has established itself in many stands that were once harvested for Douglas-fir (Grotta and Zobrist 2009). This is often a result of negligence and inadequate planting and vegetation control, but it also is very much an element of a vegetative community's natural trajectory. Red alders tend to grow much faster in the beginning of their life than conifers, allowing them to out compete conifer seedlings. Bigleaf maple, another prominent hardwood species found throughout Mitchell Hill, Preston Ridge, and Raging River, contributes to the area's diverse species composition. Reaching large diameter (>30"), many with multiple stems, bigleaf maple responds vigorously to past harvest by stump sprouting. Stump sprouting results in the growth of sprouts immediately above surrounding vegetation, giving bigleaf maple the ability to out compete and establish itself once it has been cut. Stands all contain hardwood patches of

differing size, age, structural complexity, and species composition. Understory communities are comprised of sword fern, Oregon grape and dense thickets of salmonberry.

Forest development

Pure red alder stands regularly establish on disturbed sites with as many as 50,000 stems per acre. Its highly competitive nature results in self-thinning down to nearly 1/10 of its original density, decreasing to 675 TPA in 20 years (Harrington undated). Red alder stands hit an all-time high in the 1990s through recruitment of historic clearcuts and abandoned agricultural land. Many of these stands have reached or are rapidly approaching decline, making management critical to maintain canopy cover (Grotta and Zobrist 2009).

Additional variables contributing to the establishment of pure red alder stands are disturbances such as fire or flood which leave behind soil with poor nutrient availability. These unfavorable environments allow for red alder to establish. Additionally, saturated soils and root rot pockets (*phillinus weirii*) primarily targeting Douglas-fir, often lead to pure alders stands.

Understories are often comprised of salmonberry and blackberry. Both shrubs thrive under the thin deciduous canopy, growing dense and tall. This can result in a near monoculture that outcompetes other shrubs, forbs, and seedlings for light.

Red alder begins to decline at around 60 to 80 years of age. While red alder snags provide excellent wildlife habitat, they decay more quickly once on the forest floor and do not regenerate on organic material. At this stage in the pure red alder stand's development, conifers, other hardwood and/or dense shrubs will begin taking on a dominate position.

In order for conifers to replace a pure alder stand, seedling stock/seed bank levels must be sufficiently high during the last decade of alder dominance. Shade tolerant species, western hemlock and western red cedar are the most likely to regenerate naturally, but if the canopy cover is open enough, Douglas-fir may be recruited as well.

While pure red alder stands frequently colonize floodplains and other riparian areas, they are not the optimal overstory for stream health. Pure alder stands are poor coarse wood inputs for waterways because they are small logs and decay quickly. Their canopies provide little shade compared to their coniferous counterparts, although falling leaves do contribute to stream inputs.

Although alder's short rotation age creates abundant snags, which may be used by insects, woodpeckers, bats, and small mammals, pure alder stands tend not to provide reliable, diverse habitat due to their homogeneous structure and short lifespan.

Pure alder is a common patch type in Preston, and is present in nearly all of the King County stands. These patches are mostly the result of historic clearcuts, or in some cases, brought about by floodplain disturbance of the Raging River.

Mixed hardwood stands are extremely common in riparian areas where soil moisture limits the growth of conifer species. In the Pacific Northwest, mixed hardwood stands are typically composed of red alder, bigleaf maple, black cottonwood and bitter cherry. The species

composition of these stands may evolve over the lifetime of the stand. Often, a mixed hardwood stand dominated by alder will shift to a maple-heavy forest, while large individual black cottonwood will come to dominant the canopy along with a few alder round the edges.

Mixed hardwood forests are more beneficial in regards to forest-stream interactions than pure alder stands. The stratified canopy and vertical/horizontal variation provides more shade and the average lifespan of the stand is longer. Allochthonous inputs are greater and in-stream and in-river log recruitment may be longer lived than in a pure alder stand, as the logs are able to grow larger before entering the stream. Longer lifespan of certain tree species enable them to provide superior habitat. Bigleaf maples tend to develop large, complex crowns, which host many species of birds, bats, insects and plants. Larger crowns shade out salmonberry and blackberry, resulting in greater understory species diversity. Furthermore, litterfall from many different hardwoods provides excellent biomass and returns nutrients to the soil.

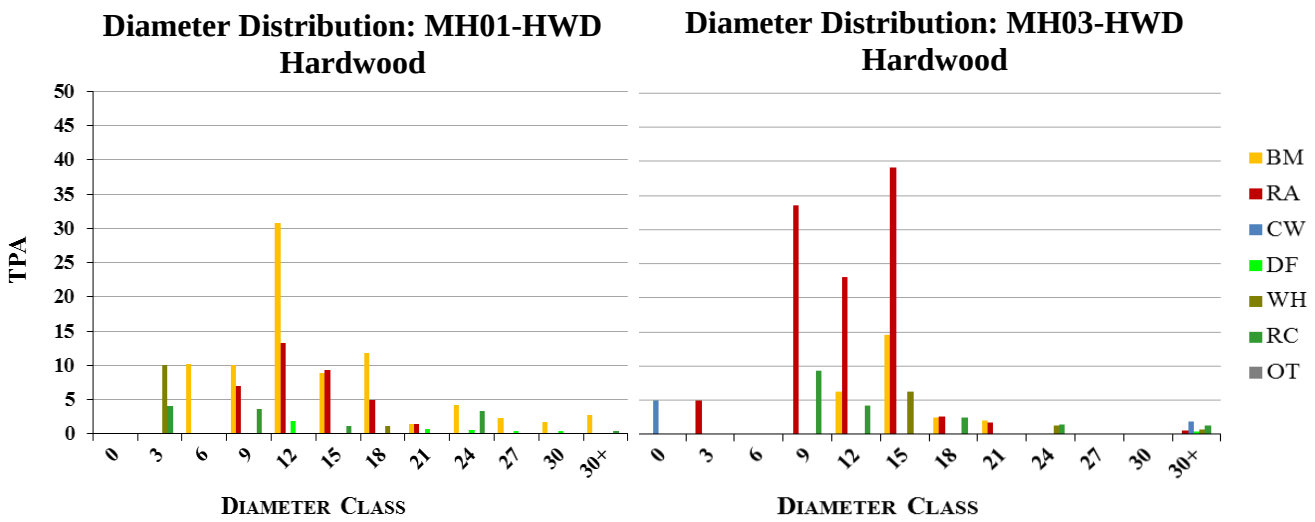
This forest type is easily observed in the project area, usually between patches of pure alder and mixed hardwood-conifer forest. The mixed hardwood patches usually include very large bigleaf maple and black cottonwood, mature red alder, and some juvenile alder in newly disturbed regions.

The highly desirable mixed conifer-hardwood forests provide an array of ecosystem services. The presence of both conifer and hardwood tree species along stream and riverbanks creates a beneficial combination of nutrient inputs, shade, and coarse woody debris. Conifers are superior in providing year round shade, and their logs tend to survive longer in large rivers, because their wood is stronger and can stand up to swift currents that might break a weaker hardwood log.

Mixed conifer-hardwood forests may begin as a mixed hardwood forest, or even as a pure alder stand. In general, hardwoods (with the exception of bigleaf maple) have a difficult time establishing in conifer stands due to canopy closure. Most hardwoods are shade intolerant and will only establish in a large gap or disturbed area, whereas many conifer species are shade tolerant and will readily sprout underneath a closed or partially closed canopy. Once the hardwoods begin dying off, the conifers are released, and join the remaining hardwoods in the upper canopy.

Ecotype B: Mitchell Hill (MH01-HWD & MH03-HWD)

Mitchell Hill's mixed conifer–hardwood forest is broken up by nine hardwood patches of various sizes ranging from 2 to 40 acres, totaling 113 acres. These hardwood patches are comprised primarily of either almost pure red alder or a mix of red alder and bigleaf maple with intermittent large-diameter black cottonwood. Currently the hardwood ecotype has 157 TPA (145 TPA >5" DBH) and 219 ft^2 of basal area (219 ft^2>5" DBH). The average height of trees greater than 5" DBH is 78' with a QMD for the unit of 17" (18" >5" DBH). Many of these patches have larger diameter trees and are reaching density limits. Hardwood patches in MH04 are getting merchantable diameter. Vine maple is common throughout the midstory along with natural large conifer saplings. The understory community is primarily sword fern with dense devil's club and salmonberry occupying saturated sites. Many alder snags are present in MH04, suggesting that patches are nearing more widespread mortality.

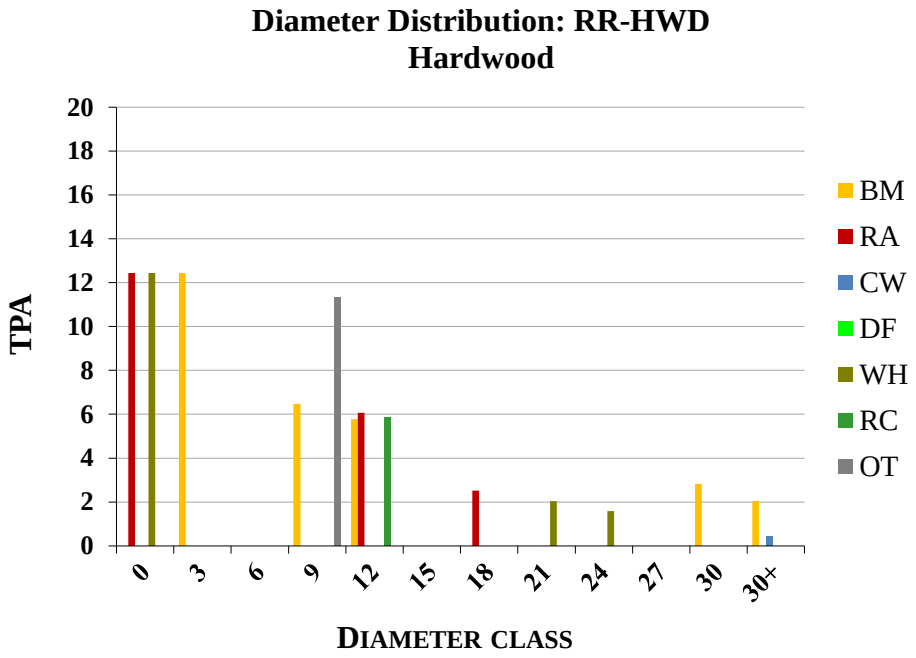


Hardwood								
Stand	**TPA**	**TPA >5"***	**Avg DBH**	**QMD**	**QMD >5"**	**BA**	**BA >5"**	**Avg Ht >5"**
MH01 - HWD	148	134 (48)	14.9	17.3	18.5	214	213	79.4
MH03 - HWD	165	155 (103)	15.9	17.1	17.6	224	224	76.3
Average	*157*	*145 (76)*	*15*	*17*	*18*	*219*	*219*	*78*

* *95% Confidence Intervals are in ( )*

Ecotype B: Raging River (RR-HWD)

21 acres of lowland, riparian hardwood forest along the banks of the Raging River is dominated by some large big leaf maple with complex crowns and co-dominated by red alder. Large black cottonwood and Sitka spruce are distributed in lesser amounts intermittingly. The riparian area contains on average 84 TPA (47 TPA >5" DBH) and 82 ft^2 of basal area (80 ft^2>5" DBH) with an average tree height of 70'. The midstory is comprised of younger bigleaf maple with small groups of bitter cherry distributed throughout. The forest canopy is largely open with sufficient spacing through most of the area. Tall, thick salmonberry dominates much of the stands understory. Sword fern and thimbleberry are also present. Infestation of Himalayan blackberry and Japanese knotweed pose threats to the native understory plant communities.



Hardwood								
Stand	**TPA**	**TPA >5"***	**Avg DBH**	**QMD**	**QMD >5"**	**BA**	**BA >5"**	**Avg Ht >5"**
RR - HWD	84	47 (44)	22.1	23.8	25.9	82	80	69.7

* *95% Confidence Intervals are in ( )*

C. Ecotype C: Young Forest

Some young forest, managed in the past as plantations, are both in the eastern portion of Mitchell Hill and Preston Ridge. This ecotype varies widely in species composition between planning areas. Species composition includes Douglas-fir, western hemlock, red alder and bigleaf maple.

Current conditions

Mitchell Hill's plantations are composed of primarily 20 year old plated Douglas-fir with some young red alder growing along disturbed areas and western hemlock advanced regeneration remaining in the midstory. Preston Ridge's young forest ecotype is predominately small diameter hardwoods, bigleaf maple and red alder with some Douglas-fir and larger diameter western hemlock. Understories are comprised of primarily salmonberry, sword fern, salal, vine maple and snowberry with some trace amounts of Indian plum and cascara. Stand densities are between stages of low competition and early stages of maximum biomass. With canopies beginning to close, understory vegetation is in decline and in some areas trees are beginning to die due to competition induced mortality. In some areas spacing is even and good but in others, where most Douglas-fir have died, spacing is variable.

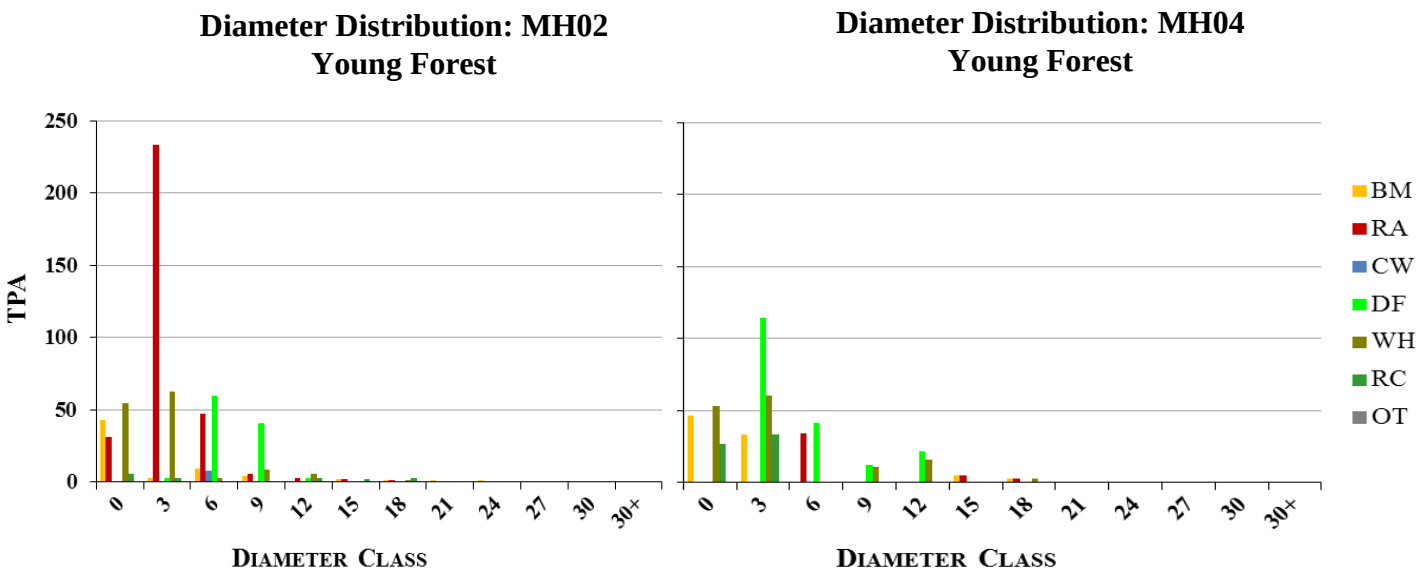
Forest development

These stands are beginning to reach stages of maximum biomass in which they will decrease in density and increase in diameter. Some conifers may be outcompeted by hardwoods and where

hardwoods are dense the stands can persist as mainly hardwood stands until reaching ages of mortality.

Ecotype C: Mitchell Hill (MH02 & MH04)

Previously managed plantations account for 71 acres of Mitchell Hill. Planted to 300 TPA and partially pre-commercially thinned in 1999, the young conifer-hardwood ecotype is primarily evenly spaced Douglas-fir growing alongside some small diameter red alder occupying disturbed areas. The plantations have an average of 585 TPA (273 TPA >5" DBH) and 146 ft^2 of basal area (131 ft^2>5" DBH). The average height of trees greater than 5" DBH is 60' with a QMD for the unit of 7" (10" >5" DBH). Stand densities are 229, in early stages of the Mortality Zone for stand density. The midstory is comprised of naturally regenerating, shade tolerant western hemlock and the understory is primarily sword fern and salal. Some evidence of root rot (*Phellinus weirii*) appears to be affecting Douglas-fir in areas.



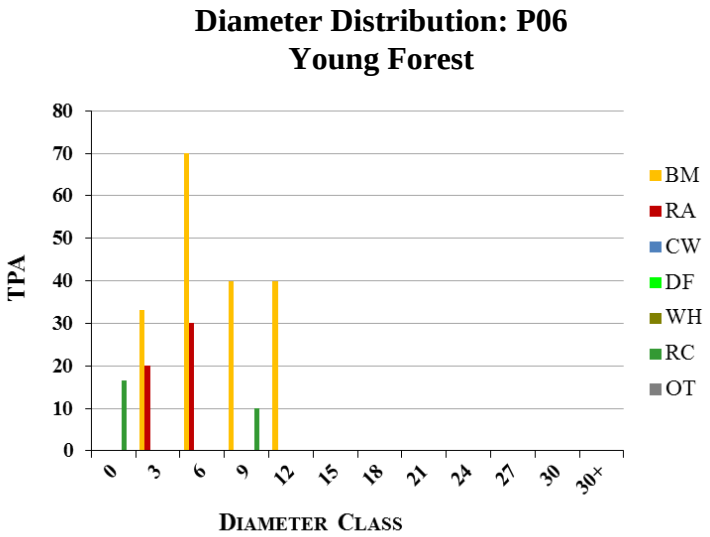
Young Forest										
Stand	**TPA**	**TPA >5"***	**Avg DBH**	**QMD**	**QMD >5"**	**BA**	**BA >5"**	**SDI**	**SDI GT 5"**	**Avg Ht >5"**
MH02	617	273 (114)	5.9	7.0	9.9	147	129	276	225	56.8
MH04	554	273 (130)	5.5	7.0	9.6	144	133	268	234	63.9
Average	*585*	*273 (122)*	*6*	*7*	*10*	*146*	*131*	*272*	*229*	*60*

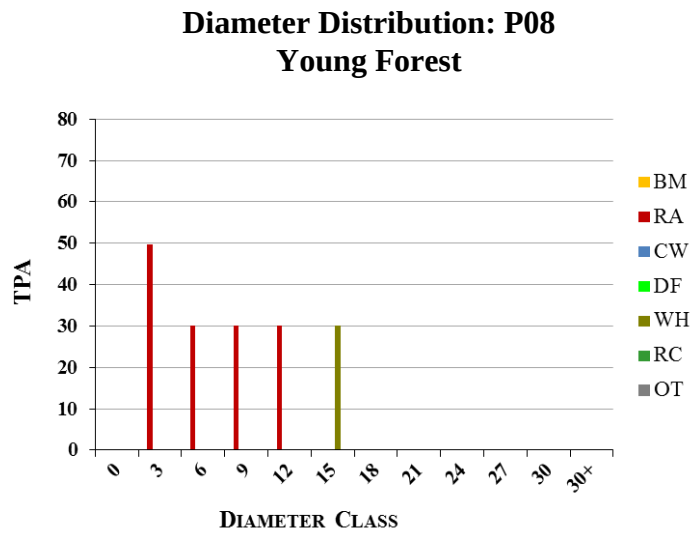
* 95% Confidence Intervals are in ( )

Ecotype C: Preston Ridge (P06 & P08)

Primarily hardwood stands dominated by small diameter red alder and big leaf maple, make up this ecotype, with some larger dominate western hemlock among the overstory in P08. Many

small and large sapling red alder and big leaf maple occupy the midstory. These younger units have on average 273 TPA (215 TPA >5" DBH) and 116 ft^2 of basal area (113 ft^2>5" DBH). The average height of trees greater than 5" DBH is 62' with a QMD for the area of 9" (10" >5" DBH). The SDI is 222. The forest is developing quickly and will begin high competition in the next 10 years. The understory includes sword fern, salmonberry and stinging nettle.





Young Forest										
Stand	**TPA**	**TPA >5" (*)**	**Avg DBH**	**QMD**	**QMD >5"**	**BA**	**BA >5"**	**SDI**	**SDI >5"**	**Avg Ht >5"**
P06	376	310 (85)	7.2	7.8	8.5	131	129	249	243	55.9
P08	170	120 -	9.5	10.5	12.2	102	97	173	160	67.7
Average	273	215 -	8	9	10	116	113	211	201	62

* 95% Confidence Intervals are in ( )

IX. Forest Management Recommendations by Ecotype

A suite of management recommendations are designed for each ecotype. Proposed treatments in all ecotypes depend on forest health, age, structure, species composition and operational constraints. Below are flow charts for Ecotype A: Mixed Conifer-Hardwood and Ecotype B: Hardwood and a detailed ecologic rationale for the management options of different ecotypes.

A. Ecotype A: Mixed Conifer-Hardwood

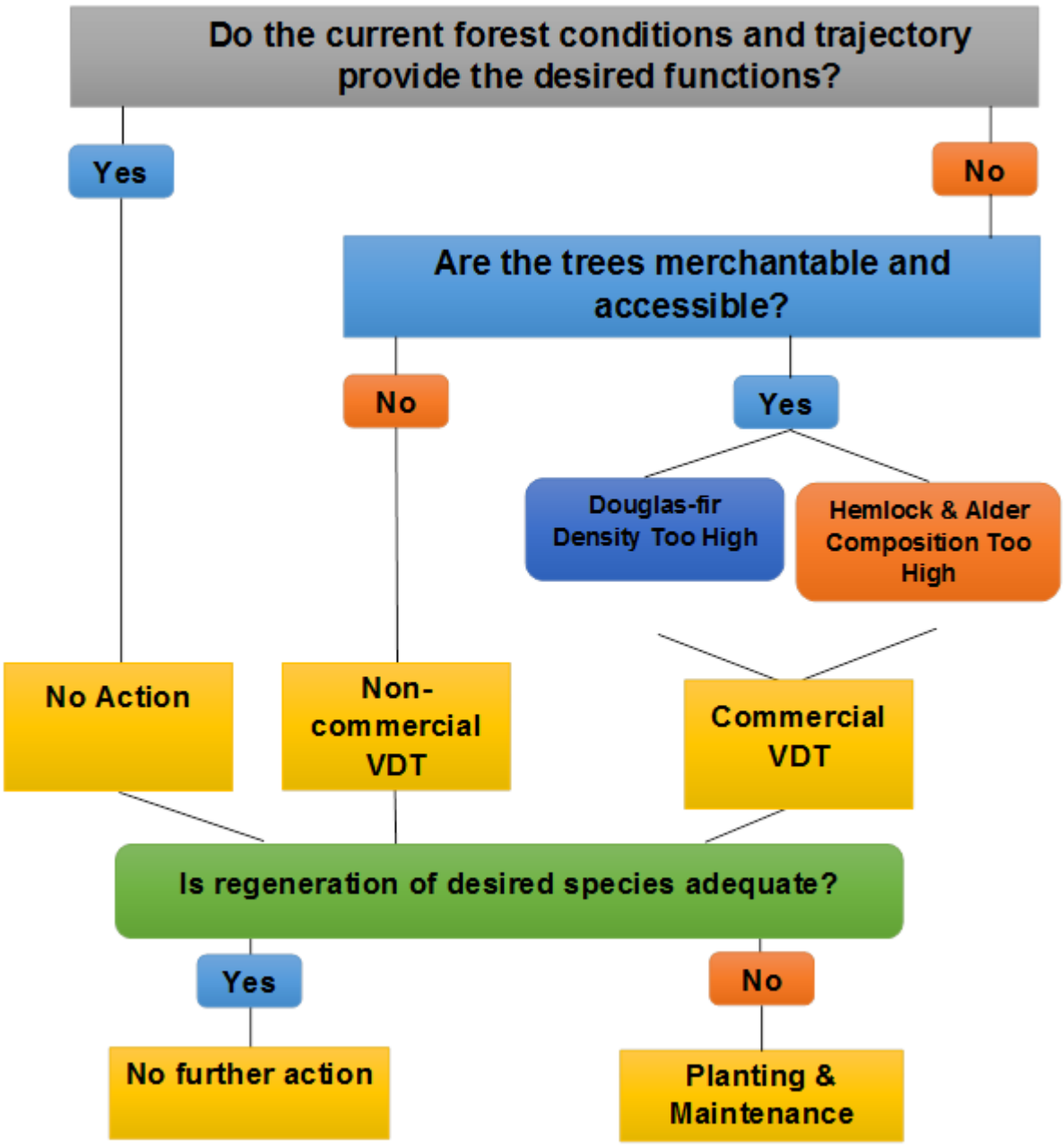


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Figure: Flow chart for forest management decisionsin mixed confier-hardwood forests

<u>No action</u>

Natural stand development following a no action pathway is preferable when:

- current forest condition provides the desired functions
- stand has sufficient natural regeneration of the desired species mix,
- few to no invasive or undesirable species present,
- access to the site is difficult,
- alternative treatment options are unrealistic, or

- governmental and procedural limitations limit active management.

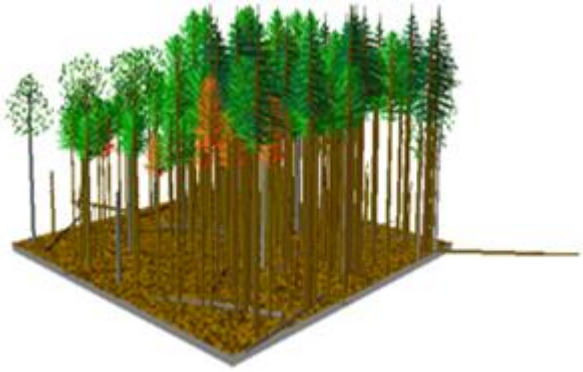


Figure: Forest growth modeled with no action

Planting and maintenance

Composition can be diversified through planting a mix of tree species. Meanwhile, limiting disturbances can impact certain sites. Underplanting may be a good option in:

- ecological reserves or natural areas, or
- riparian management zones and riparian buffers where harvesting is not permitted
- areas where desired species diversity is not being met

Depending on the vigor of understory vegetation, hand-thinning or herbicide may be necessary to reduce shrub competition. Species selection for underplanting depends on the canopy condition. For widely spaced alder, Douglas-fir may be a realistic option, as long as the fir seedlings have at least one tree height width of canopy space to grow in. Shade tolerant conifer species, namely western hemlock, western red cedar, and Sitka spruce often regenerate naturally below alder, and are all good options for underplanting.

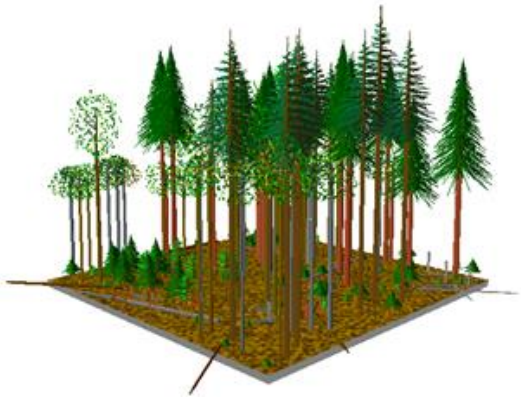


Figure: Forest growth modeled for planting under an existing canopy

Non-commercial thin - drop and leave

Dropping and leaving trees on site may meet objectives and improve residual stand quality by:

- creating coarse wood when desired,
- opening small gaps to meet tree selection guidelines,

- creating growing space for canopy trees,
- treating with low intensities,
- being flexible about when, where and how cutting can take place, or limiting impact by not using logging equipment

Downed logs contribute coarse woody debris, an important component for wildlife habitat and soil stability. Large-diameter downed wood is especially important in riparian areas, creating structures and shade for fish and other aquatic animals.

Drop and leave treatments create custom canopy openings. Openings large enough to increase light exposure, often one tree length in diameter, can be treated and planted with tree species that may be less shade tolerant. This is an option for creating small patches (5-7 trees) or addressing western hemlock mortality. Successful planting and tree survival often requires some vegetation control.

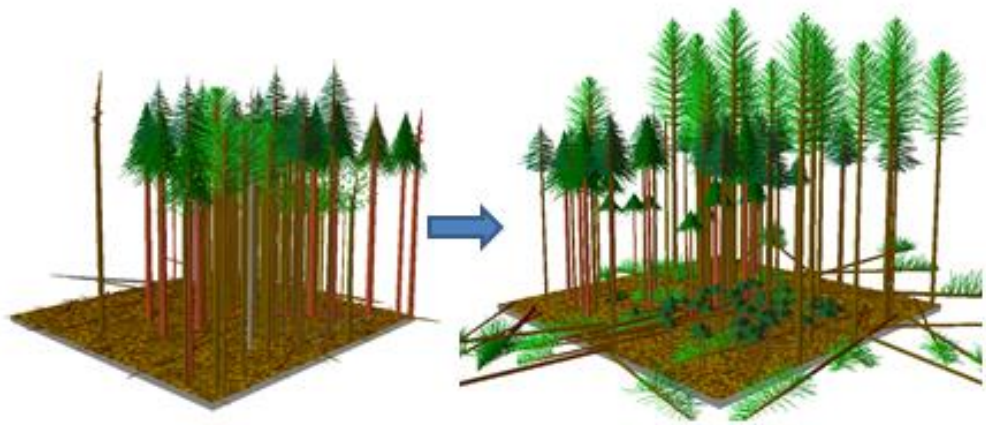


Figure: Modeled forest development pathway for non-commercial drop-and-leave harvest

Commercial thin

Commercial harvests remove co-dominate and intermediate tress to generate revenue to cover costs and increase profits, while decreasing stand densities for long term viability. Variable density thinning (VDT), an ecologic approach to density management, leaves behind an uneven mosaic of gaps, areas of higher intensity harvesting, skips, untreated areas, and thinned areas. VDT can meet management objectives by:

- capturing the stand's present value,
- improving species composition by reducing tree density of Douglas-fir and competing hardwoods,
- augmenting existing gaps,
- protecting biological hotspots, unique structures and desirable species composition, or
- prioritizing thins in areas that are readily accessible

Vegetation control by herbicide, brushcutter or hand scalping may be necessary following partial or complete harvest. Stands that have been commercially harvested and cleared of vegetation may be planted with a combination of conifer or hardwood species.

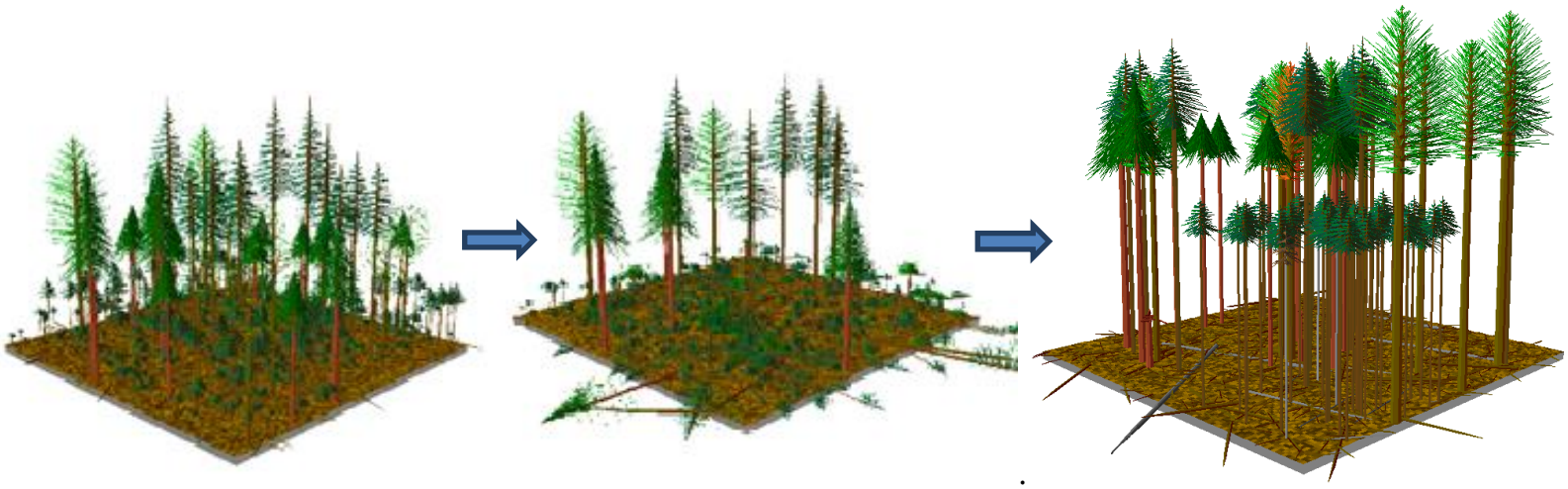


Figure: Modeled forest development pathway for commercial harvest

B. Ecotype B: Hardwood

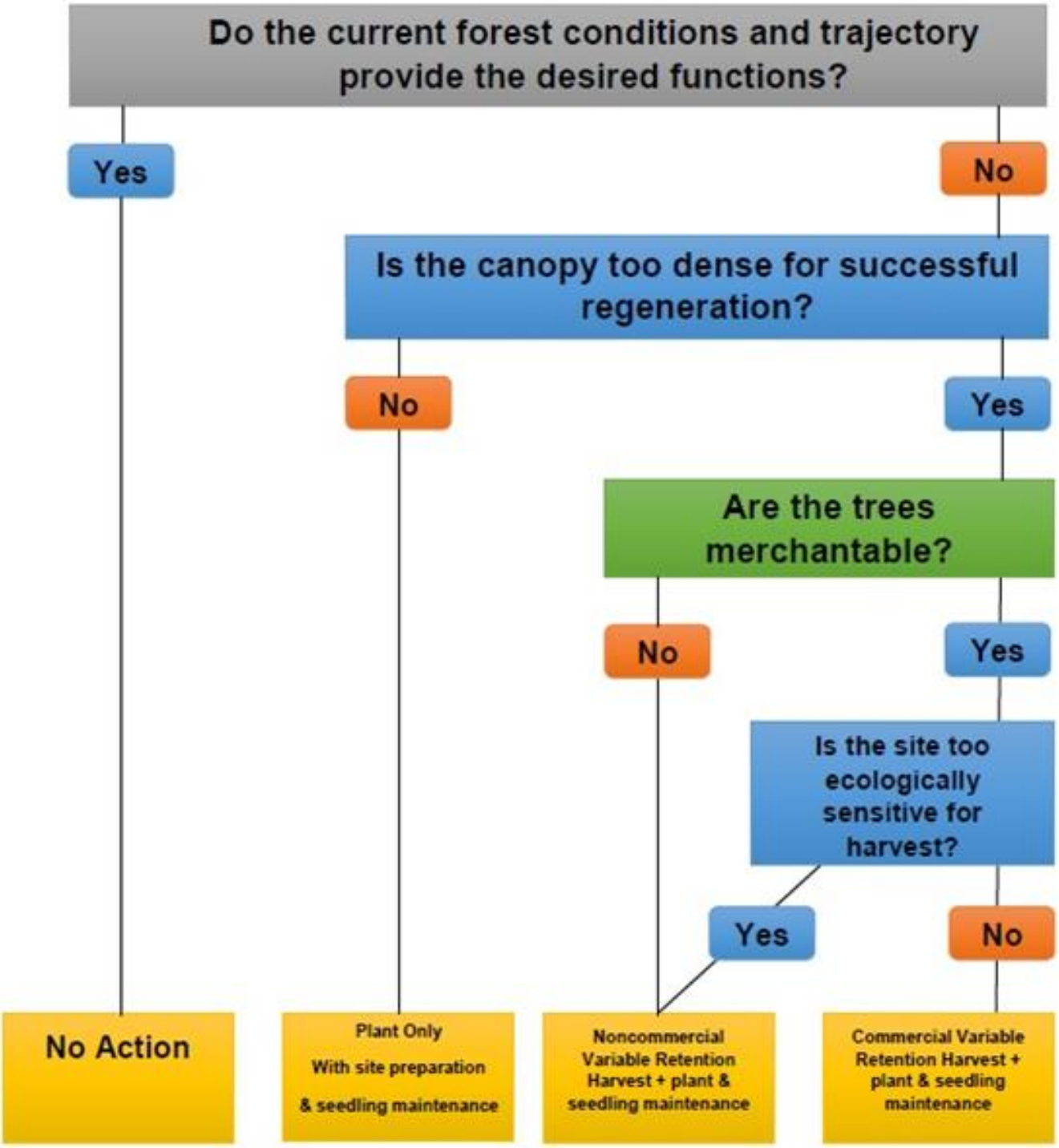


Figure: Flow chart for forest management decisionsin hardwood forests

No action

Natural stand development following a no action pathway is preferable when

- stand or patch type has sufficient natural regeneration of the desired species mix,
- few to no invasive or undesirable species present,
- access to the site is difficult,
- alternative treatment options are unrealistic,
- current conditions are simply preferred for whatever reason or,
- Governmental and procedural limitations

Underplanting

Composition can be diversified by underplanting a mix of tree species at the same time thereby limiting disturbance and impact on certain sites. Underplanting may be a good option in:

- ecological reserves or natural areas, or
    4. **riparian management zones and riparian buffers where harvesting is not permitted**

Depending on the vigor of understory vegetation, hand-scalping or herbicide may be necessary to reduce shrub competition. Species selection for underplanting depends on the canopy condition. For widely spaced alder, Douglas-fir may be a realistic option, as long as the fir seedlings have at least one tree height width of canopy space to grow in. Shade tolerant conifer species, namely western hemlock, western red cedar, and Sitka spruce often regenerate naturally below alder, and are all good options for underplanting.

Non-commercial thin - drop and leave

Dropping and leaving trees on site may meet objectives when:

- areas might be difficult to access,
- areas are ecologically sensitive,
- extraction is not economically feasible,
- soil is sensitive to compaction, or
- manager does not wish to harm standing trees or understory vegetation with machinery

Downed logs contribute coarse woody debris, an important component for wildlife habitat and soil stability. Downed logs and coarse wood creation is especially important in riparian areas, creating structures and shade for fish and other aquatic animals.

Drop and leave treatments create canopy openings. Openings large enough to increase light exposure can be treated and planted with tree species that may be less shade tolerant. This is an option for those who wish to convert red alder dominated riparian areas to longer lived and more decay resistant conifer species. Successful planting and tree survival often requires some vegetation control.

Commercial harvest

Commercial harvests remove overstory trees, generating revenue to cover costs and increase profits. This approach is appropriate when hardwood stands and patches:

- contain valuable timber species and volumes,
- are not ecologically sensitive, or
- are readily accessible by necessary machinery

All three tree species covered in the Appendix A have some economic value. Presently, the most valuable are red alder and black cottonwood. Commercial harvests include a variety of treatments. A variable retention harvest (VRH) creates:

- 1/2-3 acres openings where most or all the trees are removed, areas skipped and untreated and, areas thinned to specified densities, and
- Openings large enough to increase light exposure, can be treated and planted with tree species that may be less shade tolerant. This is a good option for treating larger, maturing red alder paths, capturing the stands value before trees reach decline.

Vegetation control by herbicide, brushcutter or hand scalping may be necessary following partial or complete harvest. Stands that have been commercially harvested and cleared of vegetation may be planted with a combination of conifer or hardwood species.

X. Management Recommendations by Management Unit

A. Mitchell Hill

Mitchell Hill's combination of complex forest types, variable size of treatment units, and the need for operational efficiency suggests that multiple entries can be implemented in phases. In each phase, both mixed conifer-hardwood and hardwood ecotypes will be treated simultaneous. Each ecotype, depending on forest health conditions, age, structure, species composition and operational constraints, may require a combination of treatments.

<u>Mixed Conifer-Hardwood</u>

a. No action

If no action were taken these stands would continue to develop in the Mortality Zone of stand density. Considering the large, mature, shade tolerant species making up much of the forest on Mitchell Hill and the currently adequate regeneration, a no action alternative may be acceptable for some time. In some areas too steep for harvesting equipment or in and around riparian management zones, no action or skips can be effective. However, such an approach does not address more dynamic disturbances and climate change influenced variables, such as drought and hotter temperatures that can be anticipated in the future. If an effort to set this stand on a trajectory to become higher functioning, a more resilient ecosystem is a goal for this unit. We do not recommend "no action" for any part of this stand.

b. Variable density thinning, MH01 & MH03

The mixed conifer-hardwood ecotype (88 acres) will benefit most from an ecologic variable density thinning with skip (25%) and gap (12%) creation. Treatment in phases, combining non-commercial thinning and drop and leave techniques in addition to underplanting is suggested to create more variability and unique structure that will contribute to better quality habitat. Non-commercial treatments will take place in the remaining portions of the stand that are either too sensitive, too steep for harvest operations or riparian management zones. These activities should take place as soon as possible. The remaining work would be a combination of commercial and non-commercial thinning to an estimated 100 TPA of trees greater than 10" DBH accompanied by under planting of Douglas-fir (150 TPA) in small gaps created (about one tree length diameter)to allow for higher survival rates of seedling. An effort should be made to preserve existing snags or other wildlife trees.

c. Skips and gaps

Variable density thinning incorporates skips, areas left untreated, and gaps, openings created by removing trees. This approach creates some spatial variability and structural complexity as a means of restoring some ecosystem functions. Skips would be placed in biological hotspots such as clumps of large diameter western red cedar and bigleaf maple, or in areas difficult to harvest. Gaps will be placed in areas that would benefit from tree removal such as red alder patches and areas of severe western hemlock mortality or used to augment already existing gaps for larger planting zones. Openings can be planted with a species mix of Sitka spruce, western red cedar and Douglas-fir.

d. Non-commercial thin, drop and leave and underplanting

Non-commercial treatments serve two main purposes: treating western hemlock mortality and creating openings for Douglas-fir regeneration. This approach is also an option in the steep eastern and southern slops of Mitchell Hill where tree harvesting can be challenging or the riparian management zones in the eastern region of MH01. The thin would target bigleaf maple, red alder and western hemlock. Drop and leave treatments allow for non-uniform removal allowing there to be small gaps (about one tree length diameter) created where Douglas-fir can be planted increasing the representation of this species in the future. Under planting is recommended to facilitate additional regeneration in the case of increased western hemlock mortality.

Considering carbon

Treatments enhancing mixed conifer – hardwood ecotype's ability to store and sequester carbon should be a priority. An efficient way to meet these objectives when drought is anticipated is to remove western hemlock within the ecotype when possible. Drought resistant species should be a part of residual stands, and planted when suitable. Carbon's life cycle is complex, but general storage capabilities of stands can be illustrated when modeled as the comparison to alternative treatments and climate scenarios like reduced precipitation. Variable density treatments combined with planting eventually store more carbon per acre when compared to no treatment or drought scenarios.

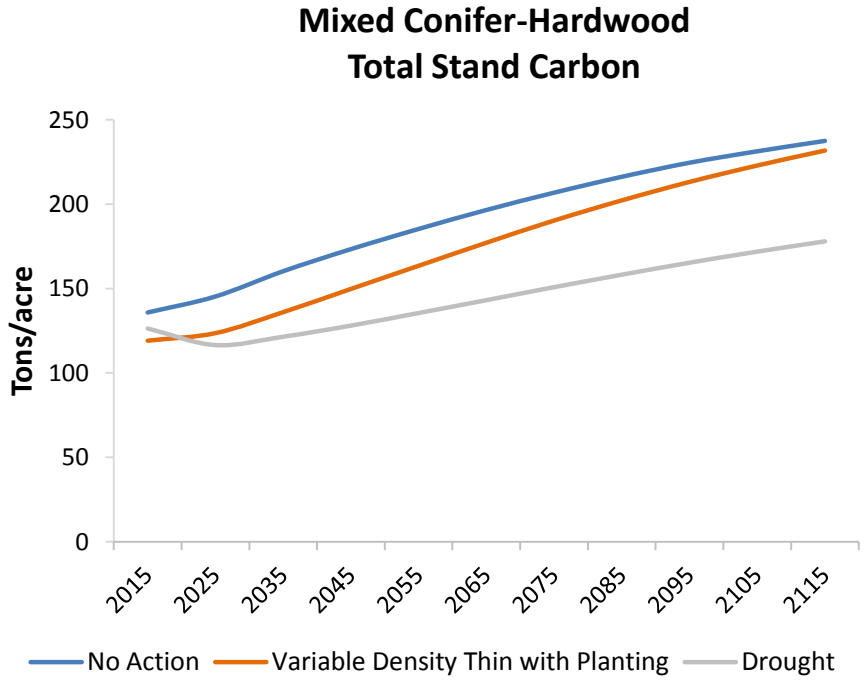


Figure: Mixed conifer-hardwood forest carbon dynamics under with-treatment, no-treatment, and no-treatment with climate change projections.

Hardwood

a. No action

If left untreated large portions of existing hardwood patches will begin to die off. Some patches are 60+ years old and capturing what value red alder has now would help meet economic objectives. Concentrated mortality during a relatively short timeframe can be complicating and is likely to result in the release of the already abundant understory species, such as salmonberry and sword fern, decreasing the chances of favorable natural regeneration. Minimal hardwood regeneration in the understory does not bode well for the future of the stand, decreasing the site's value as a wildlife corridor due to the decrease in canopy cover and structure. Natural seeding and survival of existing conifers for advanced regeneration is also unlikely, again due to the extensive, dense shrub and ground cover. The few large diameter western red cedar present on this portion of the site will not provide adequate canopy cover to maintain or regenerate a healthy forest.

b. Variable retention harvest, MH01-HWD

Similar to the mixed conifer-hardwood ecotype's distribution throughout Mitchell Hill, hardwood patches here are highly variable and should be treated in phases, further providing for natural structural complexity. Where the TPA is above 150, we suggest reducing hardwood stands to 150 TPA. No more than 55% of hardwood patches in the entire stand will be treated. Where treated, we would replant to an overall density of 200 TPA with a species mix of western red cedar, western white pine and Sitka spruce. For areas that tend towards a higher percentage of conifer species, hardwoods may be cut to release suppressed conifers. A six foot radius should be used to clear out any competing hardwoods.. To ensure successful seedling survival, follow up with some shrub control treatment is recommended. Releasing suppressed conifers can allow for greater fragmentation and stratification of the upper canopy to stimulate growth in the lower canopies, triggering individual tree productivity and changing the stand's dynamics.

a. Variable retention harvest, MH03-HWD

MH03-HWD has two hardwood patches on either side of a type XX stream that is buffer. This is a good opportunity to capture the red alder value and conifer conversion in riparian areas by creating gaps for planting conifer species. Treating hardwood patches in MH04 should be prioritized, as they are of marketable diameter and nearing an age when mortality can be expected. Larger patch cuts, one half to one acre in size, will maximize efficiency and allow shade-intolerant Douglas-fir seedlings enough space and light to grow. Retaining some young and (20-30%) mature alder will provide potential wildlife trees, habitat quality and quantity into the future. For stream protection and to provide shade, we recommend planting long lived Douglas-fir, Sitka spruce and western red cedar in riparian areas and buffers, diversifying the stand both in age class and species composition.

Considering carbon

It is especially important to enhance features of hardwood patches that increase the forest's capability to store and sequester carbon. Shorter lived hardwoods not resilient to drought. For example, red alder decline rapidly, without sequestering or storing carbon. Downed hardwood logs decompose quickly, releasing stored carbon back into the atmosphere. VRH treatment of mature hardwood patches approaching mortality transitions them to fast growing, longer lived conifer compositions which in a short time can store many more tons of carbon per acre. As shown below, forests fifty years in the future that have been VRH treated and planted with a

more drought tolerant mix of conifer species store more carbon than those modeled in a drought scenario or not treated.

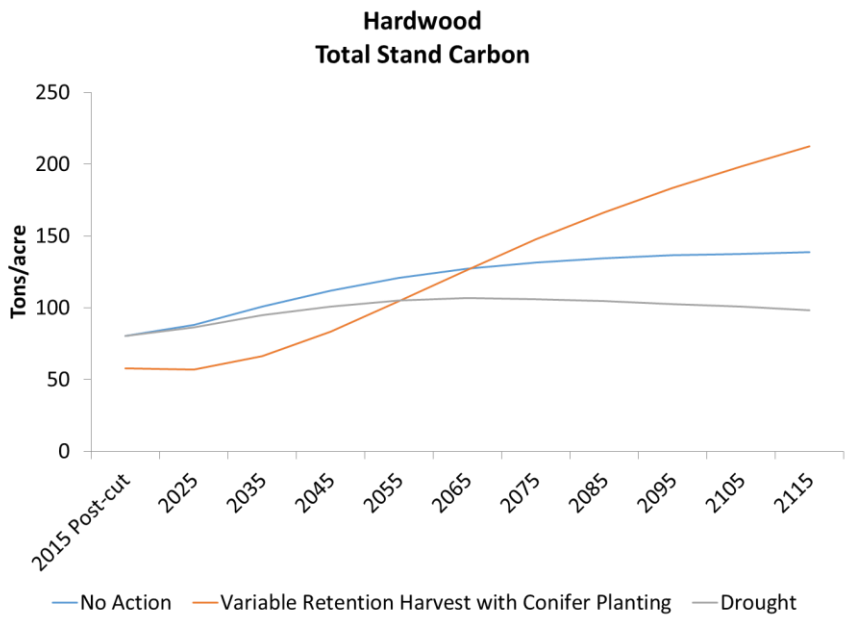


Figure: Hardwood forest carbon dynamics under with-treatment, no-treatment, and no-treatment with climate change projections.

Young Forests

a. No action

If left untreated, young trees would grow taller but spindly with high height to diameter ratios as a result of the forest's dense condition. These trees would then be susceptible to blowdown, eliminating any economic value the stand had. Relative density, which is a measure of stand density relative to the biological maximum a stand can support (Curtis 1982), will increase over time resulting in poor forest health and rapidly increasing tree mortality. In addition, laminated root rot would spread and contribute to the increasing tree mortality.

b. Variable density thin, MH02 & MH04

In an effort to restore forest health, reallocate resources and reinvigorate residual tress, a variable density thinning is recommended in 5-10 years (approximately 2025) once the Douglas-fir have reached merchantable diameters. Mitchell Hill's young forest units are currently in the stage of Low Competition, and a delayed treatment would allow the forest to continue accumulating

biomass. At the time of treatment, gaps should be replanted to 200 TPA with a mix of species. Root rot pockets should be treated at the time of VDT.

Cutting guidelines suggest that root rot pockets be treated by complete removal of affected overstory trees and trees within 2 crown widths of the infected tree, or by the "donut treatment" in which the affected tree is retained, while trees within 2 crown widths around the infected tree are removed. The donut treatment would promote decadence and structural complexity which is important for wildlife habitat. While mortality is an important part of forest dynamics, and root rot is a native disease, these Douglas-fir plantations are susceptible to rampant spread of the disease and extensive mortality. Root rot resistant species such as red cedar and white pine are to be planted in gaps created by the laminated root rot treatment at approximately 300 TPA. Prior to the post thinning planting, a thorough herbicide treatment is recommended to control for invasive and competing shrub and ground vegetation thereby ensuring the successful establishment of new seedlings.

B. Preston Ridge

Similarly to Mitchell Hill, Preston Ridge will require multiple entries, treated in phases. In some of the phases, mixed conifer-hardwood forest and hardwood patches will be treated simultaneous, each requiring a variety of different treatments

<u>Mixed Conifer-Hardwood</u>

a. No action

Taking no action in this stand is not a preferred option for several reasons. While the stand is currently meeting the stated objectives of wildlife and riparian area protection it could be treated to perform them better, especially in the pure stands of Douglas-fir that could be thinned to enhance old growth characteristics. The stands SDI has decreased slowly over time indicating mortality is occurring and snags and downed wood are accumulating. However, we also want to speed succession, create vertical diversification, and promote crown complexity to occur faster than it would naturally, and this can be accomplished with thinning. This option may also be preferred due to lack of manpower to complete more expansive treatments across KCP landholdings.

b. Variable density thin, P01 & P02

Density managemtn and removal of Douglas-fir < 21" dbh will fragment and stratify the canopy, stimulating growth of intermediate, suppressed trees and shade tolerant species. This will trigger tree productivity and speed up successional pathways. It will also allow the dominate Douglas-fir more growing space to become even larger, encouraging epicormics branches and the development of complex crowns. Complex crowns support wildlife and the removal of some trees will enhance flying corridors. In addition to commercial removal, non-commercial treatments create snags and large downed wood providing valuable habitat for small mammals, amphibians, and bird species which is important in these mature stands. When compared to the no treatment option, stand density actually increases

over time, indicating that this option will also create more snags and downed wood.

c. Variable density thin, P03, P04 & P05

Removal of Douglas-fir < 15 dbh will open canopy positions for more shade tolerant trees thereby stimulating a second cohort and enhancing its prominence in the midstory, speeding up successional pathways and building the stands resilience to disturbance. It will also allow the dominant Douglas-fir more growing space to become even larger and the gaps created around them will encourage epicormic branching and more old growth complex crowns to form. These complex crowns will support wildlife and the removal of trees will create/enhance flying corridors in the unit. In addition to commercial treatments, the stand will benefit from non-commercial activity in areas deemed difficult to harvest efficiently. Drop and leave helps in aiding the creation of snags and large downed wood that provides valuable habitat for small mammals, amphibians, and bird species. When this option is compared to the no treatment option the SDI decreases over time and results in a slightly less dense forest than the no treatment option. Lastly, these treatments can help generate revenue to help fund development of recreational opportunities for King County residents.

Young Forest

a. No action

An unhealthy dense, even aged, hardwood forest will persist if no action is taken. Densities would drive hardwoods toward accelerated decline, many trees would fall out and recalcitrant understories would limit any favorable naturally regenerating trees. Young hardwood forest can continue for many years, but eventually die off, and they cannot replace themselves with new trees.

b. Variable retention harvest, P06 & P08

A variable retention harvest treating hardwood patches will stimulate residual conifer and hardwood species in 15-20 years, when hardwood species are of merchantable diameter (approximately 2035). Allowing hardwood treatments to guide unevenly distributed patch cuts, will create gaps large enough for plating a mix of conifer species, including western white pine, Douglas-fir and western red cedar. This will diversify the composition and age, and aid transitioning to a more conifer dominated forest.

Non Forested

In the east portion on Preston Ridge, 7 acres of non-forest (P07) have developed into heavy shrub and grass composition. Between young forests (P06 and P08), this unit offered limited species diversity and wildlife habitat. Predominantly, Himalayan blackberry, the site will continue to be degraded, not benefiting adjacent ecotypes.

a. No Action

Non forested conditions will carry on into the future, acting as an invasive species vector.

b. Planting and maintenance, P07

Invasive species eradication by a combination of hand removal and backpack spraying will remove competing invasives, primarily Himalayan blackberry, and thereby create areas to plant. We would propose to plant a mix of drought tolerant conifers species. Invasive and competing vegetation will require follow up treatments to ensure an adequate success rate for the conifer seedlings.

C. Raging River

a. No action

This option would avoid disrupting sensitive soils, saturated sites, and riparian areas throughout the stand. The overall habitat quality of the stand would remain acceptable, especially in the eastern and southern regions, as would the forested wetland patches to the west. The northern central portions of the stand would likely remain densely vegetated with salmonberry and vine maple, making natural regeneration challenging for many years. The alder will eventually die, leaving large shrubs to dominate these open areas. Eventually, red cedar may establish in the open areas to shade out a portion of the shrubs, but this could take decades. Without any treatment to the overstory, we suggest serious consideration be given to the use of invasive species treatments.

b. Non commercial - drop and leave, RR & RR-HWD

Raging River's ecological objectives and designation as a natural reserve suggest that non-commercial strategies will restore some horizontal complexity, increase species diversity, and restore some resilience and resistance to the area. Initial treatments should include invasive species removal by a combination of hand and backpack sprayed spot and basal treatments with herbicide where necessary. Additionally, a drop and leave strategy cutting red alder will open the canopy and create gaps to plant a species mix of Douglas-fir, western white pine, western red cedar, and Sitka spruce. In addition to planting a mix of species and live staking onsite black cottonwood, it is expected that some hardwood species will naturally regenerate. In addition to planting, it is crucial to address the Japanese knotwood infestation at this site. Japanese knotweed is present in forested areas in the northwestern region of the stand, and also along the riverbank, although this is not part of the Raging River stand. We also suggest hand-felling upland areas to cut and leave five western red cedar trees per acre to increase the density of large coarse woody debris. These downed logs should be between 15" and 30" DBH. In addition, three conifers per acre (>15" DBH) should be converted to standing snags. We also believe planted areas should be revisited to cut Sitka spruce/western red cedar pairs. Western red cedar should be cut if it has been significantly browsed (missing a leader, little foliage), and Sitka spruce should be cut if it shows signs of spruce budworm damage.

XI. Forest Management Timeline & Financial Analysis

	Years 1-5				Years 6-10		
Treatment	Acres	Feet/ #	Total Amount		Acres	Feet/ #	Total Amount
Variable Density Thin	144	0	$ 191,000		60	0	$ 61,000
Non-Commercial Thin	70	0	$ (17,500)		69	0	$ (13,350)
Invasives Control	175	0	$ (14,141)		39	0	$ (3,120)
Planting and Maintenance	164	73150	$ (74,838)		90	0	$ (31,050)
Trail-Road Work	0	23673	$ (57,743)		0	3500	$ (13,743)
Culvert	0	15	$ (9,000)		0	0	$ -
Total	**553**	**96838**	**$ 17,778**		**258**	**3500**	**$ (263)**
	Years 11-15				*Years 16-20*		
Variable Density Thin	185	0	$233,200		0	0	0
Non-Commercial Thin	0	0	$0		0	0	0
Invasives Control	60	0	($10,500)		0	0	0
Planting and Maintenance	416	0	($70,080)		0	0	0
Trail-Road Work	0	5300	($14,400)		0	0	0
Culvert	0	0	$0		0	0	0
Total	661	5300	$138,220		0	0	0

XII. Roads, Treatment Access & Harvest Operations

A. General description

Mitchell Hill

Mitchell Hill is the largest unit in Preston and can be split into two regions for the purpose of establishing access. To reach the west half of the unit from I-90 take a left on SE High Point Way and proceed west for approximately 1.5 miles. Take a right onto 280th Ave SE and proceed until the intersection of 290th Ave SE and SE 61st Street. At this point there are two potential access points to Mitchell Hill. The first is to follow SE 61st Street which turns into 284th Ave SE for .5 mile at which point there is a hairpin turn and access can be had. The second point is to follow 290th Ave SE for .5 mile to its end. A potential third access point is located up a driveway from the 290th Ave SE access point to a residence recently purchased by King County. Also, access may be available in the future at the trail head of the Grand Ridge Trail off of 280th Ave SE. Finally, a fifth access point may be available in the future from the northern boundary from the end of 286th Ave SE. The first two points provide established access. The last three would require further investigation into the actual feasibility of access from these points.

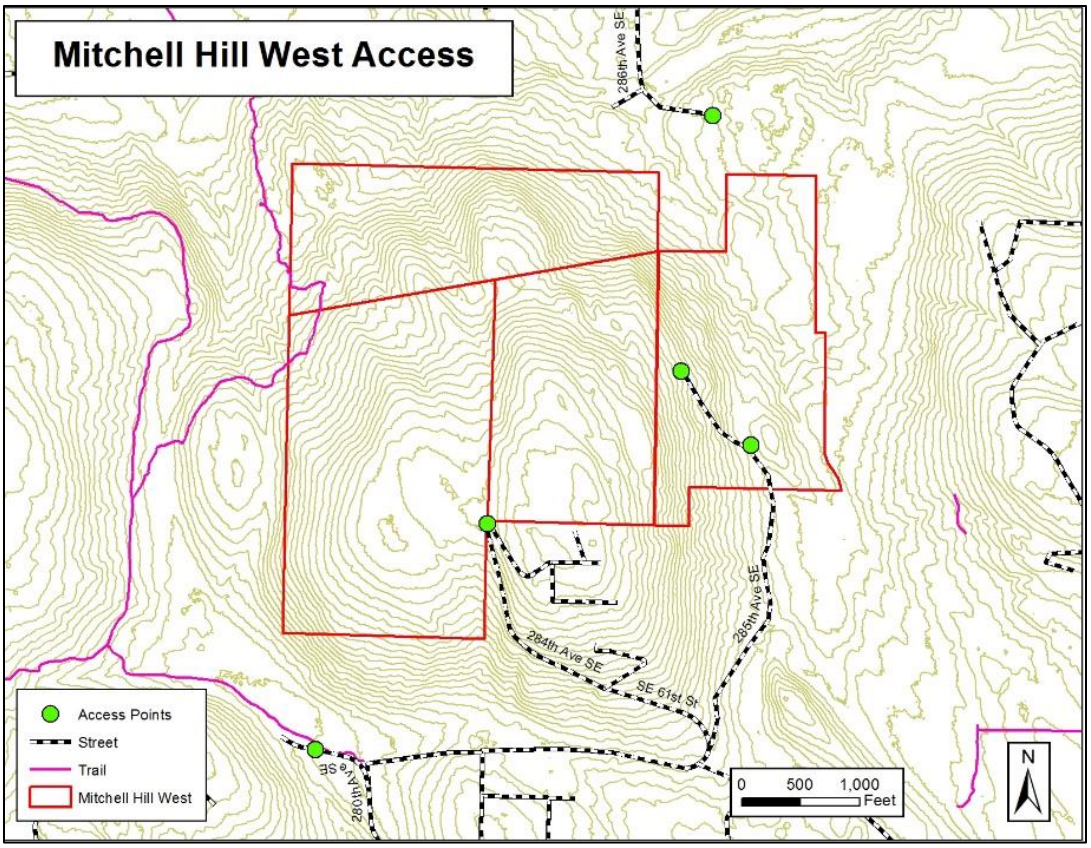
Mitchell Hill East can be reached from I-90 by turning right on SE High Point Way and following it south for .3 mile until turning left onto SE 87th Place for 0.2 mile. At this point turn left onto 308th Ave SE follow for .8 mile and take a slight right onto 12th Place which continues into 308th Place SE. Follow onto SE 64th St. At the end of SE 64th St is a King County gate where access to the east portion of Mitchell Hill can be had.

Preston Ridge

Preston Ridge can be accessed at various points along SE High Point Way about 1 mile after turning left onto SE High Point Way from I-90. Additional access may be available through the parking lot of Cascade Crossfit.

Raging River

To access Raging River, turn right onto SE High Point Way and follow south for .5 mile until it turns into Preston-Fall City Road SE. In 1.7 miles turn right onto SE 68th St. On SE 68th St there is access to the Raging River Natural Area Trail which can be used for access to the unit.


Mitchell Hill West Access
286th Ave SE
285th Ave SE
284th Ave SE
SE 61st St
280th Ave SE
Access Points
Street
Trail
Mitchell Hill West
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Feet
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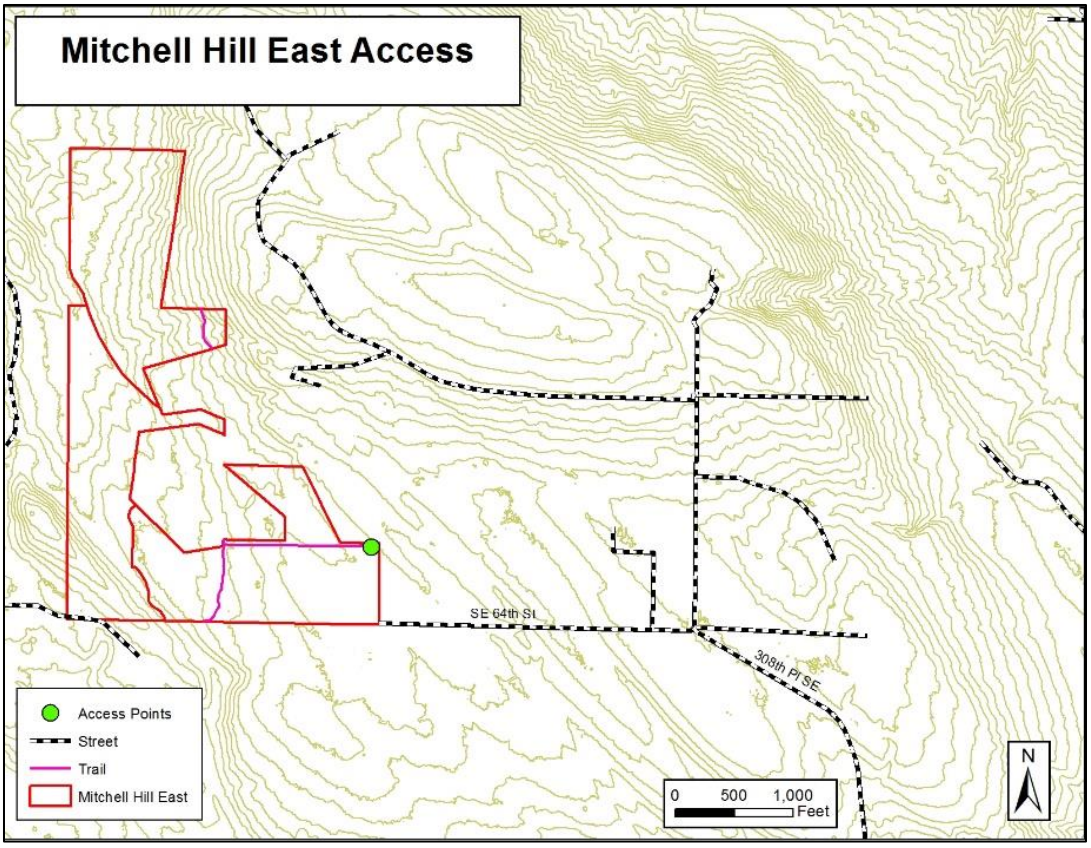
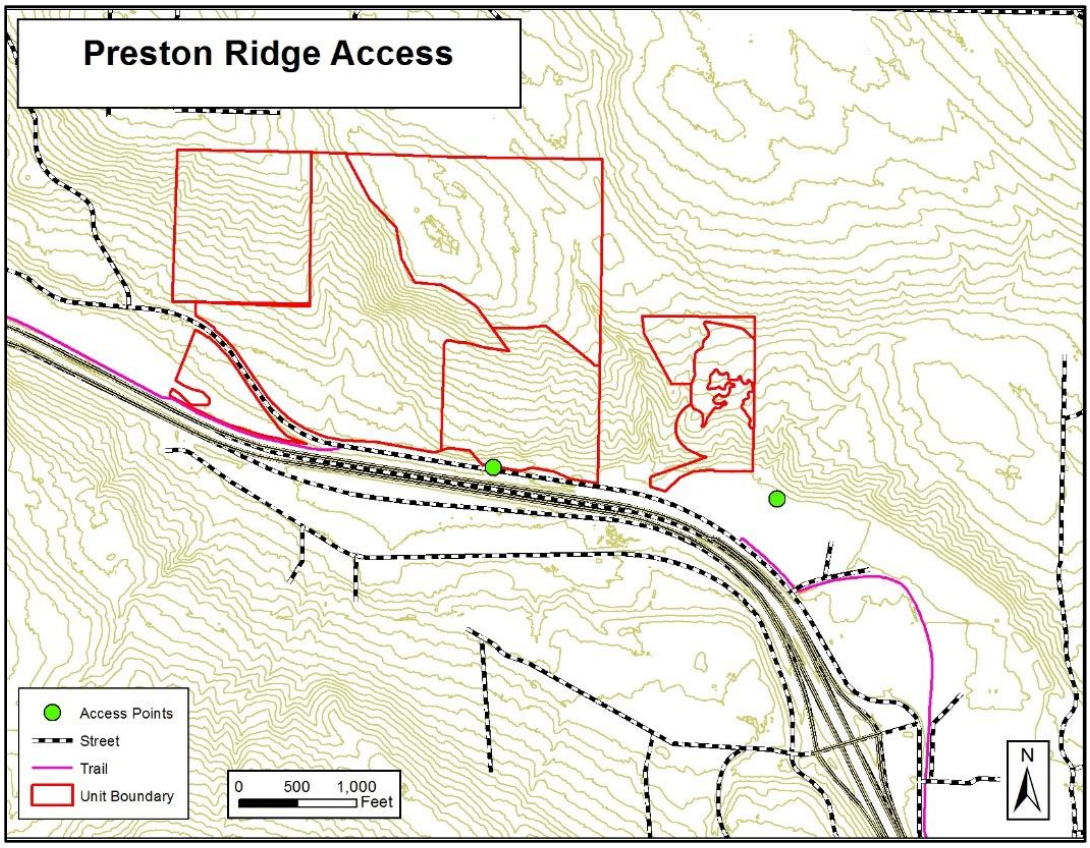
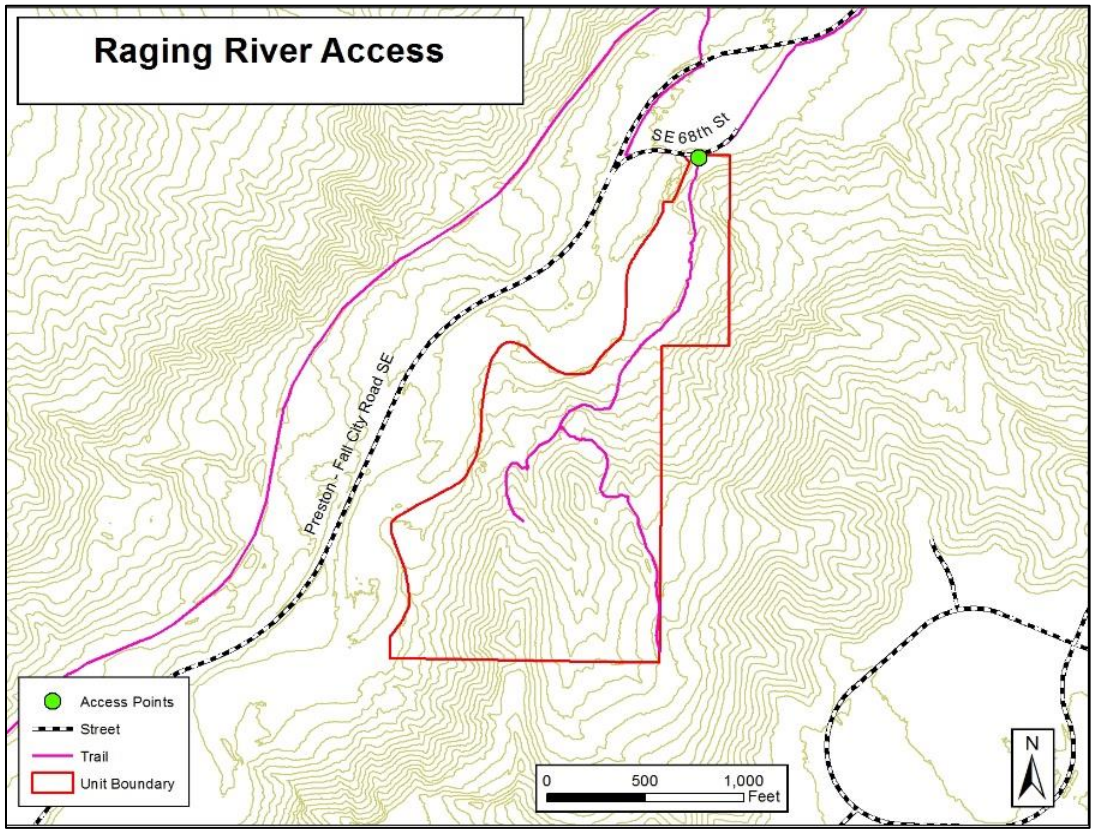

Mitchell Hill East Access
SE 64th St
308th Pl SE
Access Points
Street
Trail
Mitchell Hill East
0 500 1,000
Feet
N


Preston Ridge Access
Access Points
Street
Trail
Unit Boundary
0 500 1,000
Feet
N


Raging River Access
SE 68th St
Preston - Fall City Road SE
Access Points
Street
Trail
Unit Boundary
0 500 1,000
Feet
N

B. Future road development for forest management

From the various access points outlined above there are many viable options for road development into the units. In order to undertake many forest management activities some level of road infrastructure will have to be installed into the units especially Mitchell Hill and Preston Ridge. Below are the recommended road development strategies.

Mitchell Hill

Mitchell Hill presents many challenges for road development due to the steep slope and presence of streams in some areas. However, it will be possible and practical to implement some level of road infrastructure in the area. After field reconnaissance and hillshade analysis in ArcMap a series of abandoned roadbeds from historic logging activities were located. These roadbeds provide an existing grade that should be used in future road development. In addition, it is our recommendation to minimize the building of permanent roads. We suggest only build one or two permanent roads to be used for all future forest management activities. From these roads temporary roads and skid trails can be built on a unit by unit basis to best meet the needs of the harvesting or management operation. Those permanent roads that will be built should be consistently maintained and when no active management operation is taking place should be opened for recreation. Following operations, any temporary roads or skid trails should be abandoned and planted, unless they provide the opportunity for improved recreational access. The eastern portion of Mitchell Hill currently has road infrastructure that would need minor maintenance and improvements such as drainage. It needs to be confirmed that King County has the right of way for this road. Current paved roads that will be identified as haul routes need to be inspected and approved for additional traffic and load bearing prior to any forest management activities. This issue will be further discussed in the Neighbor Interaction and Communication section.

Preston Ridge

Preston Ridge access is arguably the best suited for installation of road infrastructure. Access can be had from the south directly off of a main public road eliminating right of way issues unless access is desired through the parking lot of the current gym. In addition, there is an existing gravel road that can be accessed from the southern boundary. Currently, Washington State Department of Natural Resources manages land off of 308th Pl SE which is adjacent to Preston Ridge. The DNR has road infrastructure from 308th Pl SE to the eastern border of the Preston Ridge unit. Ideally, King County would attempt to gain right of way of this road and then develop short roads to the Preston Ridge unit specific to the management activity. This option would eliminate severe grades, utilize existing infrastructure and minimize the building of new infrastructure by King County.

Raging River

Raging River may prove to be the most difficult area in which to implement any sort of road infrastructure. The most apparent issue is the proximity to the Raging River and the severe topography. It is critical to ensure roads have little to no impact on the river. In addition, the bridge on SE 68th St needs to be inspected and approved for any management activities that may take place. The terrain of the unit is also a difficult one on which to implement roads. The best

option, if roads are necessary, would be to use and expand the existing trail grade for road use. Upon completion of the forest management activity the road would be repaired and updated for continued recreational use.

C. Harvest options and logging systems

The Preston Block provides the opportunity for King County to implement many different forest management activities from regeneration harvests to thinning of various intensities. These operations require some level of harvest system and the accompanying infrastructure to efficiently accomplish these operations. Harvest systems are outlined in further detail in the figure below.

	Ground	Cable
Operational Slope	0-35%	35-90%
Yarding Distance	1000 ft (<500 ft ideal)	>500 ft (1200 ft ideal maximum)
Ground Disturbance	Most	Minimal
Loads per Day	2-4	4-6
Costs	about $75/mbf	about $190/mbf
*Kellogg 2002		

A plan was developed as if some sort of operation were to take place on the entire 716 acres of the Preston Block. To do so approximately 11.5 miles of road would have to be reopened or installed. The goal of reopening this road is to minimize installation of new road, while utilizing existing roadbeds. In addition, operational efficiency and other considerations were considered a priority. With that in mind 3.44 miles would be newly constructed roads combined with temporary spur roads for operational efficiency and temporary or potentially permanent roads for other access considerations. The definition of these temporary roads would be dependent on harvest timelines and goals of King County. The remaining 8.09 miles of road would come from the reopening of historic road beds that have been identified using digital elevation models and accompanying field verification. For such a large area the road installation plan meets or exceeds the goals mentioned above.

Harvest systems would be made up of a combination of cable and ground based systems dependent on the topography and cost considerations. Of the 716 acres, 228 would be harvested using cable based systems. The remaining acreage can be harvested with ground based systems. No yarding distance exceeds 1,100 feet, which is well within the acceptable range of harvest systems. In the following section, harvest systems will be discussed in further detail for each unit of the Preston Block.

<u>Mitchell Hill</u>

Mitchell Hill lends itself to a variety of forest management activities. A combination of cable and ground based systems will be required to remove timber. Nearly the entire western section (areas accessed of 290th Ave SE and SE 64th St) can be ground based due to the relatively flat ground. The wet areas in this portion can be harvested using ground based systems as long as the operations take place in the late summer to prevent excess ground disturbance. The majority of the western portion can also be a ground based operation at the top of the hill. The steep slopes can be accessed with some road installation and harvested using cable systems.

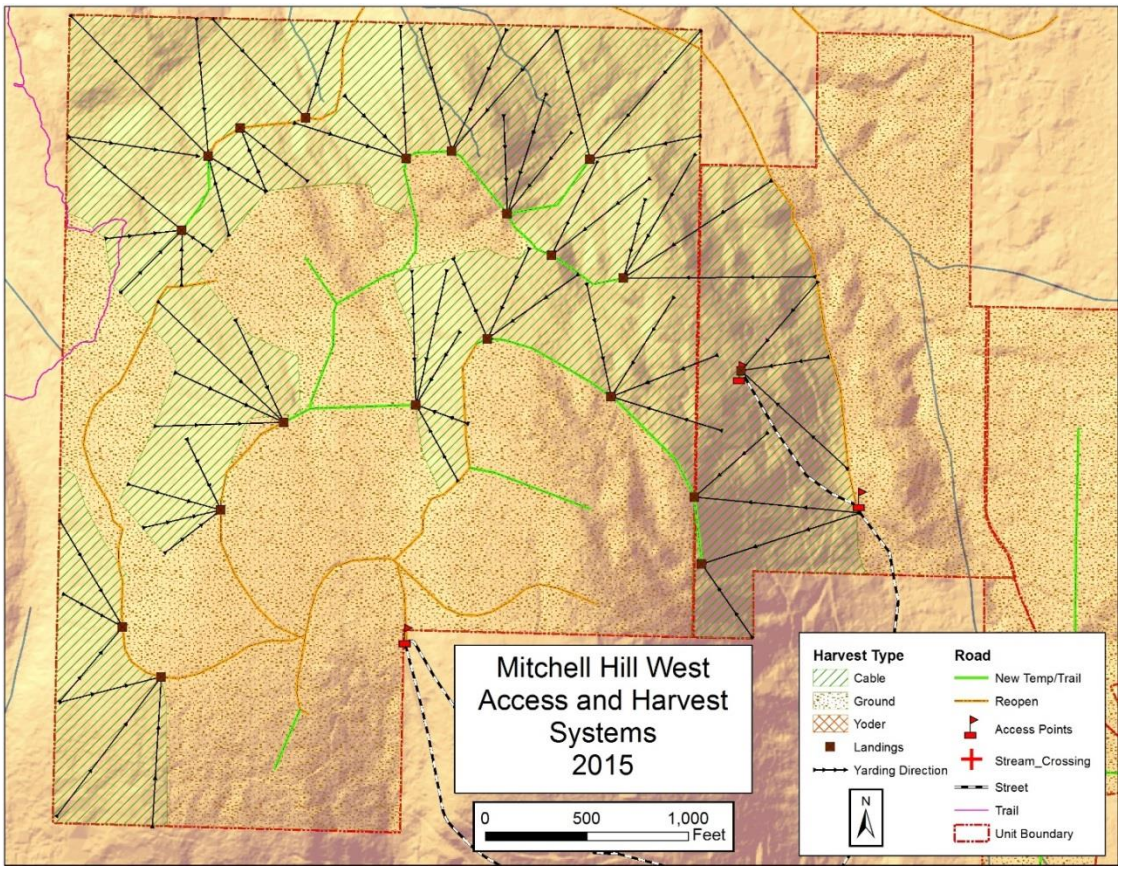
<u>Preston Ridge</u>

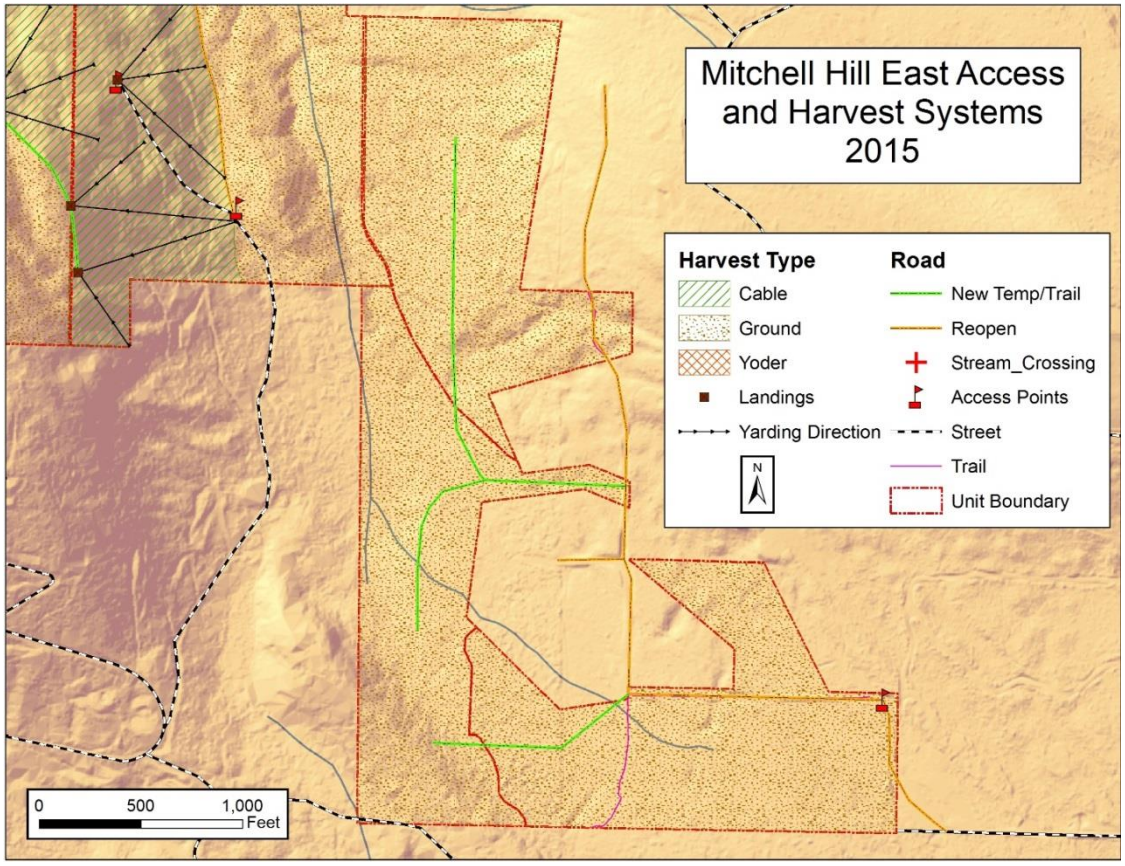
Preston Ridge provides quality access points and could be harvested efficiently using a majority of ground based logging systems with minimal cable harvesting for some areas of steep slopes.

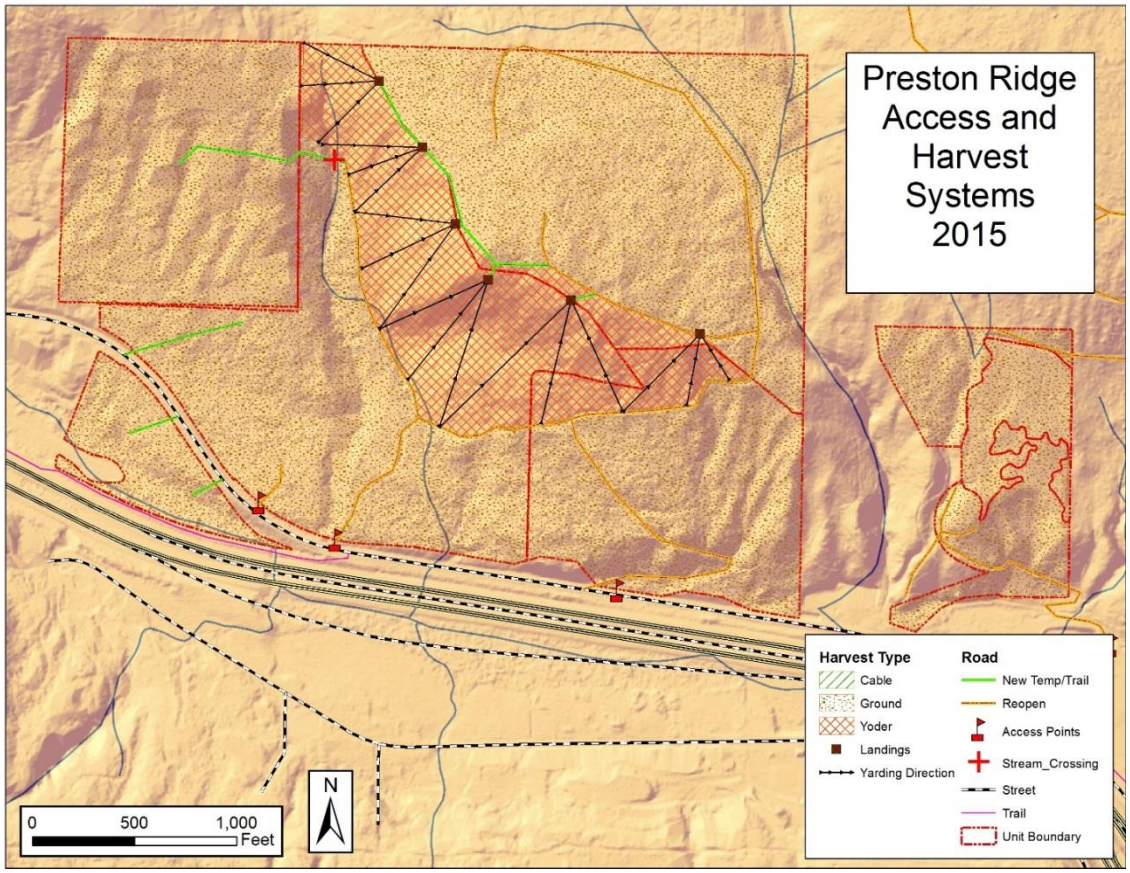
Raging River

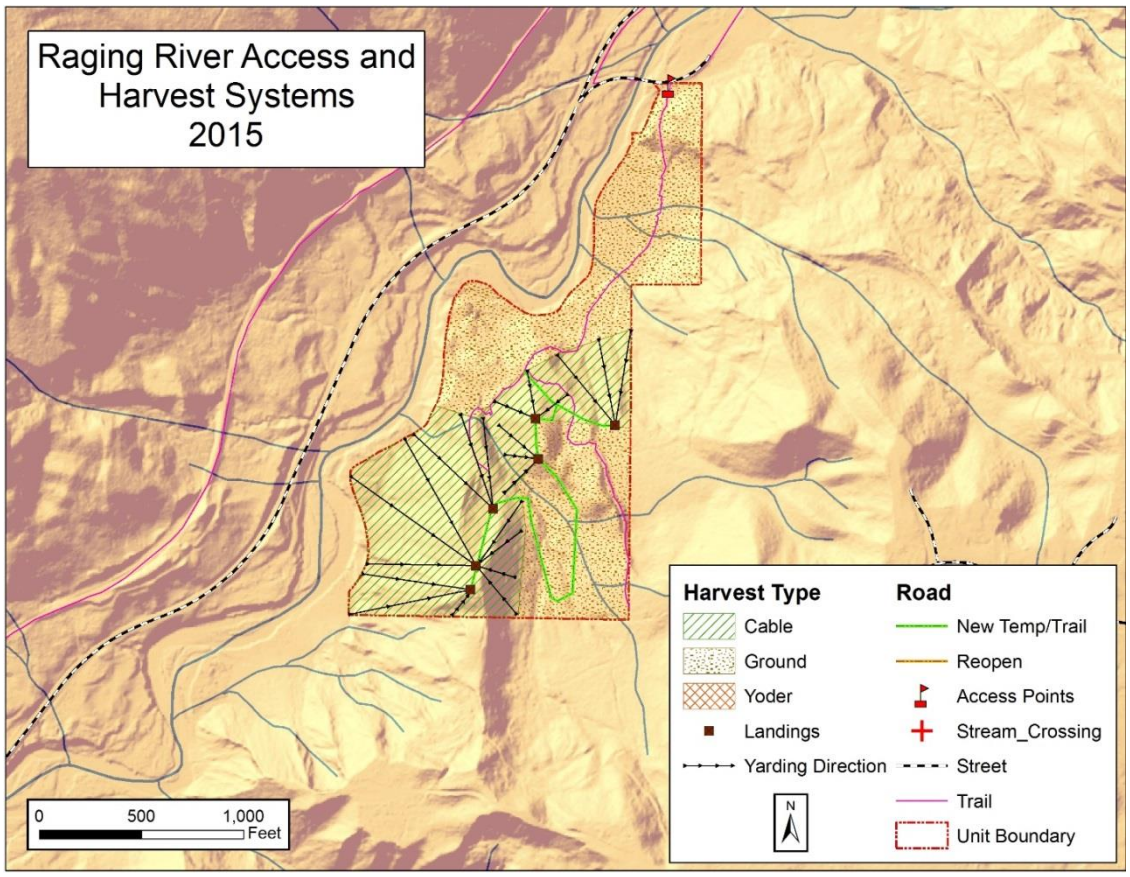
Harvesting the Raging River unit will prove to be the most difficult due to the steep terrain and shape of the unit. The best course of action would be to use the existing trail grade to develop road access and install additional road to access the southern portion of the unit. Much of this unit can be ground based but some cable harvest will be needed in the steep southern portion.
Overall, these units can be accessed and harvested safely and efficiently if desired. Minimal new road installation would be needed due to the availability of historic road beds. A combination of cable and ground based harvest systems can be used to remove timber from every area within the Preston block. It is important to remember that the outlined plan and accompanying maps are just a guideline. Specific contract administration and harvest unit layout would require further development of plan details.

D. Access and harvest system maps






Preston Ridge Access and Harvest Systems 2015
Harvest Type
Cable
Ground
Yoder
Landings
Yarding Direction
Road
New Temp/Trail
Reopen
Access Points
Stream_Crossing
Street
Trail
Unit Boundary
0
500
1,000
Feet
N


Raging River Access and Harvest Systems 2015
Harvest Type
Cable
Ground
Yoder
Landings
Yarding Direction
Road
New Temp/Trail
Reopen
Access Points
Stream_Crossing
Street
Trail
Unit Boundary
0
500
1,000
Feet
N

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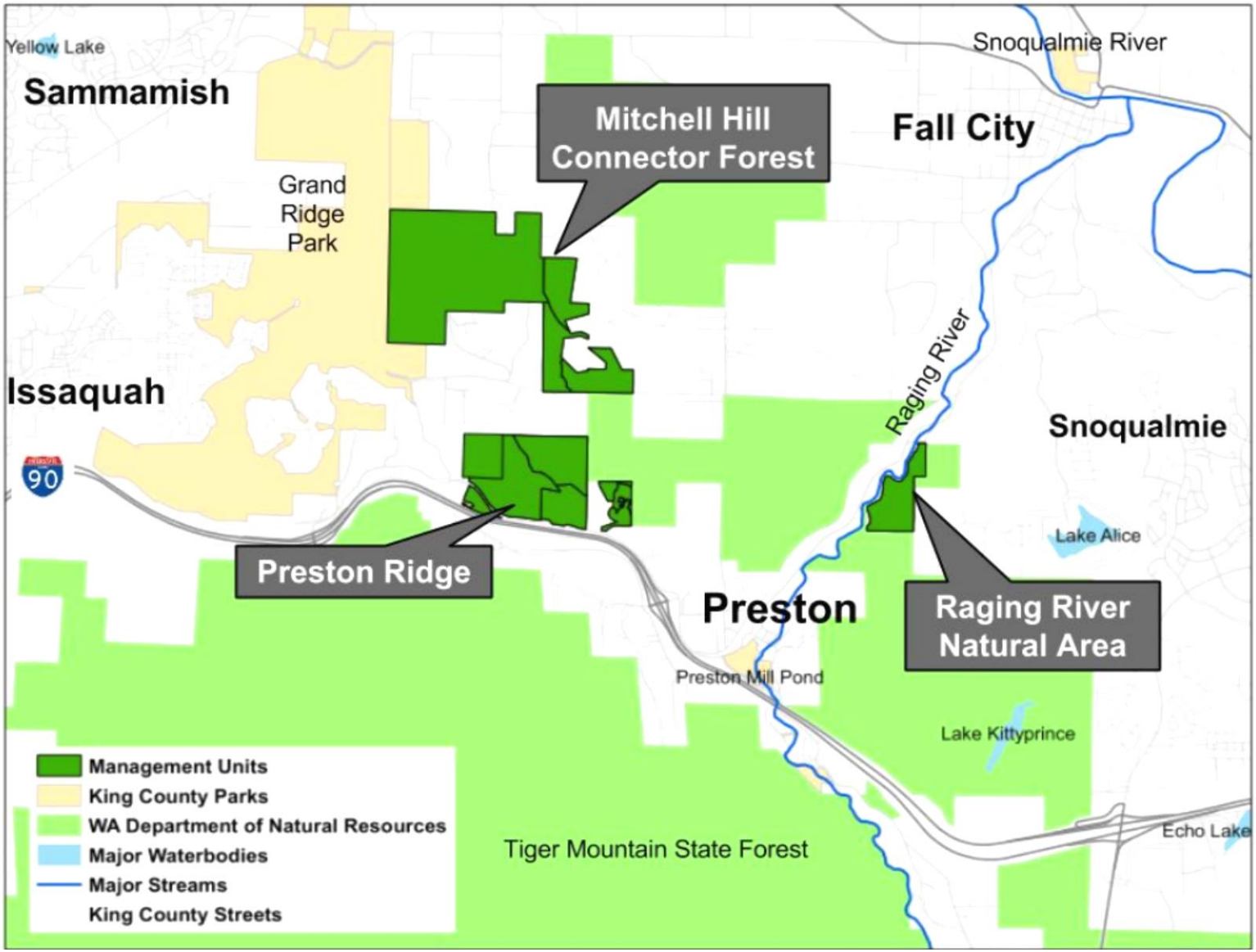
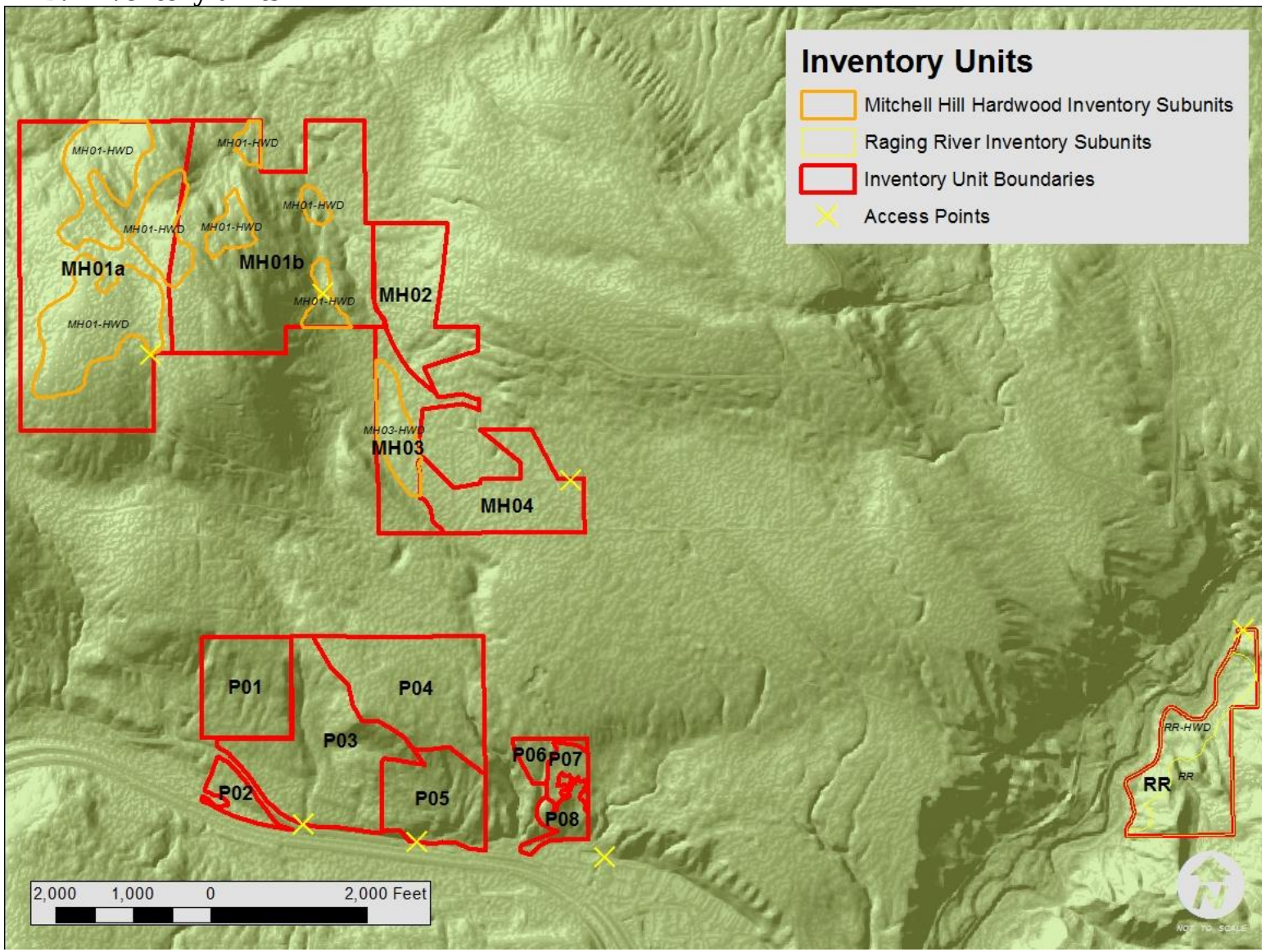
XIV. Maps

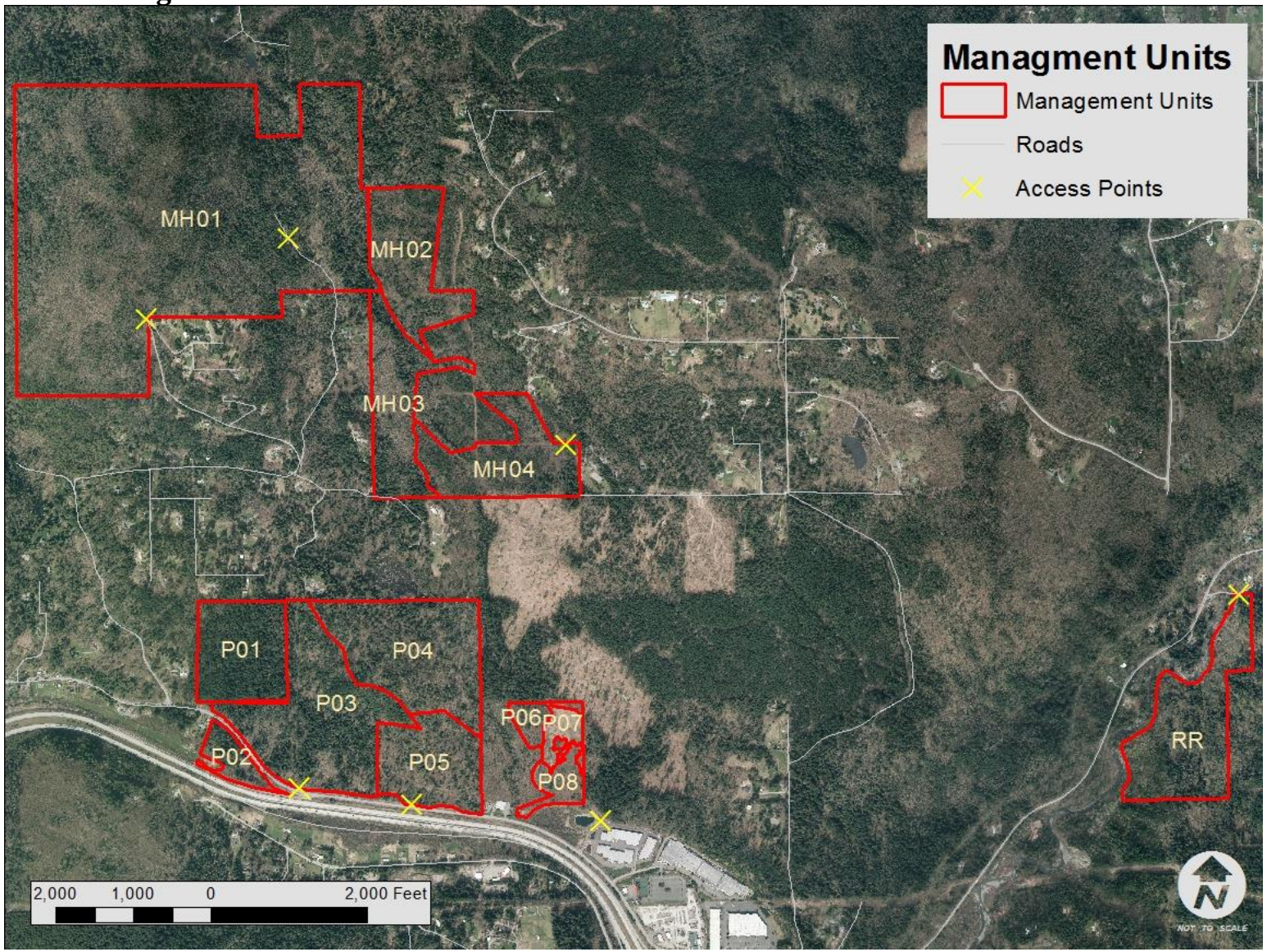
A. Vicinity



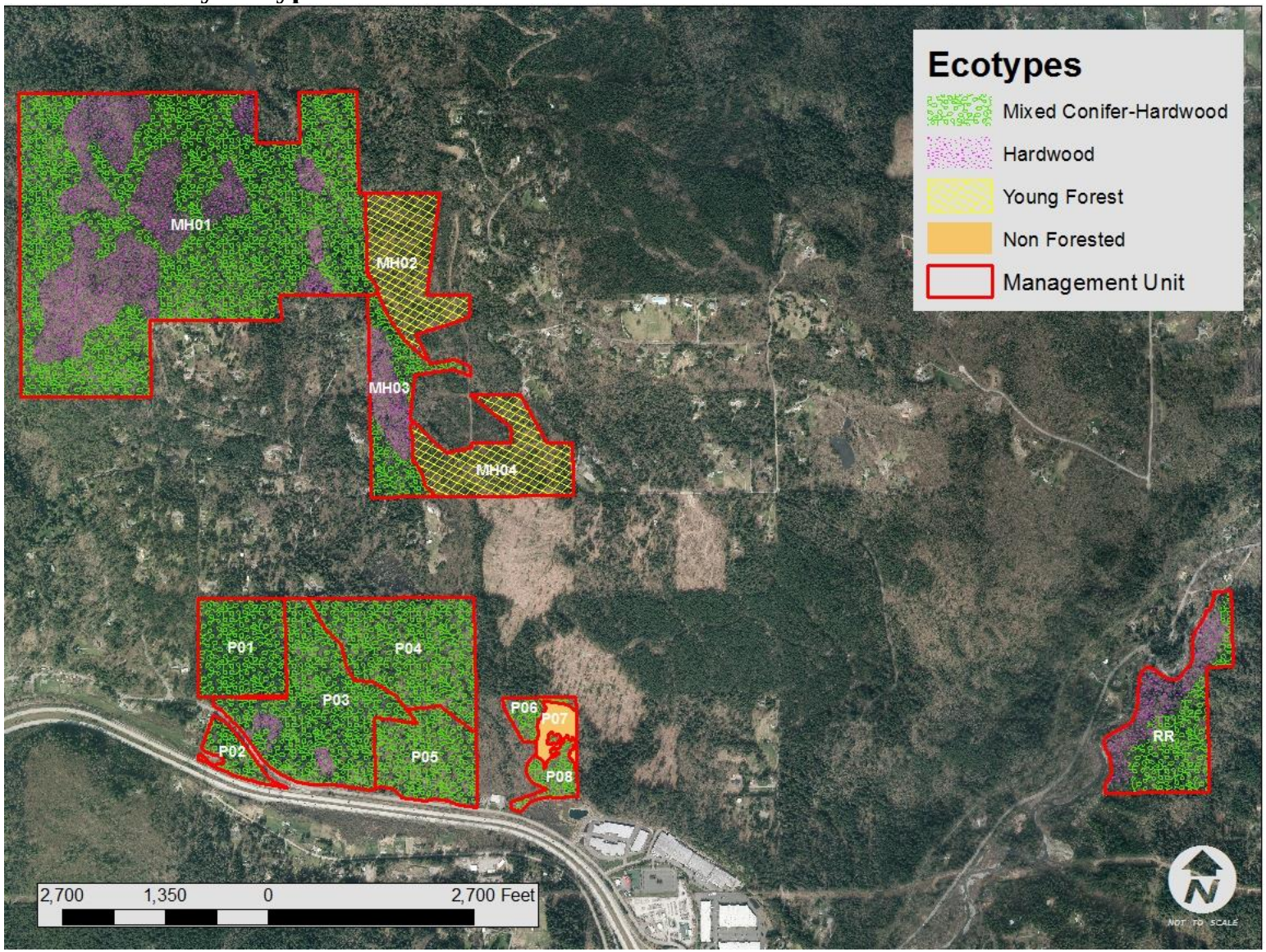
B. Inventory units



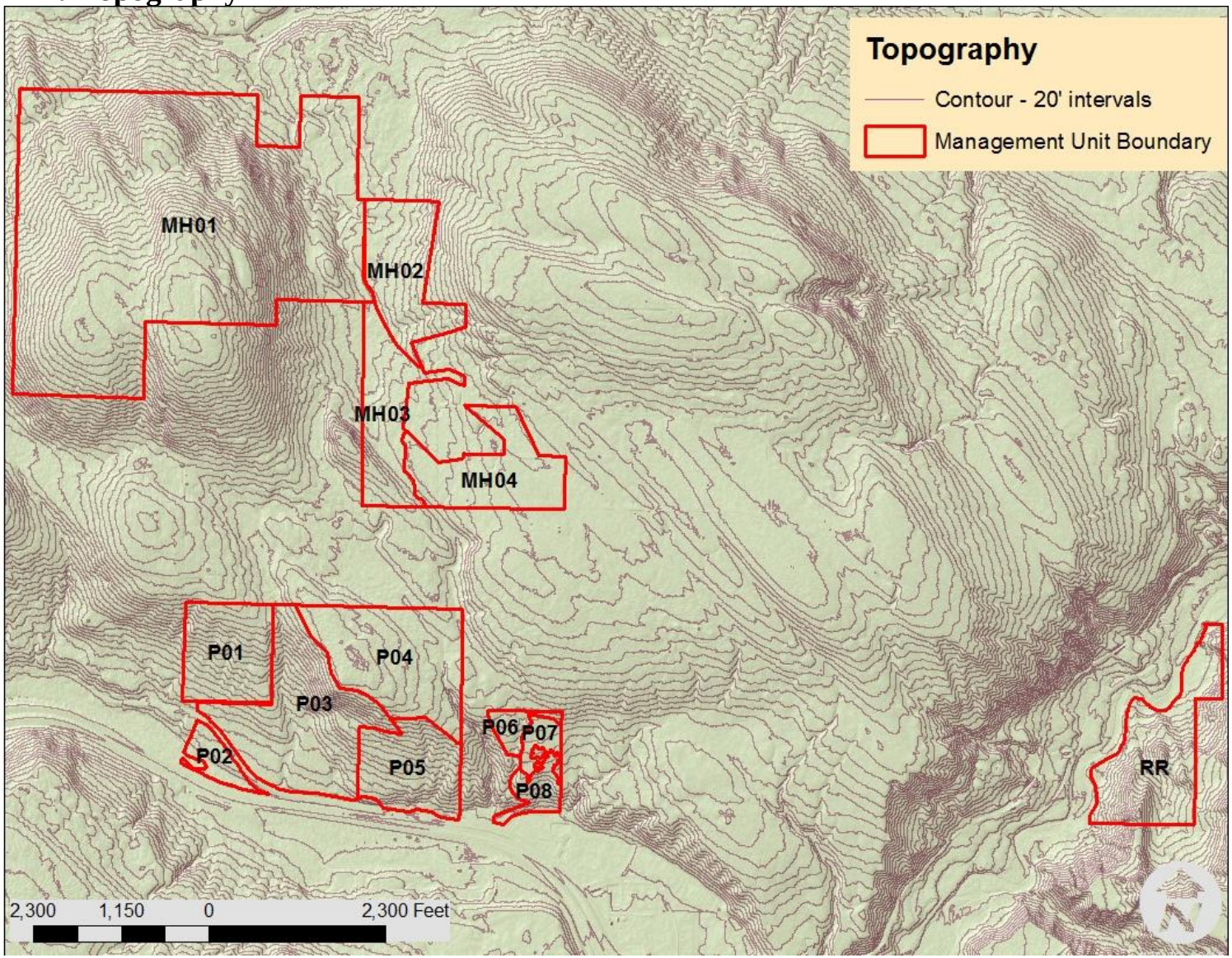
C. Management units



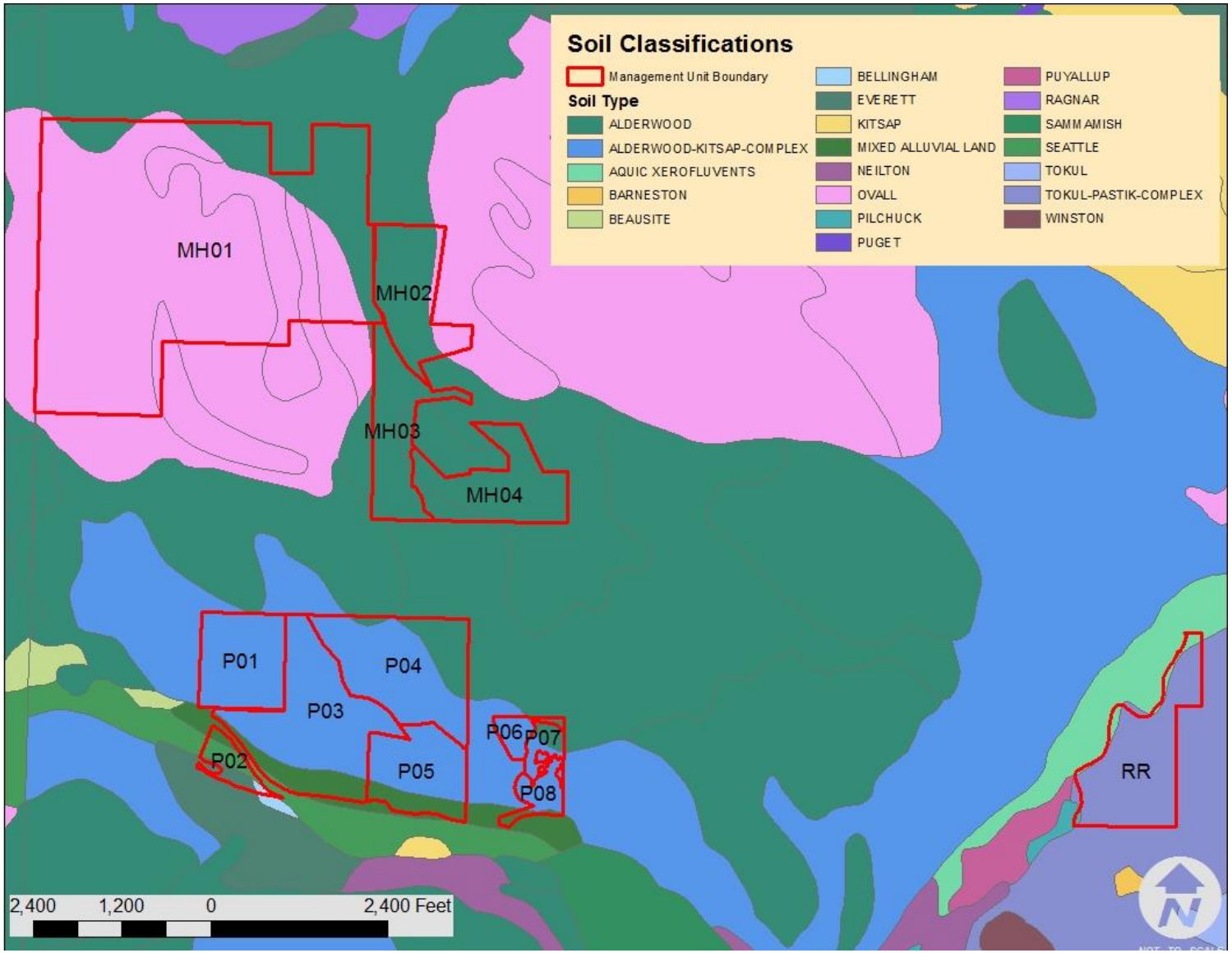
D. Stands by ecotype



E. Topography



F. Soils


Soil Classifications
Management Unit Boundary
Soil Type
ALDERWOOD
ALDERWOOD-KITSAP-COMPLEX
AQUIC XEROFLUVENTS
BARNESTON
BEAUSITE
BELLINGHAM
EVERETT
KITSAP
MIXED ALLUVIAL LAND
NEILTON
OVALL
PILCHUCK
PUGET
PUYALLUP
RAGNAR
SAMMAMISH
SEATTLE
TOKUL
TOKUL-PASTIK-COMPLEX
WINSTON
MH01
MH02
MH03
MH04
P01
P02
P03
P04
P05
P06
P07
P08
RR
2,400 1,200 0 2,400 Feet

XV. Appendices

A. Hardwood management

Red alder

Red Alder Red is the most common hardwood tree in the Pacific Northwest. Typically growing below 2500ft elevation. It prefers humid climates with at least 25 inches of annual precipitation; thus, it is usually found west of the major mountain ranges of the west coast.

Red alder can grow in many soil types, regardless of drainage, though it grows best in inceptisols and entisols in Washington and Oregon. Red alder thrives on deep alluvial soils often found in flood plains and riparian areas and is tolerant of drainage stress/ saturated soils growing in streams and wetlands. Predictably, it does not handle drought very well. Red alder is a pioneer species, establishing itself in disturbed areas, scarified soil and microsites that have light exposure and exposed mineral soil. Its nitrogen fixing capabilities allow it to grow in low-nutrient soils, leaving sites enriched after its decline.

Red alder does not necessarily compete well with competing vegetation and is not shade tolerant. Although it does well in pioneering sites, heavy self-thinning occurs later on in dense alder stands. In mixed stands, it must remain in a dominant canopy position, or it will not survive the competition.

The understory plant community associated with red alder changes with soil moisture and site quality. In lower, wet areas, species such as devil's club, skunk cabbage, sedges, and salmonberry can be found growing underneath red alder. Further upland, sword fern, elderberry, thimbleberry, and huckleberry are more common. Red alder also hosts ectomycorrhizal fungi on its roots, and produces small nodules on the roots, which contain a special bacteria that helps fix nitrogen in the soil. Thus, red alder's role as a pioneer species benefits other plants that cannot grow in low-nutrient soil by providing nitrogen after its decline.

Red alder is one of the smaller native hardwoods, although it does grow rapidly in its juvenile stage. By age five, it may attain heights of 30 feet, reaching nearly 80 feet at age 20 (Harrington). However, after the juvenile stage, its growth slows dramatically compared to other associated species. At the end of its life, a very large red alder may grow up to 35" in diameter and just over 100 feet tall. Red alder usually does not live longer than 100 years.

Red alder has few insect or pathogen sensitivities, especially as a juvenile. Damaging agents typically take hold if the tree is wounded in some way. There is a white heart rot (*Phellinus igniarius*) that may cause mortality in alder, along with a few canker-producing diseases. Red alder logs begin decaying rapidly after harvest or blow-down, so logs must be retrieved quickly if they are to be sold. Browse can be a minor problem for juvenile trees, but is not as severe a problem as western red cedar browse.

Bigleaf maple

Another common hardwood species in the Pacific Northwest is Bigleaf maple, regularly found in low-elevation areas, near water and along floodplains. It does not require nutrient rich soils, and typically grows in mixed hardwood stands and mixed conifer-hardwood stands. It is not very tolerant of extended flooding events and individuals may begin to die after two months or less of constant flooding,

In all associations, bigleaf maple serves a significant ecological role through litter fall. As its large leaves fall and decay, they return beneficial nutrients and help build the volume of the soil. Bigleaf maple also hosts several epiphytic plants, which can quickly grow to a very large mass upon mature trees, leading to the conditions seen on the heavily carpeted maples of the Olympic Peninsula.

Bigleaf maple seedlings establish best on mineral soil and can germinate in low light and shaded environments as long as there is some complexity in the canopy structure allowing limited light through. In fact, bigleaf maple seedlings establish much better in shaded conditions than in clearcuts, due to their decreased visibility to predators. Once established, seedlings grow rapidly—up to two meters in one growing season under favorable conditions. Bigleaf maple responds very quickly to a disturbance, as it can report from a damaged stem and cut stump. Over 60 sprouts may emerge from a single stump, and the new seedlings can reach up to five meters in only three years. Like many other species, competition severely limits growth, as does ungulate browsing.

Bigleaf maple continues to grow quickly throughout the sapling stage, slowing as it approaches saw timber size. Trees with very large diameters tend to have very large crowns as well if they are able to grow in open conditions. Very old individuals may live up to 200 years and reach about 100 feet, sometimes with an equally wide crown. Rooting structure of bigleaf maple tends to be wide and shallow in response to its preferred soil structure.

Bigleaf maple is susceptible to several pathogens, which lead to heart and root rot, the main cause of mortality.

Black cottonwood

Black cottonwood is the largest hardwood tree growing in the western U.S., and its native range extends from Alaska to northern California, and eastward to Montana. It grows on an array of different soils from silt, sand, and gravel to humus, loam and clay; however, it is almost always found thriving near water, on floodplains and along riverbanks. Associated with mixed hardwood and mixed conifer stands, it often grows alongside Douglas-fir, western hemlock, Sitka spruce, bigleaf maple and red alder.

Like bigleaf maple, black cottonwood vigorously sprouts from severed stumps. Its ability to release small leafy sprouts that then root at the point of contact with soil, give it a unique ability to regenerate naturally. Live staking black cottonwood cuttings is a successful, artificial, regeneration strategy. Reaching diameters of 8” and heights of 55’ around age 10, black cottonwood grows quickly. Like many other hardwood species, black cottonwood is shade intolerant growing best in large open areas; however, it responds well to release cuts. Black cottonwood reaches maturity at around 60 years and can live up to 200 years

Ice and snow are the biggest concern of all damaging agents. Frost kills saplings and ice can cause cracking in mature stems, while ice and snow accumulations on branches can cause breakage, particularly in combination with wind. Black cottonwood’s dominate position in the canopy makes it a prime candidate for windthrow and blowdown.

Black cottonwood has some commercial value and is frequently sold for pulp, as veneer for plywood and for pallet or crate construction.

B. Social outreach plan

Neighbor interaction and communication

Operating as a government agency has challenging aspects especially when wanting to implement forest management operations. The responsibility of the county to inform and educate the public on potential and active operations is critical. Preston is no exception. Mitchell Hill is a prime example of the importance of neighbor relationships. In order to access the unit the use of public roads through neighborhoods is necessary. To be a responsible neighbor in terms of access, King County can consider taking such steps as:

Neighbor notification

Prior to any management activities a letter should be sent out to any affected neighbors including those that the activity is adjacent to or those that may be affected by increased traffic. The letter should include the management activity, hours of operation, a rough timeline and contact information.

Maintenance

Many forest operations cause damage to existing infrastructure especially roads. Log truck and machine traffic has a negative impact on paved and gravel roads. As a good neighbor King County should draft a road maintenance plan that would ensure the return of roads to their prior condition should damage occur. This agreement would be made available to affected neighbors.

Courtesy

King County should outline a set of courtesy guidelines for contractors to follow during forest operations. These guidelines would include hours of operation, contact information, situations where a road flagger would be necessary and any other reasonable requests that may be made by neighbors or King County officials.

Overall, any amount of forest management may be met with some resistance. However, if King County is proactive, transparent and forthright with their intentions conflict will remain at a minimum. Following the above recommendations will certainly help in this regard

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C. Plant List

SHRUBS

Acer circinatum	Vine maple
Berberis nervosa	Oregon grape
Fallopia japonica	Japanese knotweed
Gaultheria shallon	Salal
Ilex sp.	Holly
Oemleria cerasiformis	Indian plum
Oplopanax horridum	Devil's club
Rhamnus purshiana	Cascara
Rhododendron macrophyllum	Rhododendron
Ribes bracteosum	Stink Currant
Rubus discolor	Himalayan blackberry
Rubus laciniatus	Evergreen blackberry
Rubus spectabilis	Salmonberry
Rubus ursinus	Trailing blackberry
Sambucus racemosa	Red elderberry
Vaccinium ovatum	Evergreen Huckleberry
Vaccinium parvifolium	Red huckleberry

FERNS

Athyrium filix-femina	Lady fern
Blechnum spicant	Deer Fern
Polystichum munitum	Sword fern
Pteridium aquilinum	Bracken fern

HERBS

Carex sp.	Sedge Grass
Dicentra formosa	Bleeding heart
Galium sp.	Bedstraw
Trillium sp.	Trillium
Urtica dioica	Nettles
Jacobaea vulgaris	Tansy ragwort

D. Shrub species and percent cover

	MH01	MH01-HWD	MH02	MH03	MH03-HWD	MH04		P01	P03	P04	P05	P06	P08		RR	RR-HWD
Bracken Fern	3	3						1			3	2				
Bleeding Heart				1	2				2	1					2	
Bedstraw			1			2						5			1	
Cascara													10			
Cranberry																
Devil's Club	6	3			1				1							
Evergreen Blackberry						3						2				
Evergreen Huckleberry					2			8	2							
Geranium												2				
Himalayan Blackberry												2				
Holly								7								
Indian Plum		1	1		2	5			2			2	10			
Lady Fern			1		2	1			2						1	
Nettle						3						3				
Oregon Grape	7	10	1	5	2	3		15	2	9	15				1	
Red Elderberry	6	2	2	2		2									1	
Red Huckleberry	4	3	1	3	3				3							10
Rhododendron	4	3	1	3	3				3							10
Salmonberry	4	9	13	3	14	10		2	14	3	41	37	70		4	30
Stink Currant															1	
Salal	2		1		11			8	11	1						
Sword Fern	21	8	15	35	28	32		26	28		36				13	20
Trailing Blackberry	1				1				1			2				
Tansy ragwort				1												
Vine Maple	8		5	14	9	3			9	13	7	20			14	
Woodfern												2				
Total Percent Cover	*55*	*39*	*38*	*50*	*68*	*61*		*67*	*68*	*14*	*95*	*54*	*90*		*22*	*70*

E. Glossary

Forest Characteristic Codes

- TPA: trees per acre
- BA: Basal area in ft^2/acre
- QMD: quadratic mean diameter
- Site Index: DF King 50 year
- 95% CI: 95% Confidence interval
- SDI: Stand density index
- Relative Density: Curtis (1982)