Lake Whatcom Watershed Forest Management Plan

DRAFT FOR PUBLIC COMMENT

Prepared by Northwest Natural Resource Group

For

City of Bellingham

Whatcom County

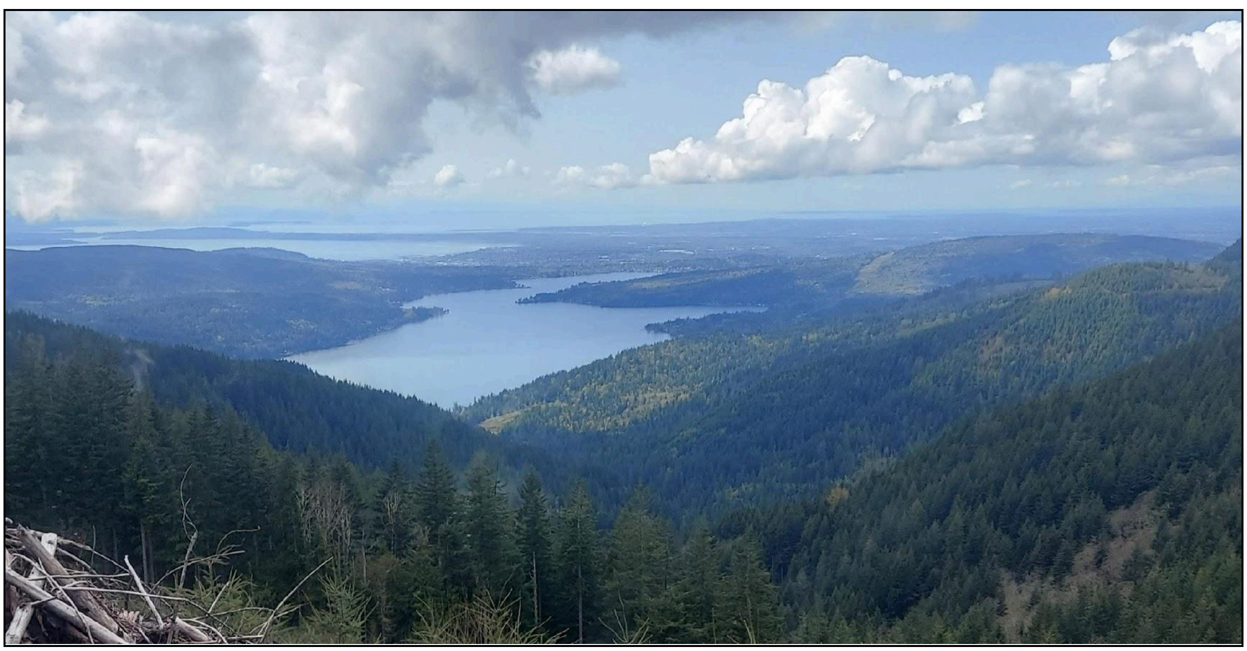


TABLE OF CONTENTS

EXECUTIVE SUMMARY

Lake Whatcom has and continues to play an important role in the quality of life for the people and ecosystems surrounding it. The Lake Whatcom watershed was first inhabited and utilized by Coast Salish tribes who continue to maintain deep spiritual, cultural, and subsistence connections to the lands and waters of the region. Today, the watershed is the drinking water source for more than 120,000 people, valuable habitat for plants and animals, a recreational destination for outdoor enthusiasts, and home to more than 19,000 residents.

The Lake Whatcom watershed encompasses more than 36,000 acres of land that is divided between private, city, county, and state ownerships. Land uses include forestry, agriculture, recreation, and residential development. The County acquired over 8,000 acres from the Washington Department of Natural Resources in 2014 through a reconveyance process that specified the land be used for public recreational access (RCW 79.22.300). To date, the City has acquired approximately 3,500 acres through the Lake Whatcom Land Acquisition and Preservation Program, specifically to prevent development and protect forests, safeguarding Lake Whatcom's water quality. In 2024 Whatcom County and the City of Bellingham embarked on a collaborative effort to develop a comprehensive forest management plan to guide the long-term conservation and restoration of 12,205 acres of their combined forestland.

This ecologically-based forest management plan integrates the goals and objectives of the Lake Whatcom Management Program—including protection of water quality, reduction of sedimentation and nutrient loading, and enhancement of watershed resilience—with principles of ecological forest management. The overarching goal is to restore and maintain a complex, uneven-aged forest mosaic that emulates the structure and function of old-growth ecosystems while safeguarding the watershed's hydrological integrity.

Management strategies emphasize the gradual transition of even-aged, second-growth forests into structurally diverse stands characterized by multi-layered canopies, large live trees, abundant coarse woody debris, and variable understory composition. Silvicultural treatments will use variable-density thinning, gap creation, and extended rotations to accelerate late-successional characteristics while minimizing soil disturbance and surface erosion. Riparian buffers, unstable slopes, and areas of high hydrologic sensitivity will receive special care, prioritizing natural recovery processes to protect water quality and slope stability.

In alignment with the Lake Whatcom Management Program 2025-2029 Work Plan, this strategy also seeks to minimize road-related sediment delivery through upgrading and properly maintaining legacy forest roads and ensuring any new road construction is not hydrologically connected. Active management areas will incorporate Best Management Practices (BMPs) for road maintenance, forest management timing, and equipment operations to prevent turbidity and protect aquatic ecosystems.

Ultimately, this plan envisions the Lake Whatcom watershed as a resilient, self-sustaining forested landscape that supports clean water, diverse habitats, and compatible public uses. By applying principles of ecosystem complexity, legacies, and natural disturbance emulation, management actions will promote forest heterogeneity, enhance carbon storage, and strengthen ecological integrity over time. The result will be a forest that not only meets contemporary resource protection objectives but also provides a living model for sustainable watershed stewardship in the Pacific Northwest.

Plan Overview

Plan Purpose

The purpose of the Lake Whatcom Forest Management Plan is to provide an actionable document that guides management activities and provides recommendations for the long-term management of County and City-owned forestlands within the Lake Whatcom Watershed. Implementing the recommendations in this plan is a separate process which will be undertaken by City and County work planning efforts respectively.

This forest management plan:

1. Focuses on actions that positively impact and safeguard water quality and forest health and otherwise supports the goals and objectives of the current Lake Whatcom multi-parameter Total Maximum Daily Load to meet water quality standards, Whatcom County Comprehensive Plan, City of Bellingham Comprehensive Plan, and Lake Whatcom Management Program Work Plan;
2. Presents management strategies and stand-level prescriptions that utilize Best Management Practices to improve forest health, improve water quality and watershed health, increase fire resistance, preserve and protect critical and unique habitats, and reduce the risk of mass wasting/debris torrent events;
3. Addresses issues affecting timely and efficient implementation, including the consideration of budgetary and other resource/capacity needs associated with management activities in order to inform County and City decision-making;
4. Addresses potential issues affecting implementation and/or outcomes including those potentially associated with climate change and adjoining land use practices.

Management Objectives

- **Water Quality -** maintain and improve water quality in Lake Whatcom and the surrounding watershed with particular attention on reducing sediment delivery to the lake.
- **Forest Health and Resiliency -** promote healthy and resilient forests that are adaptable to a changing climate and ensure long-term forest cover in the watershed.
- **Resistance to Wildfires** - improve forest resistance to and recovery from wildfires.
- **Wildlife Habitat -** provide quality wildlife habitat throughout the watershed while preserving and protecting critical and unique habitats.

- **Recreational Access** - ensure management recommendations align with and support recreation goals and access that are appropriate for the County and City respectively.

Desired Future Condition

The desired future condition for the Lake Whatcom watershed is a resilient, late-seral forest landscape that emulates the structure, composition, and ecological function of native old-growth ecosystems. Guided by the principles of ecological forest management, the watershed will consist of a diverse mosaic of forest stands varying in age, species composition, and structural complexity—featuring large, old trees; multi-layered canopies; abundant standing dead wood and downed logs; and rich understory diversity. These conditions will enhance habitat connectivity, promote carbon storage, and sustain essential ecological processes such as nutrient cycling and natural regeneration. Hydrologically, the forest will stabilize soils, regulate streamflows, and protect water quality by minimizing sedimentation and maintaining intact riparian systems. Over time, this restored, late-seral forest condition will provide clean drinking water, ecological resilience, and enduring habitat integrity while supporting compatible public and cultural values within the Lake Whatcom watershed.

Forest Overview

The current forested condition of city and county owned properties in the Lake Whatcom watershed reflects a legacy of intensive historical land use, including extensive logging, road building, and limited reforestation prior to public ownership. Much of the watershed is now dominated by second-growth Douglas-fir and western hemlock stands between 40 and 90 years old, originating from clearcuts that occurred primarily during the mid-20th century. These forests tend to be even-aged, densely stocked, and structurally uniform, with relatively closed canopies, limited understory vegetation, and sparse amounts of coarse woody debris and standing dead wood. Such simplified stand structures provide fewer ecological niches and reduced habitat complexity compared to the late-seral and old-growth forests that historically covered the basin.

The hydrological and geomorphic consequences of this management legacy are also evident. A dense network of legacy logging roads—many of which were constructed before modern Best Management Practices—contributes to surface runoff, sediment delivery, and slope instability. In some areas, impacted soils and altered drainage patterns exacerbate erosion and fine sediment transport to streams and the lake, degrading water quality and aquatic habitats. Riparian zones have been partially degraded by past harvest activities and reduced canopy cover, which has affected stream shading, large woody debris recruitment, and temperature regulation.

Despite these challenges, the watershed's forests are now in a period of ecological recovery under public management by Whatcom County and the City of Bellingham. Active restoration and selective thinning projects are proposed to increase structural complexity, promote mixed-species regeneration, and enhance watershed function. Many stands are showing early signs of developing multi-layered canopies and improved understory complexity. However, the watershed as a whole remains in a transitional condition—ecologically simplified but moving toward greater resilience and complexity through the application of long-term, ecologically based forest management practices.

Management Recommendations

Over the next 30 years, ecologically based forest management in the Lake Whatcom watershed has the potential to restore late-seral forest structure and improve watershed function through a combination of active and passive restoration strategies. Selective and variable-density thinning is the recommended primary silvicultural tool for accelerating the development of complex stand structures in even-aged, second-growth forests. By reducing stem density and creating small canopy gaps, these treatments will promote understory regeneration, enhance species and age diversity, and encourage the growth of large-diameter trees characteristic of late-seral conditions. Supplemental tree planting with shade-tolerant and site-appropriate species such as western redcedar and western hemlock will increase compositional diversity and resilience to pests, disease, and climate change. Over time, these interventions will create a more heterogeneous forest canopy, improve wildlife habitat, and strengthen ecosystem functions such as carbon sequestration and clean water.

In tandem with active forest restoration, management recommendations include emphasizing conservation of sensitive areas, including riparian zones, unstable slopes, and wetlands, where natural processes can recover without disturbance. These areas will serve as ecological anchors, promoting natural regeneration, enhancing water filtration, and reducing sediment delivery to streams and the lake. Fire risk mitigation will also play an important role, using targeted thinning, surface fuel reduction, and the retention of moisture-rich species to lower wildfire potential while maintaining ecological integrity. These treatments will be designed to protect the watershed's drinking water supply and reduce the likelihood of post-fire erosion or runoff impacts.

Best Management Practices (BMPs) for forest road maintenance are recommended for implementation consistently across the watershed to protect hydrologic functions and reduce chronic sedimentation. Over the 30-year period, recommendations include upgrading road systems to improve drainage systems and hydrologically disconnecting road networks from streams. Seasonal restrictions on heavy equipment use, erosion control measures, and ongoing monitoring will ensure that road infrastructure supports both forest management access and long-term watershed protection. Together, these practices will guide the Lake Whatcom watershed toward a resilient, late-seral forest condition that sustains clean water, stable slopes, and diverse ecological communities for future generations.

SECTION 1: INTRODUCTION

Management Context

Plan Purpose

The purpose of the Lake Whatcom Forest Management Plan is to provide an actionable document that guides management activities and provides recommendations for the long-term management of County and City-owned forestlands within the Lake Whatcom Watershed. Implementing the recommendations in this plan is a separate process which will be undertaken by City and County work planning efforts respectively.

This forest management plan:

1. Focuses on actions that positively impact and safeguard water quality and forest health and otherwise supports the goals and objectives of the current Lake Whatcom multi-parameter Total Maximum Daily Load to meet water quality standards, Whatcom County Comprehensive Plan, City of Bellingham Comprehensive Plan, and Lake Whatcom Management Program Work Plan;
2. Presents management strategies and stand-level prescriptions that utilize Best Management Practices to improve forest health, improve water quality and watershed health, increase fire resistance, preserve and protect critical and unique habitats, and reduce the risk of mass wasting/debris torrent events;
3. Addresses issues affecting timely and efficient implementation, including the consideration of budgetary and other resource/capacity needs associated with management activities in order to inform County and City decision-making;
4. Addresses potential issues affecting implementation and/or outcomes including those potentially associated with climate change and adjoining land use practices.

Location Overview

This forest management planning effort encompasses over 12,205 acres of forestland split across 19 properties owned by Whatcom County and the City of Bellingham within the Lake Whatcom watershed as identified in the table and map below. City-owned properties were acquired through the Lake Whatcom Property Acquisition and Protection Program. County-owned properties include properties acquired by the Whatcom County Parks Department including lands reconveyed to the County in 2014 by the Washington State Department of Natural Resources (DNR).

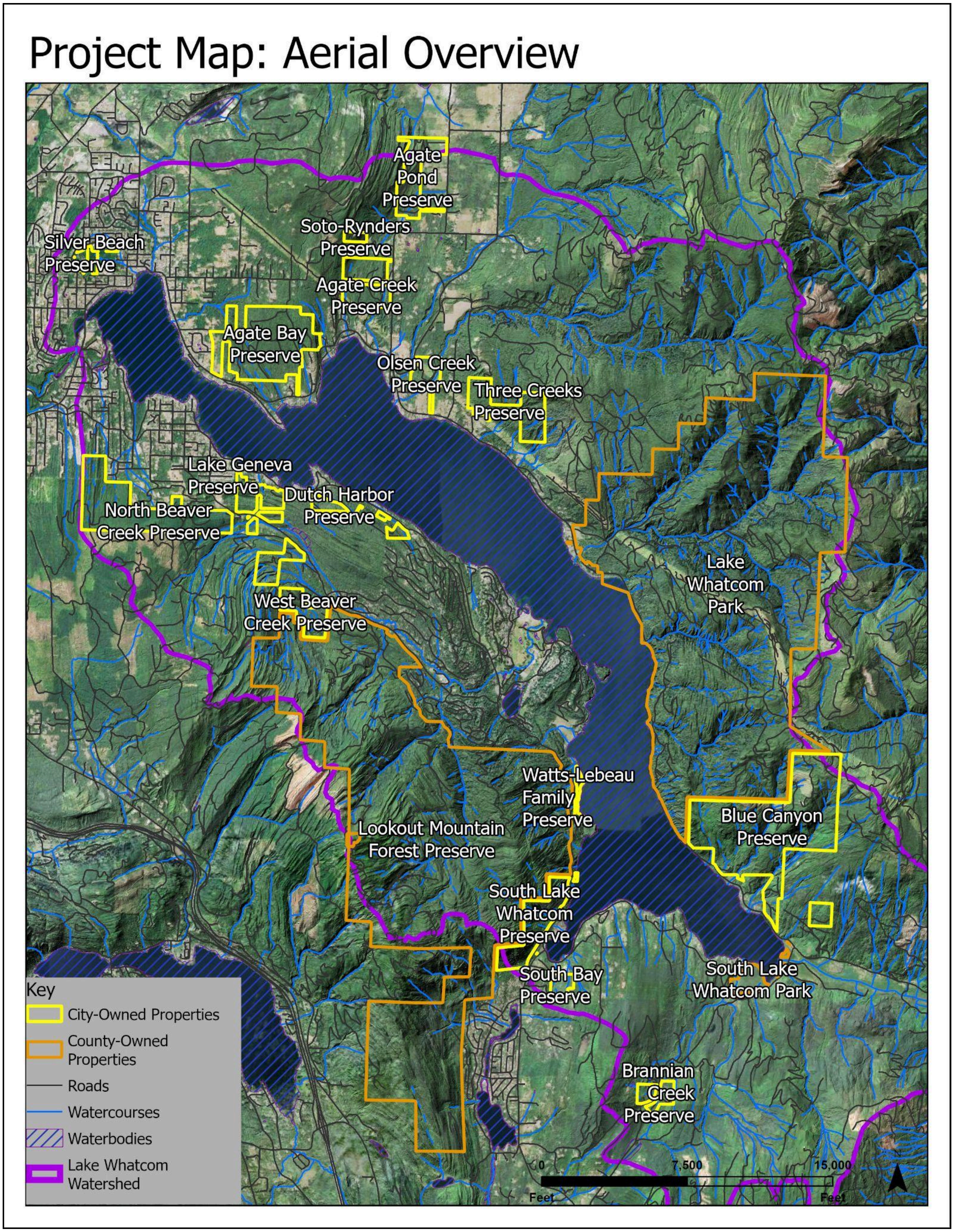
The watershed is located in northwest Washington State, primarily within Whatcom County, and spans from the western slopes of the Cascade foothills to the eastern edges of the City of Bellingham. The lake itself is approximately 10 miles long and divided into three basins. Steep hillsides and ridges surround much of the watershed, and several creeks—such as Austin, Smith, and Olsen creeks—flow into the lake. The region's topography and natural beauty also make it a popular area for outdoor recreation and residential development.

Lake Whatcom itself lies just southeast of the City of Bellingham and serves as the primary drinking water source for more than 120,000 residents. Bellingham, the largest urban center in the county with a population exceeding 90,000, is a growing urban area with a diverse economy and strong environmental and recreational values. The community of Sudden Valley, located along the western shore of Lake Whatcom, is a major residential area within the watershed; other population centers surrounding the watershed include the Geneva, Agate Bay, and Sunnyside neighborhoods.

Table of Properties Included in Current Management Plan

Property	Ownership	Acres
Agate Bay Preserve	City	421
Agate Creek Preserve	City	152
Agate Pond Preserve	City	155
Blue Canyon Preserve	City	823
Brannian Creek Preserve	City	64
Dutch Harbor Preserve	City	67
Lake Geneva Preserve	City	125
Lake Whatcom Park	County	4,660
Lookout Mountain Forest Preserve	County	4,554
North Beaver Creek Preserve	City	370
Olsen Creek Preserve	City	71
Silver Beach Preserve	City	42
Soto-Rynders Preserve	City	20
South Bay Preserve	City	39
South Lake Whatcom Park	County	76
South Lake Whatcom Preserve	City	182
Three Creeks Preserve	City	172
Watts-Lebeau Family Preserve	City	29
West Beaver Creek Preserve	City	183
	County	**9,290**
	City	**2,915**
	Total	**12,205**

Map of Properties Included in Current Management Plan



DRAFT DOCUMENT - PENDING PUBLIC COMMENT

Management History

Coast Salish peoples, including the Lummi, Nooksack, and Swinomish tribes, have long inhabited this landscape, maintaining deep spiritual, cultural, and subsistence connections to the lands and waters of the region, including what is now known as the Lake Whatcom watershed. Though the arrival of Euro-American settlers in the late 18th century and subsequent development have transformed the region, tribes continue to steward the land and exercise their treaty rights across this landscape.

The lake and its watershed have long been valued not only for their ecological and aesthetic significance, but also for their critical role in supporting human settlement, industry, and recreation. Early non-native settlers began to arrive in the mid to late 1800s, establishing several historic settlements around Lake Whatcom. Early settlers cleared land for homesteads and agricultural uses, particularly along the northern section of the watershed where the topography was flatter, but also on historic floodplains and landslide fans along the lake's edge. A steamboat line began operating on the lake in 1897, and the Bellingham Bay and Eastern Railroad was completed along the northern shore of Lake Whatcom in 1901. Mining was an early industry, with the Blue Canyon Coal Mine established at the south end of the lake in 1891 and operated there for several decades. A mine was also operated around Lake Geneva. Today many of the properties in the watershed have separately owned mineral rights, but no active mining has occurred for over 75 years[1].

In the late 19th and early 20th century, the logging and lumber industry was the primary industry in the watershed, and the Lake Whatcom Logging Company was a major player in the regional timber industry. Founded in 1898, the company owned extensive land throughout the watershed and operated sawmills at both the southern and northern ends of the lake. Short railroad lines were built to move logs and lumber out of the woods and into Bellingham Bay where it was exported across the United States and the larger world. Easily accessible timber was depleted along the lakeshore by the early 1900's and logging operations progressed uphill to find uncut timber. These early operations clear-cut large swaths of the forest, often without replanting or concern for long-term ecological impacts, such as erosion and sedimentation, and eventually removed almost all of the pre-settlement forest from the watershed. Logging continued in the upper reaches of the watershed throughout the 1950s and 60s, but the major boom was over by the 1940s with many of the early sawmills shutting down. As the boom ended, many timber owners defaulted on their property taxes, transferring ownership to Whatcom County, which, like many counties in the state at that time, transferred the lands in trust to the State of Washington's Department of Natural Resources to manage forestry operations and generate revenues on behalf of the county and its junior taxing districts.

After the logging and mining booms ended, land use transitioned to residential and recreational uses, with several summer cabins and resorts built along the lakeshore. As the population of Bellingham and surrounding communities grew, so did the demand for residential development in the watershed. In the 1950s and 1960s, subdivisions began to emerge along the lakeshore, and residential development

---

[1] Lake Whatcom watershed history summarized from a report prepared for Whatcom County Public Works entitled "The Lake Whatcom Watershed - A Retrospective Resource Directory Companion Report 1850-2007".

eventually spread across the entire northern, western, and southern shores of the lake, with notable population centers developing at Sudden Valley on the lake's west shore and Glenhaven to the south. The lake has long been used as a drinking water source for its many inhabitants, with the Bellingham Bay Water Company establishing an intake on Whatcom Creek in the 1880s. Today Lake Whatcom serves as the primary drinking water source for over 120,000 residents of Bellingham and surrounding communities.

By the 1980s, the cumulative impacts of logging, development, and poor land-use practices prompted growing concern among local governments and environmental advocates about Lake Whatcom's water quality. A large winter storm in 1983 caused an extensive sequence of landslides and debris torrents down the Smith Creek drainage, resulting in extensive property damage and spurring the local community to further consider the impacts of logging in the watershed. The City of Bellingham, Whatcom County, and the Lake Whatcom Water and Sewer District passed a joint resolution in 1992 and formed the Lake Whatcom Management Program (LWMP) in 1998 by Interlocal Agreement. The LWMP coordinates efforts between the City of Bellingham, Whatcom County, and the Lake Whatcom Water and Sewer District, with policy oversight from their legislative bodies and implementation by the Lake Whatcom Management Program's Interjurisdictional Coordinating Team. In addition, the City established The Lake Whatcom Watershed Advisory Board to coordinate efforts, promote public education, and recommend policy changes. Whatcom County also adopted stricter development regulations in the watershed, including the Lake Whatcom Watershed Overlay District, which limits new subdivisions and mandates low-impact development techniques. Stormwater retrofitting projects have been implemented to improve drainage systems in existing neighborhoods, and septic-to-sewer conversions have been prioritized in high-risk areas.

One of the most significant shifts in land management came in the early-1990s to mid-2000s, when researchers, including those from Western Washington University's Institute for Watershed Studies, revealed low dissolved oxygen in Lake Whatcom. Subsequent studies by the Department of Ecology confirmed the link between development and declining water quality, particularly low dissolved oxygen due to excess phosphorus. The Washington Department of Ecology placed Lake Whatcom on its polluted water body list for failing to meet state standards for dissolved oxygen. In response, the City of Bellingham began purchasing forested lands in the watershed to prevent future development and protect existing forest cover. The Lake Whatcom Land Acquisition and Preservation Program, launched by the City of Bellingham in 2001, has since conserved thousands of acres, reducing the extent of impervious surfaces and limiting pollutant runoff.

At the same time, growing concern around forest management activities across the state spurred the creation of additional environmental protections and the 2004 Lake Whatcom Landscape Plan which was created to guide forest management activities on state-owned forestlands in the watershed. Because many of these forestlands were originally entrusted to the state by Whatcom County, in 2012 the County began the process of reconveying these lands back to county ownership, taking over title in early 2014 to 8,844 acres of forestland. These forestlands are now managed by the Whatcom County Parks Department.

The LWMP develops work plans every five years which guide and identify work that will be completed to protect the Lake. Actions in the LWFMP 2025–2029 Work Plan span twelve program areas and include constructing and retrofitting stormwater treatment facilities, enforcing land use regulations, preserving forestland, and supporting residential retrofits to reduce runoff. Forest management was added to the 2025-2029 Work Plan as one of the twelve program areas and the development of forest management plans for County and City-owned forested properties were prioritized, resulting in this current planning effort.

Current Management

Whatcom County and the City of Bellingham have already implemented a range of forest management activities across the forest properties in this management plan. Many of the City-owned properties were previously used for agricultural or residential use and have undergone significant restoration activities to remove old structures, restore forest cover, and fight invasive species. The City has also undertaken forest thinning on a few properties to reduce tree density and promote structural complexity, and has underplanted hardwood-dominated forests with conifer seedlings. The County continues to maintain and operate the main line roads conveyed to them by the state of Washington in 2014, but has not undertaken major forest management or restoration at this time. The County manages recreational access at several developed trailheads throughout the watershed, including Lookout Mountain Forest Preserve, Lake Whatcom Park, and South Lake Whatcom Park.

Management Planning Process

Planning Framework

This forest management planning effort utilized the following framework to develop management recommendations that meet landowner and community objectives.

1. **Define Objectives** - Initial objectives were defined by landowners and informed by community engagement to identify a final set of planning objectives and define a desired future condition for the forested landscape.
2. **Assess Forest Landscape** - The forested landscape was assessed by trained foresters to objectively quantify and characterize current forest conditions.
3. **Evaluate Forest Conditions** - The forest conditions identified during the field assessment were evaluated by trained foresters against the objectives, identifying conditions that were not currently meeting the objectives and preventing the forest from achieving the desired future condition.
4. **Develop Management Recommendations** - Given the results of this evaluation, recommendations were developed by trained foresters and reviewed by landowners to aid the forest in achieving the objectives and reaching the desired future condition.

Management Objectives

Identifying management objectives is a critical part of the planning process. Through consultation with landowners and community members, the following objectives were identified to guide the development of this management plan.

- **Water Quality -** maintain and improve water quality in Lake Whatcom and the surrounding watershed with particular attention on reducing sediment delivery to the lake.
- **Forest Health and Resiliency -** promote healthy and resilient forests that are adaptable to a changing climate and ensure long-term forest cover in the watershed.
- **Resistance to Wildfires** - improve forest resistance to and recovery from wildfires.
- **Wildlife Habitat -** provide quality wildlife habitat throughout the watershed while preserving and protecting critical and unique habitats.
- **Recreational Access** - ensure management recommendations align with and support recreation goals and access that are appropriate for the County and City respectively.

In addition, it is in the intention of this plan to respect, restore and maintain tribal access for natural and cultural resource use in the watershed.

Desired Future Condition

To achieve these objectives, this plan envisions a resilient, diverse, and ecologically functional forest landscape that supports clean water, diverse wildlife habitat, and sustainable human uses. Broadly, this vision is best realized in the restoration of late-successional (aka "old growth") forests similar to those that were once prevalent in the watershed. At the landscape level, old-growth forests are not a static forest type, but a dynamic, evolving assemblage of stands representing multiple stages of successional development. These include young forests recovering from disturbance, mid-aged closed-canopy forests, and mature stands with large trees, standing dead wood, and coarse woody debris. However, it is important to note that the desired future condition is not the past, as a changing climate may not support the same plant assemblages that developed under historic climate conditions. Therefore, historical reference conditions are informative, but do not represent an absolute model for future forest structure.

Applied to the Lake Whatcom watershed, this concept supports a vision of forests that evolve through natural processes and intentional management to mimic historical disturbance regimes. Through ecological thinning, tree planting, riparian restoration, and long-term protection, forests in the watershed can develop the structural complexity associated with older forests. Structurally complex forests include a diverse arrangement of trees of different sizes and species occupying multiple canopy positions as well as a diverse collection of understory vegetation, standing snags, and downed wood. As large legacy trees, multi-layered canopies, and rich understories become more prevalent, ecological resilience is enhanced and the forest supports high levels of biodiversity, including habitats for a variety of birds, mammals, amphibians and insects.

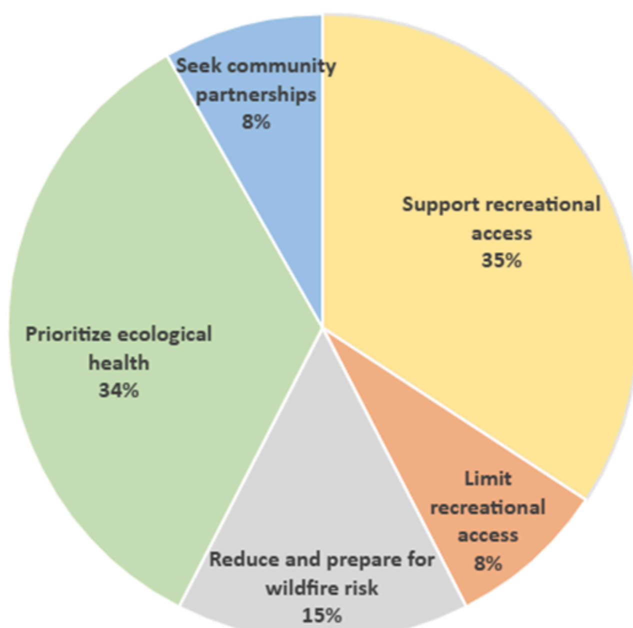
Most importantly, this vision directly supports the watershed's primary function as a drinking water source. Forests with old-growth characteristics protect water quality by stabilizing soils, reducing sediment runoff, and maintaining cool stream temperatures through dense canopy cover. Riparian buffers with late-successional features are especially important for filtering pollutants and providing aquatic habitat.

Achieving old growth conditions is a long-term, adaptive process. It requires managing across entire landscapes and timeframes that span decades or centuries. Forest management within the Lake Whatcom watershed must therefore remain flexible, science-informed, and aligned with both ecological goals and the needs of a growing community.

Community Engagement

The City and County have solicited public engagement throughout the planning process. Plan development began in April 2025 with a series of meetings with tribal partners, stakeholders, and the public at large. The City of Bellingham hosted an "Engage Bellingham" public comment site throughout the process to solicit feedback. In addition, two public forest tours were conducted in May and June of 2025 and a video tour was produced and hosted on the Engage Bellingham site for members of the public who were unable to attend the in-person tours. Additional details and results of this engagement effort are described in greater detail in Appendix VI. Overall, the planning team received 56 public comments. Comments were categorized by topic and are summarized in the figure below.

Public Comments Summarized by Comment Topic



The most prevalent feedback received during the public comment process was the desire for protection and expansion of recreational access, particularly calls to balance recreation and environmental uses, increase non-motorized access, increase mountain bike trails, and improve trail maintenance. Maintaining appropriate recreation is a high priority for Whatcom County, and the County developed a recreational trail plan in 2016 for Lookout Mountain and Lake Whatcom Park which identifies strategies for managing and developing recreational amenities on those properties. Conversely, the City of Bellingham has acquired the properties in this plan for preservation purposes, and recreation is not the primary goal. The City allows limited recreation consistent with the Lake Whatcom Property Acquisition Program land management policy. While recreation is an important topic for the community, managing recreational access and development of trails or other amenities is not within the scope of this forest management planning effort. Instead, this plan seeks to ensure that management recommendations align with and support recreation goals that are appropriate for the County and City respectively. To this end, the interaction between forest management and recreation is explored in the Recreation section in Section 2.

Another major topic of interest expressed by the public was the prioritization of ecological health, particularly limiting development in the watershed, protecting water quality, and decreasing extractive uses of the land. Managing the forest to improve ecological health is a core component of this plan's guiding objectives and the resulting management recommendations. This plan includes an assessment of the forest's ecological health and recommendations to maintain or improve its ecological functions. Another important topic raised during the public comment process was the desire to reduce and prepare for wildfire risk in the watershed, particularly the need to improve access for wildfire suppression. Managing the watershed's wildfire risk is a major objective of this management planning effort and particular attention is given to this topic in the sections on Wildfire Susceptibility and Roads and Access in Section 2.

Assessment Methodology

The goal of the forest assessment process was to identify broad forest types and forest conditions, collect sufficient information to develop generalized management recommendations, and prioritize areas of the forest for short-term management. As a result, this assessment methodology was designed to ensure that forest types, management units, and management recommendations were correctly identified at a strategic level, with the expectation that more tactical-level planning and additional data collection will be conducted in each management unit prior to executing management decisions in the future.

The forest assessment process employed a spatially-explicit sampling strategy that leveraged remotely-sensed forest data in order to improve efficiency of physical field data collection. Foresters were then deployed to the forest to sample representative stand conditions and extrapolate collected data across areas of similarity. Lidar-derived canopy-height information, visible and near-infrared aerial imagery, as well as the DNR's remotely sensed forest inventory (RSFRIS) were combined together into a high-contrast imagery layer that was used to identify potential forest types, delineate stand boundaries, and identify areas for additional investigation.

Summarized stand-level inventory data from the early 1990s was available for properties previously owned by the WA DNR (Lookout Mountain Forest Preserve and Lake Whatcom Park), and a limited number of forest appraisals were available for city-owned properties (North Beaver Preserve, West Beaver Preserve, Blue Canyon Preserve, Brannian Creek Preserve) purchased within the last decade. The historic data was generally too old or too simplified to use directly in the field assessment, but did provide a starting hypothesis for forest type and management unit delineations across the watershed.

During the forest assessment conducted between May and September 2025, 424 field plots were installed across the watershed. Plot locations were chosen to be representative of the local forest type and given a sampling weight that corresponded to the observed spatial distribution of that forest type within a management unit. A range of forest metrics were collected at each plot, including: trees per acre, basal area per acre, diameter, and height by species and canopy position. Additionally, qualitative information was collected both at plots, and between plots, including: forest health, wildlife habitat, understory species, habitat quality, and forest structure and development stage.

During this assessment forest roads were also evaluated to determine their status and suitability for management activities as well as to identify any potential maintenance or design issues that could lead to future road failures. Forest roads were identified using publicly available forest road inventory data from the DNR, lidar imagery, and historic Road Maintenance and Abandonment Planning (RMAP) documents. All active roads were walked or driven in their entirety. Water crossings, drainage control structures, and road surfaces were inspected throughout the active road system to identify potential issues. In addition, a sample of abandoned roads were spot-checked to confirm their current status and the conclusions of previous RMAP investigations.

Following the forest assessment process, forest cover was delineated into broad forest types for which general management recommendations were developed. More information on these forest types and general recommendations follow later in this plan. Using remotely sensed data, historic inventory units, and field inventory data properties were further delineated into forest management units (FMUs) that shared similar forest characteristics and management recommendations. General forest type management recommendations are adapted to the realities of each FMU and summarized in more detail in the specific property sections that follow.

Geographic and Temporal Scale

Geographically, this planning effort organizes management recommendations across four scales: watershed, forest stands, property, and forest management unit. First, in Section 2 the plan provides an assessment of landscape-scale conditions and provides management recommendations for watershed-wide issues such as forest health, wildfire, roads, and more. Forest cover is then divided into discrete Forest Stand Types, which are assessed and given management recommendations in Section 3. The watershed is then further divided into discrete “properties” in Section 4, where localized forest conditions and dynamics are described in more detail. Finally, forest cover within each property is segregated into unique forest management units (FMUs) that define changes in forest composition and share management recommendations.

This management plan also provides a 30-year timeline of management recommendations organized in 5-year increments. Effective forest management planning requires making decisions today based on assumptions about how the forest will evolve, markets perform, and management constraints change. While future conditions must be considered in the context of today's decision making, it is unrealistic to schedule future management actions with precision, as many factors may occur in the intervening years (e.g. storms, disease, changing public opinion, etc.) which can affect the appropriateness of the management recommendations proposed today. As such this management plan should be revised at least every 10 years in order to keep these recommendations up to date.

Ecological Forest Management

Overview

Ecological forest management (EFM) recognizes that forests are complex ecosystems whose natural processes are capable of providing multiple ecosystem services that are important for both human and natural communities. These services include clean water, flood mitigation wildlife habitat, carbon storage, valuable forest products, and recreational and cultural opportunities, to name a few. At its core, EFM attempts to balance landowner objectives with the conservation and enhancement of ecosystem services. To achieve this goal, management actions are designed to mimic ecosystem processes endemic to a particular site in order to produce forests that are resilient and adaptable to the current and future climatic conditions of that site. Silviculturally, EFM leads to an increase in forest heterogeneity, biological diversity, and the overall productivity of forest ecosystems.

EFM principles align closely with Whatcom County and the City of Bellingham's objectives for the Lake Whatcom watershed. Unlike production forestry that seeks to maximize a single value - timber, EFM seeks to integrate and manage a broad range of objectives. Because of the challenge of managing multiple objectives simultaneously, EFM typically employs management tools that differ from conventional forest management. Instead of large-scale clearcutting, for instance, EFM typically employs thinning and small-scale patch cuts to reduce competition and increase ecosystem complexity. Instead of homogeneous plantations, EFM utilizes natural regeneration and underplanting to improve species diversity and increase the number of tree cohorts occurring within a forest. These practices promote more complex forest structures, resulting in improved water quantity and quality, improved resiliency to natural disturbances and changing climate conditions, increased resistance to wildfire, and enhanced wildlife habitat.

Stand Dynamics

All forests are part of a dynamic, cyclical process of growth and disruption. Though these cycles can extend longer than several human lifespans combined, over sufficient time and across a landscape, the forces of disturbance and succession produce repeatable patterns of forest development. Understanding these forest dynamics allows the forest manager to utilize natural stand development processes to produce desired forest outcomes. A brief primer on stand dynamics is included below, focusing on forest succession and disturbance regimes common to the forests of the western slopes of the Cascade Mountains[2].

Disturbance Regimes

Disturbances are events which significantly change forest structure and composition, changing the forest's development trajectory. In western Washington, the most common natural disturbances are windthrow and wildfire, but avalanches, landslides, insect infestations, and fungal diseases are all potential disturbance agents. These events can be widespread, removing almost all existing forest canopy over a large area, known as stand-replacing, or more localized, forming canopy gaps or killing off individual trees. Because of differences in climate, topography, and environmental conditions, different forests vary in the type, frequency, and scale of these disturbance events, known as disturbance regimes.

Windthrow is the most prevalent disturbance type in forests close to the ocean, where stand-replacing windstorms are common and moist conditions preclude most wildfires. Inland of the coast, wildfire becomes the dominant disturbance regime, with its frequency dependent on local climate. On wetter sites, wildfires occur infrequently, but when they do, they can be large, severe, and stand-replacing. Insect infestations and diseases target specific tree species and, while not generally considered stand-replacing, these small-scale disturbances are major agents of stand diversification and help create more complex forest structure.

Though not a natural disturbance regime, logging is a major disturbance event common to local forests. From stand-replacing clearcut logging to more localized thinning and gap cuts, the method, scale, and intensity of logging can result in various levels of disturbance impacts. Notably, unlike natural disturbance regimes, most logging methods remove cut trees, resulting in a paucity of large-diameter snags and downed logs in most of the region's forests today.

Forest Succession

A forest canopy broadly consists of three parts: understory, midstory, and overstory. Forest succession is the process by which different plant species interact with and replace each other in these three forest canopy positions over time. This produces distinct ecological communities, or seral stages, that develop over time in the forest. A simplified version of this process is described below.

Disturbance

All forests begin their development from an initial disturbance event which heavily modifies the existing forest or outright replaces it, known as a stand-replacing event. Frequently the disturbance will leave

[2] Discussion on stand dynamics paraphrased from the Washington Department of Natural Resource's guide on "Identifying Mature and Old Forests in Western Washington" by Robert Van Pelt.

behind components of the old forest — surviving older trees or large snags — known as legacy structures.

Pre-Forest - Stand Initiation (Early-Seral)

After the disturbance, a new generation of trees and vegetation is initiated. Depending on site-conditions, this may occur quickly or take decades, but eventually a pioneer cohort of trees will establish. Notably, the lack of an overstory canopy results in abundant natural sunlight and a vigorously growing understory of grasses, shrubs, and small trees. Certain plant and animal species are only present during this early-seral stage of development.

Young Forest - Canopy Closure and Competitive Stem Exclusion (Mid-Seral)

Trees continue to grow and eventually their crowns touch (Canopy Closure), shading the understory and removing all but the most shade-tolerant vegetation. As trees grow, they differentiate themselves, with faster-growing trees taking up dominant canopy positions and slower-growing trees falling back into intermediate or suppressed canopy positions. Depending on initial stand densities, the forest will now begin to thin itself (Stem Exclusion) and many of the suppressed trees will die, filling the forest with small-diameter snags and downed logs on the forest floor. A midstory is not typically present.

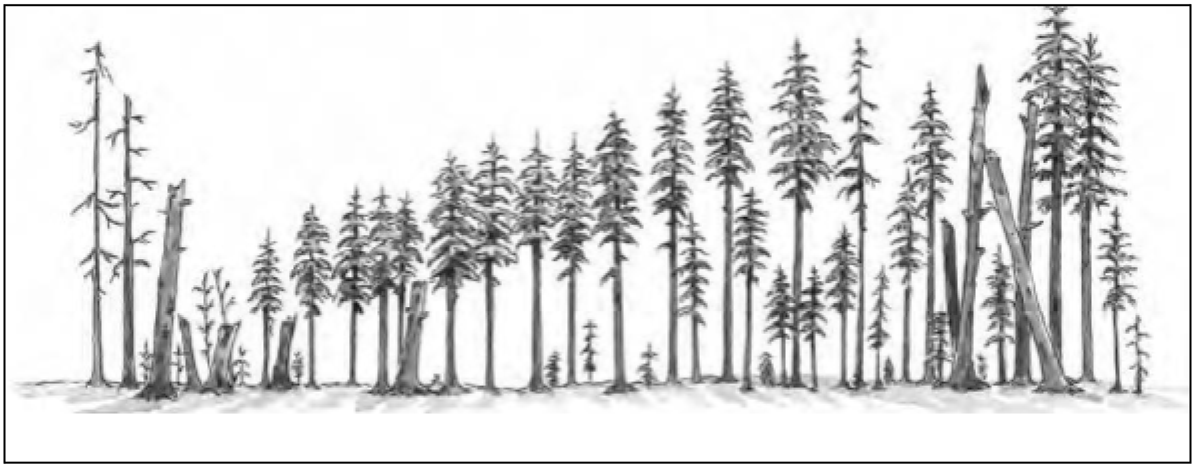
Mature Forest - Understory Reinitiation and Maturation (Mid-Seral)

Density-dependent mortality eventually reduces the forest to a sustainable stocking density, and mortality slows. At this stage the midstory will only consist of any shade-tolerant trees left behind during the competitive exclusion phase. More light now reaches the understory, re-initiating a new cohort of vegetation and shade-tolerant tree seedlings (Mature-I). The competition-based mortality process that was dominant until now switches to individual agents, such as fungi, wind, and insects which create gaps in the canopy, reduce tree density, and change growing conditions. Understory trees eventually grow into midstory positions and overstory trees may develop adventitious branches to take advantage of new light conditions (Mature-II).

Old Forest - Increased Heterogeneity and Pioneer Cohort Loss (Late-Seral)

Localized disturbance agents continue creating gaps in the previously uniform overstory canopy, which over time results in a more diverse mosaic of stand conditions and the development of late-seral habitat characteristics. As members of the original cohort of trees begin to die, they create large-diameter standing snags and woody debris on the forest floor, and are eventually replaced by vigorous midstory trees. Over time, the initial pioneer tree cohort will give way to a mixture of species, including shade-tolerant trees that can regenerate underneath the shade of their canopies. The forest settles into a dynamic equilibrium until interrupted by another stand-replacing disturbance, and the process repeats.

Simple Model of Forest Development Following Stand-Replacing Wildfire



Development Pathways

Forest development is not always a clear linear path as described above, and development pathways may vary considerably by disturbance regime. As an example, a windstorm typically removes only the overstory, enabling more shade-tolerant trees in midstory and understory positions to quickly succeed into upper canopy positions. Conversely, because wildfire can disturb a combination of soil, understory vegetation, seedlings, and mid-canopy trees, but often spares the largest trees with the thickest bark, most post-wildfire regeneration comes from the seeds of these surviving trees. Sometimes the disturbance event is only partially stand-replacing and the new cohort of trees must grow up underneath an existing canopy.

In addition, site conditions, such as soil moisture and seed availability, play a large role in determining forest development. Sometimes, a wildfire may burn at such high severity that the nearest living seed source is far away and the forest takes many years to establish any tree cover. At other times, plenty of seed may be present but hot, dry conditions restrict natural regeneration and the site becomes dominated by shrubs. Even where regeneration does occur, it can occur at such low density that the forest skips initial successional stages of competitive exclusion and understory suppression. Likewise, a site may become initially dominated by wind-dispersed hardwood seeds, such as red alder and cottonwood, which will persist for many decades before succeeding to longer-lived species.

Management Tools

Ecological forest management includes a broad “toolbox” of management tools that can be used to mimic and guide natural ecological processes. Broadly all these tools fall into two general categories: 1) methods of cutting, thinning, or otherwise removing trees and 2) methods for planting and developing new cohorts of trees. These techniques are explained in more detail below under Thinning and Planting Considerations. The main strategies are briefly summarized below:

- **Thinning From Below**. Thinning non-dominant trees to spur diameter and branch growth of dominant trees, which are important components of old-growth habitat

- **Thinning From Above**. Thinning dominant trees to release non-dominant and underrepresented trees in the understory, thereby adjusting species compositions and size distribution.
- **Variable Density Thinning**. Thinning to varying densities to create a spatially-variable patchwork of densities, including unthinned "skips", moderately thinned, and heavily thinned areas, that promotes complex forest structure by promoting tree growth at different rates.
- **Variable Retention Harvest**. A limited regeneration cut with large retention of legacy trees to better mimic natural disturbance regimes and to provide a more resilient habitat for new seedlings. Typically used after many thinning entries and/or to rehabilitate an older stand that was not previously thinned.
- **Individual Tree Selection**. Where intensive thinning is not necessary or desired, individual tree selection thinning may be used to adjust the species composition and structure of a forest.
- **Gap Creation** Cutting gaps of at least 0.5-1.0 acres to support the growth of shade-intolerant tree and shrub species and increase spatial variability.
- **Underplanting**. After sufficient reduction in canopy density through thinning, adjust species composition by underplanting desired species into the understory. Given the existing overstory density, planting densities are typically lower, and the planted species must be sufficiently shade-tolerant
- **Open Planting**. After gaps or openings in the overstory have been created or occurred naturally, it is possible to plant a wide range of species, including less shade-tolerant species. Given the lower tree density in the gap or opening, planting densities are typically higher than with underplanting.
- **Site Preparation and Vegetation Management.** Competing vegetation often precludes the successful establishment of new plantings and requires that planting sites are prepared before planting. Plantings must then be maintained and competing vegetation removed until the trees are tall enough to compete successfully on their own.
- **Retention and Recruit Woody Structures**. Retain existing dead wood structures, including stumps, downed logs, and snag of all species and diameters. Recruit new woody structures through girdling living trees to create snags, felling and leaving trees as downed logs, or using logging slash to create simulated wood structures.
- **Protection of Understory Vegetation**. Minimizing disturbance of understory plants--in particular, older and taller shrubs--and leave some sensitive areas undisturbed, such as unique plant or wildlife habitats, sensitive aquatic areas, or special topographical features.

These techniques can be adapted to most stand types, using biological criteria, in tandem with a manager's objectives, to determine which trees should be cut in a forest and which trees should be retained, recruited through natural regeneration, or planted.

Stocking Guidelines

Stand stocking can be measured in several ways, such as trees per acre (TPA), basal area per acre (BAA), stand density index (SDI), or relative density (RD) which are helpful to identify overstocked stands and guide management recommendations. Trees per acre tells us how many trees are present in the stand, but doesn't identify the size of those trees. Basal area attempts to incorporate information on the size of trees, effectively measuring the cross-sectional area of trees which is correlated with tree size and dominance, but doesn't identify if that basal area is spread across lots of small trees or lumped into a few large diameter trees. The stand density index transforms the current TPA and average diameters into a theoretically equivalent number of 10-inch diameter at breast height (DBH) trees, allowing for equal comparison of density among stands of different sizes. Since tree species have different levels of shade tolerance and can tolerate different levels of competition, stands with different species compositions can support more or less trees before competition induced mortality begins. Relative density attempts to account for these differences and assesses how close the stand is to this theoretical maximum carry capacity in a standard, comparable way.

Relative density is measured on a scale from 0 (no competition) to 100 (maximum competition) with growth rates varying in between. Trees grow with little competition until canopy closure occurs around RD 15 and the stand grows enthusiastically up to RD 35. From RD 35 to 55, growth slows slightly under competitive pressure and live crowns lift significantly as lower branches die, but trees remain healthy and robust. Above RD 55, trees begin to succumb from competition induced mortality and become extremely tall and skinny. Above RD 75, trees are often extremely skinny, stressed, and unstable suffering from high mortality rates and often holding such limited live crowns that they struggle to respond to improvements in their growing conditions. Stands with RD levels above 55 are considered overstocked and candidates for thinning interventions to reduce density. While useful for measuring competition in younger and more homogenous stands, accurately measuring competition with relative density becomes challenging in older, more structurally diverse stands with multiple canopy classes, and other metrics, such as the proportion of TPA or BAA by canopy class and stand development stage, are better suited to guide stocking decisions.

Management Sequence

Ecological forest management uses the tools, guidelines, and stand dynamics described above to actively shift stand composition and structure to better achieve management objectives. In some cases, a single management intervention (e.g. a one-time thinning) may be sufficient to restore a forest to historical reference conditions and fulfill management objectives, while in others, multiple entries are needed to shape a stand to better meet management objectives, which may include the ongoing production of valuable forest products.

The exact management sequence varies considerably by forest type and objective, but broadly includes periodic thinning entries in order to reduce competition between trees, adjust species composition, and introduce spatial heterogeneity. In time, reducing canopy density will support natural tree regeneration in the forest's understory and the recruitment of new cohorts of trees into the stand. Manual planting may be used, especially in highly homogenous or hardwood-dominated stands, to quickly increase the desired species composition and density. Depending on objectives, additional thinning entries may continue to occur, with small gaps created to increase heterogeneity and create opportunities for less shade-tolerant trees to prosper.

Thinning Considerations

Given the productive nature of the soils and climate across most of the Pacific Northwest, forests grow rapidly and — depending on initial densities — can quickly become overstocked. Periodic thinning entries may be required to minimize competition, adjust species composition, and introduce additional complexity into the forest. When stands are young and small, this thinning is typically pre-commercial, meaning the trees are too small to have merchantable value and are therefore left in the woods to decompose. However, as stands grow larger, commercial thinning can be used, meaning cut trees are removed and sold to nearby sawmills. Commercial thinning sometimes requires several entries before final target densities are reached. Considerations common to all thinning recommendations in this plan are discussed below.

Pre-commercial Thinning

Overstocked stands with small-diameter trees (under 10” DBH) are good candidates for pre-commercial thinning to reduce density and shift species composition. Though these thinnings don’t yield any revenue, the small-diameter trees can be cut easily and at relatively low cost. Thinning should be *from below*, focusing on removing suppressed and damaged trees as well as trees considered unsuitable for site conditions, in order to release and retain the most vigorous, dominant, and highest-quality trees of each species that are suitable for the site.

Commercial Thinning

Overstocked stands with larger diameter trees (over 10” DBH) that are readily accessible by road, occur on slopes less than 40 percent, or occur on steeper slopes where cable logging will not impact slope stability or surface water should be prioritized for commercial thinning. Importantly, it is generally unsafe to leave large quantities of large-diameter dead conifer trees in the stand, as the larger trees take longer to decompose and may stimulate insect outbreaks, such as Douglas fir or silver fir beetles, which can harm residual living trees. Since larger diameter trees cost more to fell, these thinning entries can be expensive, but since the trees are large enough to sell, a commercial thinning can typically pay for itself. Thinning can be either from below in order to produce additional diameter growth and monetary value, or variable density in order to focus on introducing spatial complexity as well as achieving diameter growth.

Variable density thinning is a good tool to use in most larger diameter stands. It is primarily thinning from below, but designed to create a spatially-variable patchwork of densities, including unthinned “skips”, moderately thinned, and heavily thinned areas that promotes complex forest structure by improving tree growth at different rates. Thinning should first focus on removing suppressed and damaged trees as well as trees considered unsuitable for site conditions in order to release and retain the most vigorous, dominant, and highest-quality trees of each species that are suitable for the site. Some dominant trees should also be selected for removal where they will release vigorous understory trees, thereby increasing the vertical heterogeneity of the forest canopy.

Non-Commercial Thinning

Stands that are currently inaccessible by road, occur on sensitive sites such as unstable slopes or in riparian areas, should be evaluated for non-commercial thinning. In these situations, hand crews fell trees, but the dead material is left in the forest to decay. In addition to felling, crews can girdle trees, effectively killing them while leaving the trees standing in order to produce high-quality snags for wildlife. Not only is working with trees this size expensive, but leaving dead material in the stand increases the risk of fire and insect pest infestations. The exact target densities and sequence of entries will vary from site to site, primarily driven by initial stocking and target species susceptibility to insect outbreaks. As an example, in Douglas-fir dominated stands over 10 inches DBH, cutting and leaving 3 TPA or less annually will prevent an outbreak of Douglas-fir beetle. Cutting more than this will lead to a beetle outbreak which will kill on average an additional six live trees for every 10 cut trees over the next 2 to 4 years. Without an additional source of dead, large-diameter material, the outbreak will eventually subside. Thus, any non-commercial thinning entry must either avoid triggering a beetle outbreak through a long series of light, periodic entries or accept the likely eventuality of a post-thinning outbreak and reduce thinning intensities to account for future insect-driven mortality. Given the high costs and uncertainties around managing insect outbreaks, this technique is not widely recommended and should be used sparingly.

All Thinning Treatments

Site-specific factors drive the selection of preferentially retained species during thinning, but the broad goal is to increase species diversity by retaining and recruiting a wide range of conifer and deciduous hardwood species. Notably, retained species should be suitable to site conditions and drought-tolerant species should be favored on sites with low soil moisture.

Prescriptions should be written in order to protect riparian habitat, understory vegetation, and retain existing woody structures such as standing snags and downed logs. Thinning and commercial logging is also an opportunity to recruit additional woody structures into the stand. As an example, equipment operators can often create snags by topping trees as high as possible and non-merchantable portions of logs can be used to create habitat piles and constructed logs.

After thinning, monitor stand conditions over the 5-10 years following a thinning, in order to assess the stand’s response and adapt future management accordingly. Sometimes there is more post-thinning mortality than anticipated, some species respond better to the new growing conditions than others, and in some cases new regeneration of seedlings may even begin to occur.

Slash, such as limbs and treetops, produced during thinning has the potential to increase short-term fuel-loading and thus wildfire risk. Fine woody debris under four inches in diameter is the most flammable, so slash mitigation efforts should focus on this category of slash, leaving larger-diameter wood to slowly decay. Slash from commercial thinning should either remain where it falls or — if gathered to the landing as it is in many common logging systems — it needs to be spread back out into the forest. After thinning, slash under four inches in diameter should be processed to bring it within 18 inches to 24 inches of the soil. Driving over slash with logging equipment is a quick way to incorporate this woody material into the soil, thus increasing its decomposition rate and reducing the period over which it will elevate wildfire risk. Slash produced during pre- or non-commercial thinning remains where it was cut, but requires manual processing, known as lop and scatter, to get the material below 24 inches, which increases costs but reduces fire risk.

Depending on initial stand conditions, repeated thinning entries may be necessary to achieve management objectives. In this case, the return interval should be no shorter than 10 years, allowing sufficient time for stand conditions to stabilize and preventing excessive understory damage and soil compaction. For fast growing stands, such as site class II or better, a 10-year waiting period should give just enough time for trees to increase in diameter and ensure that the second thinning produces additional economic value to pay for the cost of labor. Under average growing conditions, such as site class III, more economic value will be captured by waiting roughly 15 years, and up to 20 years on even slower growing sites. Management objectives and operational constraints can also influence the return interval, but ultimately thinning should occur before overstocking and competition stress begins to increase once again.

Planting Considerations

Planting may be necessary in many stands including those that are: understocked, lacking species diversity, lacking multiple canopy layers, or lacking longer-lived conifer species. Open planting entails planting a wide mix of species into a relatively open area, while underplanting entails planting primarily shade-tolerant species under an existing canopy. In either case, species should be selected for planting that are suitable to the site conditions. See Appendix III for a list of species tolerances to drought and shade.

Successful planting starts with site preparation in which the site is prepared to receive new trees. This can be a broadcast preparation, such as pre-emergent herbicide, mechanical scarification, or broadcast burning across large areas. While more localized gap or under planting, may simply require removing competing brush within a three-foot radius circle to prepare a potential planting spot.

After sites are prepped, trees can be planted in western Washington anytime from late fall to early spring as long as the ground is not frozen. This ensures seedlings have a chance to root before temperatures increase in late spring and summer. Trees are typically planted in a grid, but more random arrangements are possible to increase spatial heterogeneity, though this adds additional effort for post-planting monitoring and maintenance.

Planting densities vary considerably given site conditions and management objectives. Planting at a high density is a common technique to mitigate against potential mortality. When objectives include timber production, high-density planting also ensures there is sufficient stocking for future commercial thinning entries to reduce density and produce timber. For more restoration focused objectives, planting densities may only overplant by 25 from final target density to account for potential mortality.

After planting, seedling survival should be monitored and competing vegetation controlled around all newly planted seedlings for the first 5 years, or until the seedlings have reached a free-to-grow height above the surrounding brush. If seedling survival exceeds density targets, then pre-commercial thinning can be used to easily adjust density. If mortality exceeds expectations, then it may be necessary to plant again, adapting the planting plan as necessary to ensure success.

Operational Considerations

Regulatory Restrictions

The Washington State Department of Natural Resources (DNR) regulates timber harvest and other forest management activities on all private and state-owned forestlands in Washington State through the Forest Practices Act. This includes all activities related to growing, harvesting, or processing timber. Some activities, such as harvesting or salvaging timber; constructing forest roads; installing or replacing culverts or bridges, or working across fish-bearing streams or shorelines, may require submission of a Forest Practices Application/Notification to the DNR before work can proceed.

In addition, properties reconveyed to Whatcom County from the DNR are also encumbered by the DNR's Habitat Conservation Plan (HCP) regulations that were in place at the time of reconveyance. These restrictions broadly match general Forest Practices Act regulations with minor differences around water type classifications and riparian and wetland buffer distances and management. Whatcom County ordinances may require forest management activities within 200 feet of Lake Whatcom to obtain a shoreline exemption permit.

Though this plan considers these regulatory restrictions when developing management recommendations, additional surveying and documentation is required at the time of activity in order to submit a Forest Practices Application and is outside the scope of this management plan.

Implementation Constraints

There are several significant constraints to implementing the management recommendations in this plan, namely: planning and operating costs, steep and inaccessible topography, and a limited forest road network. This plan provides management recommendations at a strategic level that are designed to give forest managers the necessary guidance to prioritize management actions. However, this plan does not provide prescriptive operational details, as these must necessarily be developed prior to conducting a management action in order to take site specific considerations into account. Additional information must be collected at the time of implementation that may adjust or restrict activities. Major factors that might influence the final implementation of the management recommendations in this plan include: thinning or logging costs, available funding and staff capacity, road access and road improvement or building costs, riparian features, and unstable slopes.

Some forest management operations in the Lake Whatcom watershed require significant financial investment due to the complex and sensitive nature of the environment, requiring careful planning and implementation to protect water quality and ecosystem health. These operations often involve extensive planning, monitoring, and the use of specialized equipment to minimize sedimentation and runoff that could harm the lake's water quality. Additionally, the watershed encompasses diverse land uses, including residential, commercial, and recreational areas, necessitating coordination with multiple stakeholders and compliance with federal, state, county and local regulations.

Designing the layout of thinning operations is beyond the scope of this plan. However, this plan does identify properties and management units that are less suitable for commercial logging due to prohibitive costs or concern for environmental impacts. For example, slopes that exceed 40-50 percent may not be accessible to conventional ground-based logging equipment, requiring the use of specialized logging equipment that yards logs by cable, greatly increasing the cost of operations. In addition, the cliff and bench topography common to many properties in the Lake Whatcom watershed introduce additional logging challenges, presenting short impassable barriers that require longer ground-yarding routes, tethered logging systems, or complicated cable-yarding systems with interim supports.

The potential for slope instability in the watershed is discussed later in this document and it is critical that forest management follows existing rules limiting forest operations on unstable landforms. This management plan utilizes remotely mapped topographic, hazard zone, and historic landslide data to gauge the likelihood that unstable slopes will be found within a proposed management area. The presence of a mapped hazard zone or historic landslide does not preclude management, but indicates that further investigation is required. Positively identifying and avoiding these landforms requires field investigation at the time of operation before forest practice applications will be approved by the DNR.

The challenges of road building and maintenance are discussed later in this document, however, a lack of adequate road access can limit the amount of land that can be accessed by heavy machinery and the creation of roads necessary to implement an activity can increase operational costs and environmental impacts. Regulatory restrictions on activities that can occur within certain distances of wetlands and streams can restrict operations and further increase the cost of road building. For this management planning effort existing documentation of stream and wetland locations and types have been used. However, during the course of future planning activities additional water features will likely be identified, and existing water type designations may require further review.

SECTION 2: FOREST ASSESSMENT & MANAGEMENT RECOMMENDATIONS

Topoclimate

Overview

A forest's natural ecology is driven by regional climatic factors which are modified by local topography to create site-specific *topoclimates* which influence species composition, forest productivity, and disturbance regimes. Precipitation and temperature patterns in this region are greatly influenced by proximity to the Pacific Ocean and regional topography, leading to a regional climate that is broadly temperate, characterized by mild, wet winters, and dry, warm summers. Within a forest, differences in local topography can influence growing conditions. Sites with southern aspects receive more solar radiation and are typically hotter and drier than sites on northern aspects. Sites on steep slopes and situated on landforms with little uphill catchment areas, such as ridgetops or plateaus, frequently drain quickly and have less capacity to retain soil moisture. Local landforms also influence the impact of natural disturbance regimes, with ridgetops bearing the brunt of wind-related disturbances, while drier and steeper areas are more likely to burn in a wildfire than wetter and flatter areas.

Plant growth slows down as temperatures and sunlight decrease in winter, and can dramatically slow without sufficient soil moisture. Forests growing in colder and darker locations, such as higher elevations, northerly latitudes, or northerly aspects, typically grow slower and support different vegetation than sites in warmer topoclimates. Likewise, a forest occurring in areas with more precipitation, or on sites that retain more moisture, such as northern aspects and valley bottoms, will grow faster and support different vegetation than a forest growing in drier topoclimates.

In the Pacific Northwest, the timing of temperature and precipitation is one of the critical factors determining forest productivity and species composition. Though winter brings an excess of water, plants make little use of it during the cold, dark days. Similarly, while summer brings warm temperatures and long sunny days, trees only profit from these conditions when sufficient water is available. How different plant species manage these environmental conditions ultimately determines which vegetation will survive, thrive, and come to dominate a site.

Assessment

The forests in the Lake Whatcom watershed are split between two broad ecoregions. The properties on the north, south, and west sides of the lake are in the Puget lowland ecoregion, generally characterized by a mild mid-latitude maritime climate, marked by warm dry summers and mild wet winters. Temperature averages between 72 degrees in the summer and 32 degrees in the winter. The mean annual precipitation ranges from 35-65 inches and the frost-free period ranges from 145-200 days. The east side of the lake is in the north Cascades ecoregion, generally characterized by a mild to severe mid-latitude climate, varying by elevation, with mostly dry warm summers and relatively mild to cool very wet winters. Temperatures range from 76 degrees in the summer to 30 degrees in the winter. The mean annual precipitation ranges from 60-90 inches and the frost-free period ranges from 120-200 days. The prevailing wind is generally from the southwest in the summer and the northeast in the winter.

The forests within the Lake Whatcom watershed experience a topoclimate shaped by the surrounding ridges, nearby ocean influences, and proximity to the North Cascade Mountains. The lake is encircled by steep ridges that strongly influence local wind patterns, precipitation distribution, and sunlight exposure. Lake Whatcom is at an elevation of about 300 feet. The properties in this plan have an elevation that ranges from the shores of Lake Whatcom at 300 feet to Lookout Mountain on the southwest side at 2,700 feet and Stewart Mountain on the east side at 3,000 feet. Slopes facing west and southwest tend to receive more precipitation as moist air is lifted from Bellingham Bay and the Strait of Juan de Fuca, while leeward slopes can be slightly drier and warmer. Elevation differences across the watershed also affect temperature, with upper slopes experiencing cooler temperatures and more frequent snowfall than low areas near the lake, but generally do not hold persistent snow packs throughout the winter. During the winter, these forests are particularly vulnerable to intense winter storms. Storm fronts moving inland from the Pacific are funneled through the Strait of Juan de Fuca and are squeezed over the ridges surrounding Lake Whatcom, leading to intense winter storms that can deliver large volumes of precipitation in short time spans.

Climate Change Impacts

Several climatic shifts are expected over the coming decades in response to anthropogenic global warming, well within the lifetime of the trees now growing on site. Summers are expected to become hotter and drier, with reduced summertime precipitation, increased temperatures, including more frequent extreme heat waves, and more frequent periods of drought. Wintertime low temperatures are expected to increase and storm intensity is projected to increase, with rainfall and snowmelt concentrated into shorter time periods. Site-specific factors will exacerbate or mitigate these changes, with low-elevation, south-facing, or drought-prone soils experiencing the greatest impacts of warmer and drier conditions.

The greatest risk to Pacific Northwest forest ecosystems, and individual species, is the potential for climate change to exacerbate existing stressors and reduce forest productivity. Reductions in available soil moisture, particularly during the hot summer months, can have negative consequences on tree growth, stand density, survival of drought-sensitive species, seedling establishment and survival, capability of trees to resist pathogens and insects, increased risk of wildlife, and potential for invasive species to spread further. Climate change is altering how forests burn, and forests are increasingly at risk of large-scale, high-severity wildfire events.

Vegetation Zones

Overview

Forest vegetation zones represent recurring groups of terrestrial plant communities that are found in similar climatic and physical environments and are influenced by similar disturbance regimes. Using this information, ecologists are able to identify the likely forest composition, structure, and landscape pattern of succession that would have existed across the vegetation zone prior to Euro-American settlement, known as the historical reference condition. While vegetation zones are generalizations, they provide an important starting point for understanding how current and future vegetation will respond to management interventions, natural disturbance regimes, and changing climatic patterns. This report uses the Ecological Systems classification system, widely employed by federal and state agencies for biodiversity conservation and management planning.

Assessment

Using vegetation zone maps for North America, the following Ecological Systems were identified as likely to be present in this forested landscape prior to Euro-American settlement.

Vegetation Zone Summary Table

Vegetation Zone	Acres	Relative Prevalence
North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest	5,100	42%
North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest	4,205	34%
North Pacific Mesic Western Hemlock-Silver Fir Forest	982	8%
North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest	743	6%
North Pacific Seasonal Sitka Spruce Forest	572	5%
North Pacific Lowland Riparian Forest and Shrubland	396	3%
North Pacific Broadleaf Landslide Forest and Shrubland	136	1%

The table above identifies relative prevalence of these zones within the assessment area and are described in more detail below.

North Pacific Hypermaritime Western Redcedar and Western Hemlock Forest

The most prevalent vegetation zone in this assessment area, the North Pacific Hyper Maritime Western Redcedar and Western Hemlock Forest is part of the coastal temperate rainforests of North America extending from western Washington north into the southern half of southeastern Alaska, typically never more than 15 miles from saltwater. It occurs on low, gentle terrain, typically below 2000 feet of elevation, inland of the immediate fog zone and downslope of the rain-on-snow zone. The hypermaritime climate is characterized by cool summers, persistent fog, and very wet winters without a significant snowpack. Annual precipitation ranges from 100-150 inches, mostly as heavy winter rain. Soils are often nutrient-poor, acidic, and poorly drained, with a thick organic layer overlying mineral soil or bedrock.

The overstory is dominated by western red-cedar and western hemlock. Pacific silver fir and shore pine are sometimes present while Sitka spruce and Douglas-fir are rare. Nearly pure stands of western hemlock are common in highly wind-exposed sites. The understory is rich in shade-tolerant shrubs such as salal, salmonberry, and vine maple, with sword fern, deer fern, and other moisture-loving ferns abundant. Mosses and lichens form a dense ground and epiphytic layer.

Fire is extremely rare in this system, with natural fire return intervals typically exceeding 1,000 years. Instead, small gap dynamics and periodic windstorms are the dominant disturbance processes. Small windthrow and landslides, as well as insects and fungal pathogens operate to create small gaps in the canopy, while intense wind events, occurring at intervals from decades to centuries, can cause patchy blowdown, especially on ridges and upper slopes, creating larger canopy gaps. Pre-settlement forests were predominantly old growth with abundant coarse woody debris, complex multi-layered canopies, and high structural complexity. Western redcedar can exceed 1,000 years in age, often displaying multiple tops from past wind breakage. In some highly exposed or wind-prone topographic settings, forests may remain in early or mid-seral conditions for long periods due to repeated disturbance.

Since European settlement, this system has been heavily altered by development, timber harvest, road building, fire suppression, tree plantations and introduced diseases. In particular, historic timber harvests and plantation forestry have reduced canopy structural complexity, species diversity, and coarse woody debris with most forest succession truncated well before late-seral characteristics are expressed. Undisturbed conditions of this system are uncommon to rare.

North Pacific Maritime Mesic-Wet Douglas-Fir Western Hemlock Forest

The second most prevalent vegetation zone in this assessment area, the North Pacific Maritime Mesic-Wet Douglas-fir Western Hemlock Forest is known to occur throughout the lowlands, foothills, and lower montane zones from western British Columbia to Oregon, where it is characterized by a relatively mild climate with high precipitation, long frost-free periods, and low fire frequencies. Elevation ranges from sea level to approximately 2000 feet. Annual precipitation ranges from 30-100 inches, mostly as heavy winter rain, and while snowfall becomes more common at higher elevations, persistent snowpacks rarely form. The topography includes glacial till plains and steep mountainous terrain, with soils that are moist to somewhat wet for much of the year being typically well watered from upslope sources and seeps.

The overstory canopy is dominated by Douglas-fir, western hemlock, and/or western redcedar but grand fir can often be codominant. Bigleaf maple and red alder are commonly found as canopy or subcanopy codominants, especially at lower elevations, and small patches can be dominated by these same broadleaf trees for several decades after a disturbance event. Late seral stands typically have an abundance of large coniferous trees, a multi-layered canopy structure, large snags, and many large logs on the ground. Early seral stands typically have smaller trees, single-storied canopies, and may be dominated by conifers, broadleaf trees, or both. The understory is dominated by sword fern, salmonberry, and devil's club, though salal, Oregon grape, pacific rhododendron, and evergreen huckleberry can be present. Vine maple is a very common tall shrub and mosses are often a major ground cover.

Fire is the major natural disturbance regime in this system. Historically, large, high-severity, stand-replacing wildfires were common every 300-500 years, while about 75 percent of fires were smaller, mixed severity fires occurring every 100-150 years. These more frequent mixed severity fires were possible in the driest areas, but would generally not burn wetter microsites. In addition, insects, fungal pathogens, windstorms and landslides create small gaps in the canopy contributing to stand heterogeneity. Pre-settlement landscapes consisted of a mosaic of forest patches, averaging between one and five square miles in size, growing in different age and stand structure conditions. Approximately 5 percent of the landscape would be in early seral conditions, 20 percent in mid-seral conditions, and 75 percent of the forest in late-seral conditions.

Since European settlement, this system has been heavily altered by development, timber harvest, road building, fire suppression, tree plantations and introduced diseases. Development has fragmented the landscape changing fire regime and connectivity of this system, particularly in lowlands. Historic timber harvests and plantation forestry have reduced canopy structural complexity, species diversity, and coarse woody debris with most forest succession truncated well before late-seral characteristics are expressed.

North Pacific Mesic Western Hemlock Silver Fir Forest

The third most prevalent system in this assessment area, the North Pacific Mesic Western Hemlock Silver Fir Forest is known to occur throughout the mid-montane zone west of the Cascade crest from coastal British Columbia to Washington where it is characterized by a cool, moist climate with an infrequent fire regime. It occupies a distinct elevational band above Douglas-fir / western hemlock forests and below the mountain hemlock zone. The climate is characterized by high annual precipitation, with a winter snowpack lasting between 2 - 6 months. The system is often subject to winter rainfall events on top of snow—earning the nickname "rain-on-snow zone."

The overstory is dominated by western hemlock and Pacific silver fir, with Alaska yellow-cedar codominant at higher elevations. Western redcedar can also be present, but notably, unlike drier systems, Douglas-fir is rare or absent. The understory is dominated by mesic-wet understory species, such as oval-leaf huckleberry, redwood sorrel, and deer fern.

Stand-replacing fires are rare, with estimated return intervals of 700-1000 years. Natural disturbance regimes are primarily shaped by small-scale windthrow events which open gaps in the canopy and allow for successional regeneration. As a result, this forest system tends to develop complex late-seral characteristics, including multi-layered canopies and abundant coarse woody debris.

Since European settlement, this system has been altered by timber harvest and plantation forestry, which have reduced canopy structural complexity, species diversity, and coarse woody debris with most forest succession truncated well before late-seral characteristics are expressed.

North Pacific Maritime Dry-Mesic Douglas-Fir Western Hemlock Forest

This system is closely related to the North Pacific Maritime Mesic-Wet Douglas-Fir Western Hemlock Forest. The primary difference is lower available soil moisture manifesting in slight differences in species composition. Otherwise, climate and disturbance regimes are similar to the mesic-wet zone.

The overstory is dominated by giant Douglas-fir, often codominant with western hemlock or western redcedar. Other species such as grand fir, bigleaf maple, and western white pine can also be present but are generally less abundant. Western hemlock often regenerates as the dominant understory conifer but is typically absent in younger stands, especially in the Puget Lowlands. Late-seral forests exhibit a multi-layered canopy, large-diameter conifers, abundant snags, and significant coarse woody debris. Early seral forests tend to have single-storied canopies and may be dominated by either conifers or broadleaf trees, retaining biological legacies of prior stands. The understory is dominated by salal, Oregon grape, Pacific rhododendron, vine maple, and evergreen huckleberry. Sword fern is present but not a dominant cover, while mosses often dominate the ground layer in older stands, and canopy lichens are abundant.

North Pacific Seasonal Sitka Spruce Forest

This system is closely related to the North Pacific Hypermaritime Western Redcedar Western Hemlock zone where it occurs at slightly lower elevations up to 1,000 feet. Unlike the hypermaritime zone, it is characterized by more frequent fog events as well as a more vigorous wind disturbance regime that produces large canopy gaps. The additional fog and canopy gaps favor the growth of Sitka spruce. As a result, the overstory is typically dominated or codominated by Sitka spruce, western hemlock, and western redcedar, while Douglas-fir remains rare. Otherwise, disturbance regimes and species compositions closely resemble the hypermaritime zone.

North Pacific Lowland Riparian Forest And Shrubland

This system occurs primarily at low elevations west and east of the Cascade Range from British Columbia to Oregon. It is most common in the Puget Lowlands, Willamette Valley, and lower river valleys, where it forms narrow bands along rivers, streams, and floodplains. Elevation typically ranges from sea level to about 2,000 feet, though it can extend higher along major valley bottoms. The climate is mild and maritime, with wet winters, dry summers, and frequent autumn and spring rain events. Seasonal to episodic flooding is a defining feature, influencing soil development, vegetation composition, and successional pathways.

Flooding is the primary natural disturbance, with return intervals ranging from annual overbank flows to major channel-reforming events occurring every few decades. High flows scour vegetation, deposit new sediment, and create conditions for early-successional plant establishment. Beaver damming alters local hydrology, floods riparian benches, and promotes diverse habitat structure. Infrequent fire can occur in drier riparian terraces, but it is not a dominant process. Windthrow, ice damage, landslides, and insect or disease outbreaks cause localized disturbance and canopy gaps.

Early-seral stands are dominated by fast-growing pioneer trees such as black cottonwood and red alder, often accompanied by willows and a variety of herbaceous and shrub species. Mid- to late-seral forests may support large bigleaf maple and a conifer component including grand fir, Douglas-fir, Sitka spruce, and western redcedar. Conifers historically occupied stable riparian terraces but are now uncommon in many reaches. The shrub layer is often dense, dominated by red-osier dogwood, Pacific ninebark, salmonberry, and snowberry.

Historically, this system exhibited a dynamic shifting mosaic, with patches ranging from newly deposited gravel bars to mature, multi-layered forests over a short distance. Large woody debris, derived from mature forests upstream, was abundant and influenced channel form and habitat diversity. The riparian corridor provided continuous habitat connectivity, supporting fish migration, wildlife movement, and nutrient cycling between aquatic and terrestrial systems.

Since European settlement, extensive hydrologic modification, historic logging, and residential and agricultural development of floodplains have greatly reduced the extent and integrity of this system. Flood control structures have disconnected rivers from their floodplains, altering sediment and wood recruitment. Historic logging removed the majority of mature conifers and agriculture and urban expansion have converted or fragmented the remaining forest. Invasive species such as reed canary grass have replaced native herbaceous and shrub layers in many disturbed sites. These changes have simplified vegetation structure, reduced habitat quality, and impaired the system’s natural disturbance-driven processes.

North Pacific Broadleaf Landslide Forest And Shrubland

This system occurs throughout the Pacific Northwest mountains and lowlands where it occurs on steep slopes and bluffs that experience periodic mass soil movements such as landslides, slumps, and earthflows. Soil parent materials are often glacial in origin, including till, outwash, and marine or lake sediments. Heavy rainfall events, freeze–thaw cycles, erosion, and seismic activity, can trigger slope movement.

Vegetation is typically dominated by deciduous broadleaf forests, woodlands, or shrublands. Black cottonwood, red alder, and bigleaf maple are common canopy species, often occurring in mixed stands. Conifers such as Douglas-fir, Sitka spruce, and western redcedar may be present but usually make up less than half the cover in early to mid-successional stands. The shrub layer is often dense, with salmonberry, thimbleberry, stink currant, and devil’s club among the dominant species.

Landslides are the primary natural disturbance in this system where they maintain early-successional habitats in otherwise mature forest settings. Recently disturbed areas are typically dominated by fast-growing deciduous trees and shrubs not present on adjacent forestland, though without regular slope movement, these areas would likely succeed to conifer-dominated stands over time. Occasional windstorms and wildfires also affect these systems, which along with insect and fungal pathogens work to create additional stand heterogeneity.

Today, this system is considered imperiled due to its rarity, small patch size, and ongoing threats. Non-native plants such as English ivy and Himalayan blackberry often invade disturbed slopes, displacing native species and altering successional pathways. Human activities, including development at the top of bluffs, road construction, timber harvest on unstable slopes, and slope stabilization projects, have altered natural disturbance processes. These interventions can either accelerate slope failure through poor practices or suppress landslide activity by artificially stabilizing slopes, reducing the natural renewal of early-successional habitats.

Though this system is only a minor component of the assessment area, it is a notable archetypal vegetation zone to consider, given the high frequency of landslide events in the Lake Whatcom watershed.

Climate Change Impacts

Vegetation zones are likely to shift in the coming years as disturbance regimes are modified by climate change and existing species may become less suitable to future growing conditions, but how fast these zones will change is unclear. Under drier and warmer conditions forests will likely experience large-scale, high-severity wildfire events at a frequency that exceeds historical reference conditions. Likewise, drier and hotter conditions reduce the presence of moisture-loving zones, such as the Seasonal Sitka, in favor of similar but drier zones.

Soils

Overview

The wealth of a forest can be measured in its soil. Soil, interacting with local climate and topography, is responsible for determining a forest's potential species composition and productivity. Given the slow process of soil formation, if soil is damaged or lost, it may not be replaceable in the foreseeable future.

Broadly, soils are composed of organic matter, mineral components, and empty space occupied by air or water. Different soil structures have different capacities to store water. Loose, coarsely-textured soils, with large components of gravel and sand, hold less water and drain quickly, while dense, finely-textured soils, containing organic matter, silts and clays, retain more water and drain slowly. Deeper soils provide better anchorage and have higher potential water storage than shallow soils with similar structure.

The timing and duration of soil moisture largely determines which tree species will survive and thrive. Local hydrology and topography determine water availability and soils become saturated when available water exceeds their innate storage capacity. The frequency and duration of soil moisture, known as soil drainage class, is an excellent indicator of soils prone to waterlogging or conversely drought. In the dry summers of the Pacific Northwest, shallow, excessively-drained soils contain insufficient soil moisture for optimal growth and are unsuitable for drought-intolerant species. Conversely, poorly drained soils are prone to waterlogging, especially during wet winters, and only suitable for the most water-tolerant species. Well-drained soils that retain moisture without waterlogging are suitable for many species, and deep, well-drained soils with high potential water storage are the most productive and able to grow giant trees.

Forest productivity is commonly measured by site class, which groups soils from highly productive (Class I) to least productive (Class V) and can be used to estimate a site's potential annual timber growth. Appropriate use of heavy machinery is necessary to maintain productivity and avoid compaction or erosion, especially during wet winters when many soils are saturated. Well-drained soils are usually suitable for winter-time activities, while poor-draining soils are best operated on during drier summer months. Wetland soils that are saturated year-round should be avoided at all times.

Assessment

The sedimentary Chuckanut Formation underlies the majority of the soils in the watershed and primarily consists of fine to medium grain sandstone as well as deposits of conglomerate, shale, and coal. Over millions of years, folding and tilting have exposed the sedimentary layers of this formation, which have eroded at unequal rates leading to the many parallel cliff bands and ridgelines found across the watershed today. In the watershed's southeast corner an older, underlying deposit of metamorphic Darrington Phyllite is exposed and parallel cliff bands are notably absent. Glacial activity during the last Ice Age heavily influenced the region's terrain, carving valleys and leaving behind glacial deposits that fill the flat plains at both the south and north ends of the lake. In addition, periodic volcanic eruptions from nearby Mt Baker and other volcanoes have deposited volcanic ash into the watershed's soils.

Data from the USDA Natural Resource Conservation Service (NRCS) Soil Surveys[3] were used to identify the major soil types that underlay this forest, which are briefly described below.

- **Andic Xerochrepts** - Consists of moderately deep soils restricted by bedrock at 27 inches. They are well drained and can hold 4 inches of water storage within the rooting zone. They have moderate productivity (site class 3) and are most suitable for growing Douglas-fir. They formed in volcanic ash and colluvium from glacial drift, sandstone, and metasedimentary rock. They are commonly found on canyons, mountain slopes, mountains and ridges.
- **Chuckanut** - Consists of deep soils restricted by bedrock at 56 inches. They are well drained and can hold 10 inches of water storage within the rooting zone. They have moderate to high productivity (site class 2) and are most suitable for growing Douglas-fir. They formed in volcanic

[3] While the NRCS soil surveys provide well researched and detailed descriptions of each soil type, the geographic coverage of these soils has been interpolated from limited sampling and remote sensing, therefore minor mapping errors are invariably present. Thus, the soil maps and data presented here should be used as a guide to the soil types likely present in this forest, and some skepticism should be given to their exact delineations in the field.

ash mixed with colluvium derived from sandstone over dense glacial till. They are commonly found on foothills and hillslopes.

- **Getchell** - Consists of moderately deep soils restricted by compacted material around 39 inches. They are moderately well drained and can hold 13 inches of water storage within the rooting zone. They have low to moderate productivity (site class 4) and are most suitable for growing western hemlock. They formed in volcanic ash mixed with colluvium over dense glacial till. They are commonly found on mountain slopes and ridges.
- **Nati** - Consists of moderately deep soils restricted by bedrock around 37 inches. They are well drained and can hold 5 inches of water storage within the rooting zone. They have moderate to high productivity (site class 2) and are most suitable for growing Douglas-fir. They formed in volcanic ash, colluvium, and alluvium deposits derived from sandstone, siltstone and glacial drift. They are commonly found on foothills and hillslopes.
- **Revel** - Consists of moderately deep soils restricted by bedrock around 35 inches. They are well drained and can hold 6 inches of water storage within the rooting zone. They have low to moderate productivity (site class 4) and are most suitable for growing Douglas-fir. They formed in volcanic ash, and colluvium derived from glacial drift, bedrock of mixed lithology, and slope alluvium derived from sandstone and siltstone. They are commonly found on mountain slopes, mountains, plateaus and ridges.
- **Squalicum -** Consists of deep soils restricted by compacted material around 44 inches. They are moderately well drained and can hold 10 inches of water storage within the rooting zone. They have moderate to high productivity (site class 2) and are most suitable for growing Douglas-fir. They formed in volcanic ash, loess, and slope alluvium over glacial drift. They are commonly found on foothills and hillslopes.
- **Welcome** - Consists of deep soils restricted by bedrock around 52 inches. They are well drained and can hold 8 inches of water storage within the rooting zone. They have low to moderate productivity (site class 4) and are most suitable for growing western hemlock. They formed in volcanic ash, and colluvium derived from glacial drift, bedrock of mixed lithology, and slope alluvium derived from sandstone. They are commonly found on mountain slopes, mountains and ridges.

These soil types occur in various mixtures and on varying slopes and topographic positions, yielding unique soil units. Relevant information about major[4] soil units, including their depth, drainage, productivity, and relevant management concerns are listed in the table below. The location of all soil units can be found by property in Section 4.

[4] Major soil units comprise at least two percent of the project area. Minor soil units are not described here for brevity.

Forest Soil Units Summary Table

Soil Unit	Productivity		Management Concerns					Acres (Pct)
	Site Class	Max Growth	Drought Stress Hazard	Wind Throw Hazard	Mass Wasting Hazard	Logging Rutting Hazard	Logging Compact Hazard	
Andic Xerochrepts-Rock Outcrop Complex Ashy Loam 60-90% Slopes Mod. Deep (24in) Well Drained	DF-3	143 ft3/ac/yr	High	High	High	High	High	3,662 (30%)
Chuckanut Series Gravelly Medial Loam 30-65% Slopes Deep (56in) Well Drained	DF-2	186 ft3/ac/yr	Mod. High	Low	High	High	Mod.	1,093 (9%)
Revel-Welcome-Rock Outcrop Complex Ashy Loam 30-60% Slopes Mod. Deep (37in) Well Drained	DF-3 / DF-4	126 ft3/ac/yr	Mod. High	High	High	High	High	911 (7%)
Nati Series Ashy Loam 15-30% Slopes Mod. Deep (31in) Well Drained	DF-2 / DF-3	172 ft3/ac/yr	Mod. High	Medium	High	High	High	836 (7%)
Chuckanut Series Gravelly Medial Loam 15-30% Slopes Deep (56in) Well Drained	DF-2	186 ft3/ac/yr	Mod. High	Low	High	High	Mod.	715 (6%)
Nati Series Ashy Loam 30-60% Slopes Mod. Deep (38in) Well Drained	DF-3	129 ft3/ac/yr	Mod. High	High	High	High	High	701 (6%)
Andic Xerochrepts-Rock Outcrop Complex Ashy Loam 60-90% Slopes Very Shallow Well Drained	DF-4	114 ft3/ac/yr	Mod.	Low	High	High	High	657 (5%)

Soil Unit	Productivity		Management Concerns					Acres (Pct)
	Site Class	Max Growth	Drought Stress Hazard	Wind Throw Hazard	Mass Wasting Hazard	Logging Rutting Hazard	Logging Compact Hazard	
Revel Series Loam 30-60% Slopes Mod. Deep (35in) Well Drained	DF-4	114 ft3/ac/yr	Mod. High	High	High	High	High	388 (3%)
Nati Series Ashy Loam 5-15% Slopes Mod. Deep (37in) Well Drained	DF-2 / DF-3	172 ft3/ac/yr	Mod. High	Medium	High	High	High	368 (3%)
Squalicum Series Gravelly Ashy Loam 5-15% Slopes Deep (44in) Moderately Well Drained	DF-2	186 ft3/ac/yr	Mod.	Low	Mod.	Mod.	High	358 (3%)
Andic Xerochrepts Ashy Loam 60-90% Slopes Mod. Deep (27in) Well Drained	DF-3	143 ft3/ac/yr	High	High	High	High	High	332 (3%)
Revel Series Loam 5-30% Slopes Mod. Deep (39in) Well Drained	DF-4	114 ft3/ac/yr	Mod. High	High	High	High	High	312 (3%)
Getchell Series Decomposed Material 15-30% Slopes Mod. Deep (39in) Moderately Well Drained	WH-4	200 ft3/ac/yr	Low.	High	High	High	Mod.	271 (2%)
Squalicum Series Gravelly Ashy Loam 15-30% Slopes Deep (44in) Moderately Well Drained	DF-2	186 ft3/ac/yr	Mod.	Low	High	Mod.	High	225 (2%)

Soil productivity in the watershed ranges from site class 2-4, with over 75 percent of soils having a site class of at least 3. The highest productivity sites are at lower elevations along the Lake's southern and northern shores, while the lowest productivity sites are situated on high mountain ridgelines and steep slopes where shallow soils have low moisture potential. Like many northwest soils the risk of summertime drought stress is moderate to high across most of the watershed. The risk of windthrow varies by soil type, depending on the soil's rooting depth and mechanical strength. The risk of mass wasting is almost uniformly high across all soil types in the watershed as a result of the steep slopes and shallow, glacially derived soil layers. In addition, almost all soil types are at moderate to high risk of soil compaction or rutting from heavy machinery usage when the soil is moist or saturated.

Recommendations

This plan recommends that forest management activities utilizing heavy equipment be restricted to dry, summertime months, to reduce the risk of soil rutting and compaction. In addition, the high risk of mass wasting needs to be considered when planning forest management activities and additional recommendations are given in the section on Slope Stability.

Since soils play a critical role in forest development, the following best management practices will guide the management recommendations made throughout this plan.

Best Management Practices

- Match Species to Soils. Tree species should be selected for their suitability to soil conditions, with drought-tolerant trees preferred in droughty soils and waterlogging-tolerant trees preferred in poorly drained soils. See Appendix III for a complete list of species tolerances and considerations for seedling establishment in different soil types.
- Retain and Recruit Hardwood Trees. Deciduous trees play an important role in forest nutrient cycling, providing a significant amount of annual leaf litter and woody debris to the forest floor, which quickly rots and is incorporated into the soil. Manage the forest’s species composition, targeting around 20 percent of the forest overstory in deciduous hardwoods.
- Seasonally Restrict Equipment Use. Since saturated soils are prone to compaction and rutting, potentially reducing soil productivity and increasing the risk of erosion, heavy equipment use should be limited to periods when soils are dry.
- Timber Harvesting Methods. Limit commercial thinning entries on a single site to no more than once every 10 years to minimize compaction of soils. Frequent passage of equipment across forest soils should be minimized, with activity concentrated on as limited of a trail and/or road network as possible. Woody debris should be deposited on skid trails during logging operations to minimize soil compaction and incorporate debris into the soil.
- Retain Woody Debris. During forest management operations, woody debris (e.g., limbs, tops, poles, non-merchantable logs, etc.) should be redistributed back into the woods to increase soil organic matter. Scatter woody debris across the forest floor to the extent possible without increasing fire or pest risk or creating operational hazards to future management operations.
- Conserve Legacy Structures. As possible, protect legacy structures in the forest, including: old-growth stumps, large downed logs and snags, and old trees from prior generations of the

forest. These legacy structures are known to serve as important refugia for fungi and other microbial communities that are essential to soil health.

Climate Change Impacts

In general, forest productivity is likely to decrease across the Pacific Northwest as higher temperatures increase evapotranspirative demand and reduce the effective growing season of many moisture-limited sites. In some special cases, higher-elevation sites that are currently energy-limited may see an extension of the growing season under future warmer conditions. Young seedlings with limited root networks are particularly exposed to hotter and drier future conditions and the challenges of reforestation are likely to increase.

Slope Stability

Overview

Slope stability is a major concern across the Pacific Northwest where high precipitation can trigger landslides or other mass wasting events on vulnerable terrain, endangering property and reducing water quality. Fundamentally, landslides occur when the pressure or stress on soil exceeds its capacity to support itself. This is most likely to occur in soils whose innate properties confer limited strength and on landforms whose topography increases stresses and reduces holding power. The trigger for many landslides are rain events that saturate the soil with water, temporarily reducing the soil's ability to support itself.

In the forested landscape, tree and plant roots can provide additional strength, holding soils together that may have otherwise slid away. Shallow landslides are those that occur within the rooting zone of trees, while deep-seated landslides occur much deeper in the soil and are not influenced by root strength. In addition to anchoring the soil, forests intercept precipitation before it hits the ground and absorb water through their roots, influencing local hydrology and helping to reduce the amount of water in the soil during extreme rain events.

Forest operations, such as logging and road building have the potential to influence slope stability. Clearcut logging on unstable landforms reduces root strength and has been a historic source of landslides throughout the state. Today, forest regulations in Washington State are designed to reduce the risk of slope instability by identifying and preventing forest operations on all unstable or potentially unstable landforms. These landforms, known as rule-identified landforms (RILs), include inner gorges, convergent headwalls, and bedrock hollows on slopes greater than 70 percent; toes of deep-seated landslides on slopes greater than 65 percent; and groundwater recharge area for glacial deep-seated landslides to name a few. Since most landslides occur on these landforms, by avoiding them the risk of mass wasting events is greatly reduced. In addition, poorly designed or maintained roads can transfer large quantities of water onto a slope, causing erosion and increasing the risk of instability during storm events. Historically, forest roads were frequently abandoned without mitigating the roads ongoing hydrological influence, and many landslides have originated from these old road beds. Today, modern forest regulations require that all roads are built and maintained to safely convey the water flows generated during extreme storm events and unused forest roads must be permanently abandoned to ensure no long-term hydrological effects.

Assessment

The Lake Whatcom watershed has a long history of slope instability. The steep slopes and deeply incised stream channels leading into the lake contain many potentially unstable landforms and extensive evidence of historic landslide activity. The watershed's shallow soils are prone to erosion and have a high risk of mass wasting when saturated with extensive wintertime precipitation. This manifests primarily as shallow landslide activity in the soils underlain by the sedimentary Chuckanut Formation, with deep-seated landslides a more common risk in the deeper Darrington Phyllite derived soils at the Lake's southeastern shore.

Given these conditions, landslides and other mass wasting events are part of the region's natural geophysical processes. Historical landslide activity has carved out stream channels and deposited debris, building up several alluvial fans which dot the lakeside. Landslides also transport habitat-improving large woody debris into the lake, and are a critical forest disturbance agent where they maintain early-successional habitats in otherwise mature forest settings. More recently, widespread logging and road building across the watershed's steep slopes triggered numerous slope failures during the 20th century, including events in 1917, 1949, 1971, 1983, and 2009[5]. The most notable of these occurred on January 10th, 1983 when extensive rainfall initiated numerous small landslides along the Smith Creek drainage, which swept down the creek and exploded onto the alluvial fan, destroying homes and pushing houses into the lake. Beyond threatening property and lives, landslides are a major concern in the Lake Whatcom watershed because of their potential to introduce major quantities of sediment into the lake, potentially reducing water quality and threatening the drinking water supply of over 120,000 residents.

Previous analyses by the WA DNR, starting with the Lake Whatcom Watershed Analyses in the mid-1990s and culminating in the 2004 Lake Whatcom Landscape Plan, identified areas of potential instability within the watershed. These areas are known as hazard zones and include both known and suspected areas of instability, such as historic landslides, rule-identified landforms, and areas that require additional investigation. Because these zones were generated before the era of high-resolution mapping, they are at times overly restrictive, but serve as an effective screening tool. More recently, the Washington Geological Survey completed a high-resolution landslide mapping and inventory project across most of western Whatcom County, identifying historic and recent landslide activity within the watershed. In addition, the legally mandated Road Maintenance and Abandonment Plan (RMAP) process undertaken by the DNR in the early 2000s surveyed the watershed's active and abandoned road system, initiating improvements in storm water management and proper abandonment of unused road segments. A more thorough description of this process is given in the discussion on Roads and Access.

---

[5] As documented in the 1988 WWU Master's Thesis "History and Origin of Debris Torrents in the Smith Creek Drainage, Whatcom County, Washington" by Tim Syverson and the 2009 DNR report titled "Summary Report: Landslides, State Trust Lands, and the January 2009 Storm in Whatcom County".

Recommendations

Given the potential for slope instability in the watershed, it is critical that forest management follows existing rules limiting forest operations on unstable landforms. Avoiding unstable landforms is both the law and the best strategy to avoid triggering mass wasting events. Positively identifying these landforms requires field investigation at the time of operation before forest practice applications will be approved by the DNR. If unstable landforms are correctly identified and avoided, then the risk of forest management activities causing slope failures is greatly reduced.

In order to prioritize management activities, this plan utilizes remotely mapped topographic, hazard zone, and historic landslide data to gauge the likelihood that unstable slopes will be found within a proposed management area. The presence of a mapped hazard zone or historic landslide does not preclude management, but indicates that further investigation is required. In some cases, the hazard zones are poorly mapped and field investigation will quickly reveal that no risk of slope instability exists. More commonly an unstable landform, such as a steep stream channel, exists but can be easily avoided during management operations. In addition, mapped landslides are indicative of past instability, and while this is a good indicator of future instability, some landslides are prehistoric and unlikely to move further. In any case, a geotechnical investigation may be necessary to make final determinations about slope stability and allowable management activities.

Best Management Practices

Forest management should adhere to the following best management practices in order to avoid operating on unstable landforms and reduce the risk of landslides and other mass-wasting events:

1. Slope Stability Assessment: Conduct detailed geotechnical assessments prior to management activities to identify unstable areas and avoid them during operations.
2. Selective Thinning: By retaining trees during thinning, the retained living root system continues to stabilize the soil against unforeseen circumstances.
3. Minimize Disturbance: Limit forestry operations adjacent to the most sensitive and unstable slopes to reduce risk of landslides.
4. Reforestation and Revegetation: Replant disturbed areas with native, deep-rooted vegetation to improve slope stability.
5. Erosion Control Measures: Implement erosion control practices such as mulching and using erosion control blankets, on any disturbed soils within proximity of steep or unstable slopes

Climate Change Impacts

Overall, climate change is expected to intensify the natural processes that destabilize steep slopes in western Washington. Projected increases in the frequency and intensity of extreme rainfall events, can lead to increased surface runoff, soil saturation, and heightened erosion on already vulnerable slopes. These wetter conditions weaken soil structure and reduce slope stability, making landslides and slope failures more common in the region, particularly in areas where vegetation cover has been disturbed by development or logging activities.

Furthermore, climate change may accelerate the melting of snowpack as well as rain on snow events, leading to altered hydrological cycles. Reduced snowpack can result in seasonal variability in soil moisture levels, causing cycles of wetting and drying that destabilize slopes. The increased water flow from melting snow also contributes to higher groundwater levels, reducing the cohesive strength of soil and increasing the likelihood of slope failure during heavy rain events. These changes collectively threaten the safety of infrastructure, natural habitats, and communities situated on or near steep slopes.

In addition to water-related impacts, rising temperatures can lead to more frequent and severe wildfires, which greatly affect slope stability. Wildfires remove protective vegetation cover, leaving soil exposed and highly susceptible to erosion during subsequent storms. Post-fire conditions, combined with increased precipitation, can trigger debris flows and landslides that disturb ecosystems, threaten human developments, and potentially reduce water quality in Lake Whatcom.

Hydrology and Water Quality

Overview

The hydrology of the forested landscape is complex, moderated by factors such as precipitation, soil, vegetation, and topography. Seasonal and perennial streams drain water from the forested landscape, while waterbodies and wetlands store water during wet seasons which is steadily released back to the surrounding landscape during the dry season. Streams, waterbodies, and wetlands provide critical habitat for aquatic species, such as fish and amphibians, as well as upland species.

Forests are essential to maintaining water quality within a watershed. They provide shade and moderate water temperature, stabilize streambanks and control sedimentation and erosion, provide nutrient inputs such as leaf litter and woody debris, and contribute to complex riparian and wetland habitats. They can also influence the quantity of water available. Vigorously growing younger forests (less than 40 years old) use substantially more water than older forests, leaving less moisture in the soil and less water in streams and wetlands, especially during dry summers.

Ground-disturbing activities, such as logging, hauling on forest roads, and road maintenance increase the availability of sediment that can be transported by storm events and are a major consideration in forest management. Elevated sediment loads can impact photosynthesis by aquatic plants, bury gravel beds used by fish and invertebrates, reduce habitat complexity, and impair water quality by increasing turbidity and transporting attached nutrients or pollutants. Unconfined surface runoff can be effectively mitigated by appropriately sized buffers of natural vegetation which slow and filter this runoff, preventing sediment from entering surface waters. While forest roads can operate to channel surface runoff, if properly designed with drainage controls and maintained in good operation, sediment delivery can be greatly reduced.

Assessment

The forestland in this assessment primarily drains into the Lake Whatcom basin. Most moisture falls as rain during the fall, winter, and spring, with snow accumulation sometimes occurring at higher elevations. The steep, forested terrain contains many perennial and seasonal streams that flow quickly toward the lake, often flowing down waterfalls and steep channels. Two of the most significant tributaries are Austin Creek, which enters the lake from the west, and Smith Creek, which enters from the east. Perched forested wetlands occur in the folded topography of the Chuckanut Formation, which, along with surrounding glacial deposits, creates complex subsurface flow patterns and areas of natural slope instability. The Lake Whatcom region contains the first foothills east of the Strait of Juan de Fuca, which places it directly in the path of Pacific storm systems. These can deliver heavy rainfall over short periods and occasionally trigger landslides and rapid increases in streamflow.

Most notably, Lake Whatcom is the primary drinking water source for the City of Bellingham and surrounding communities, and water quality in the lake is a major management concern. In 1998, the lake was placed on Washington's 303(d) list for failing to meet dissolved oxygen standards, with excess phosphorus identified as the primary driver. Bacterial contamination is also a documented problem, with levels exceeding state standards in 11 tributaries to Lake Whatcom. Many of these tributaries pass through developed areas where bacteria sources include failing septic systems, sewer overflows, and pet or livestock waste exposed to rainfall.

While Lake Whatcom has naturally occurring levels of phosphorus primarily resulting from natural rates of erosion and sediment delivery to the lake, modern development has increased phosphorus loading above this background rate. Much of the excess phosphorus comes from stormwater runoff, which transports soil particles, fertilizers, organic debris, and other materials from developed areas. On natural landscapes, forests and soils filter stormwater before it reaches streams and lakes, but impervious surfaces such as roads, rooftops, and compacted yards bypass this process, sending runoff directly to surface waters. Phosphorus fuels excessive algal growth when present in high concentrations. The decomposition of algae depletes dissolved oxygen and releases additional phosphorus from sediments, creating a feedback loop that worsens water quality.

Efforts to address these water quality issues are guided by the Lake Whatcom Management Program (LWMP) and the 2016 Total Maximum Daily Load plan, which set phosphorus and bacteria reduction targets. The LWMP is a coordinated effort between the City of Bellingham, Whatcom County, and the Lake Whatcom Water and Sewer District, with policy oversight from their legislative bodies and implementation by the Lake Whatcom Management Program via the Interjurisdictional Coordinating Team. Actions in the 2025–2029 Work Plan span twelve program areas and include constructing and retrofitting stormwater treatment facilities, enforcing land use regulations, preserving forestland, and supporting residential retrofits to reduce runoff. The program also invests in long-term water quality monitoring, education and outreach campaigns, hazardous materials management, recreation and boating rules, and invasive species prevention.

Recommendations

Other than road-related concerns addressed in the following section, all water resources visited during this assessment were in good condition, providing high-quality riparian habitat.

Broadly, management activities in the watershed should seek to minimize sediment delivery to Lake Whatcom, and modern Forest Practices Act rules enforced by the State of Washington around riparian buffers and forest roads are effective at achieving this goal. Logging, road maintenance, and other ground-disturbing activities should be limited to summer months to further reduce the potential for sediment delivery. Additional recommendations will be given on forest road building and maintenance later in this document.

Since forests play a critical role in regional hydrology, the following best management practices will guide the management recommendations made throughout this plan.

Best Management Practices

The DNR regulates timber harvest and other forest management activities on all privately owned forestlands in the state according to the WA State Forest Practices Act. This includes restrictions on activities that can occur within certain distances of wetlands, waterbodies, and streams, known as wetland / riparian management zones. These zones vary in size depending on the water feature and soil type and include several layered buffers that may restrict management activities up to 200 feet from streams and bodies of water and up to 100 feet from wetlands. Before a forest practices act application can be submitted, water features need to be fully delineated and typed, or evidence provided that no such features exist.

Forest management adjacent to streams and wetlands should adhere to the following best management practices:

- Restrict operations and the use of heavy equipment within the buffer zones around streams, waterbodies, and wetlands as required by law.
- Retain or restore canopy cover and shading sufficient to moderate fluctuations in water temperature.
- Retain and recruit snags and downed logs into the wetland / riparian areas to provide aquatic habitat and slow down water flows in riparian areas.
- Promote forest composition trending towards conifer dominance while controlling and/or eliminating nonnative, invasive plants.

Climate Change Impacts

The overall climatic trends of warmer temperatures and shifting precipitation patterns will impact forest hydrology and streamflows. While total annual precipitation is expected to remain the same, summertime precipitation will decrease while wintertime precipitation will increase. Winter storm intensity is projected to increase, with rainfall and snowmelt concentrated into shorter time periods, and hydrological models project streams will experience greater flashiness, higher runoff and more flooding in fall, winter and spring. In the summer, warmer air temperatures will boost evaporation from streams and lakes and increase plant transpiration, reducing soil moisture and ultimately summer stream flows, with cascading effects on the aquatic environment.

Roads and Access

Overview

A well-maintained forest road and trail system is important to ongoing forest management activities. It enables access for monitoring and harvesting and provides quick access for firefighters in the case of a wildfire. Depending on the consistency and intensity of management activities, forest roads may be used seasonally or year-round, and may or may not be surfaced. Some roads may be maintained and used annually, and some roads (or road segments) may be left alone or decommissioned until the next logging cycle. Finally, not all access needs to be roads. A network of walking trails can provide access to roadless or sensitive areas to help facilitate annual monitoring and provide recreational opportunities.

While forest roads are necessary for many forest operations, they also create problems. Many invasive species get their initial start along road edges, and roads may be subject to unauthorized use and dumping. Though forest roads are typically small and infrequently used, they can create permanent, early-seral habitat along their edges and influence the behavior of some wildlife species. Perhaps more concerning is the potential roads have to influence hydrology and water quality. On flatter terrain, roads can prevent the natural flow of water, causing ponding and saturated road beds if proper drainage is not provided. On steep terrain, roads intercept and route surface runoff, which during storm events can turn into large flows of water that need to be controlled and safely deposited downhill of the road bed. Failure to control these surface water flows can send sediment-laden water into local surface waters reducing water quality. Roads designed with adequate drainage and maintained in good operation are able to handle these flows and minimize sediment delivery.

The Washington State Forest Practices Act requires that forest landowners construct and maintain roads to minimize impacts to public resources, such as water quality and fish habitat. When roads are no longer needed, they must be abandoned following Forest Practices Act guidelines. By building, maintaining, and abandoning roads to these standards, the potential impacts of forest roads can be greatly mitigated. In most cases a professional forester or road engineer should be consulted before building any forest roads to ensure compliance with these standards.

Forest roads broadly fall into three categories: Active, Abandoned, and Orphaned. Active roads are roads that are maintained regularly and are currently available for forest management activities. Abandoned roads are roads that have been formally abandoned following the DNR’s abandonment procedures. Orphaned roads were built and abandoned prior to the regulation of forest roads in 1975, and while not the legal obligation of the landowner, may continue to influence local hydrology and pose resource concerns even today. Though modern roads are designed to avoid crossing water features whenever possible, crossings are inevitable in our steep and hydrologically complex landscape. Depending on the water type - fish-bearing, non-fish-bearing but perennially flowing, or seasonally flowing - different regulations govern crossing design, but can include bridges, culverts, and potentially fords that allow the roadway to cross over a stream or other water feature. Drainage control structures include ditches, cross-draining culverts, ditchouts, rolling dips, and waterbars which work to contain water intercepted by the roadway and redistribute it safely downhill.

Assessment

Forest roads were assessed to determine their status and suitability for management activities as well as to identify any potential maintenance or design issues. Active and recently abandoned forest roads were identified from City and County staff records as well as publicly available forest road inventory data from the WA DNR. Older forest roads were identified using lidar imagery and historic Road Maintenance and Abandonment Planning (RMAP) documents acquired from the WA DNR. During this assessment, all active roads were walked or driven in their entirety. Water crossings, drainage control structures, and road surfaces were inspected throughout the active road system to identify potential issues. In addition, a sample of abandoned roads were spot-checked to confirm their current status and the conclusions of previous RMAP investigations. Finally, this assessment also examined the potential for future road building and/or the restoration of old road grades to assist in forest management activities.

In total, this assessment reviewed 76 water crossings, 206 drainage control structures (e.g. cross-draining culverts and ditchouts), assessed over 30 miles of active roadway, and spot-checked 32 orphaned road systems. Though this assessment was thorough, it did not include an engineering assessment of roads or drainage structures, nor did it identify all potential road-related issues in the watershed. In practice, this assessment sampled the forest road infrastructure across the watershed, and further assessments will be necessary in order to form a complete and thorough analysis of the road system. Notable findings of this assessment are summarized below and additional details are included in the property-specific sections in Section 4.

- **Neglected and/or Improperly Abandoned Roads.** Several roads were identified that, having not been officially abandoned, are theoretically “active” but maintenance has been neglected for many years. Examples of these roads include the SH-94 road at Lake Whatcom Park, the LM-1000 and LM-2400 roads at Lookout Mountain Forest Preserve, unnamed roads in the southeastern corner of Blue Canyon Preserve and at South Lake Whatcom Preserve, and unnamed spurs off the LM-4000 road at West Beaver Creek Preserve. Without ongoing maintenance, the drainage control structures, such as ditches and culverts, on these roads may fail, causing erosion and slope stability issues that could endanger local water quality. Improperly abandoned roads were also identified at the city-owned Agate Creek and Agate Pond Preserves.
- **Existing Orphan Roads.** These roads exist throughout the Lake Whatcom watershed where modern day lidar data can identify faint traces of these old road grades. This assessment did not identify any major concern with existing orphan roads that warrant a management recommendation. The RMAP process undertaken by the DNR at Lookout Mountain Forest Preserve and Lake Whatcom Park prior to reconveyance included a thorough investigation of

these orphaned road systems. Spot checks of these roads concurred with the DNR findings that these roads posed a limited risk. Though no culverts or water crossings were found on these historic road beds, evidence of past sidecast failures and small landslide activity was observed, and the roads are now reforested with large diameter trees growing on the old road grade. The RMAP process mitigated several high-consequence road segments and crossings, but under the assumption that most potentially unstable areas have already failed, concluded that attempting to mitigate the entire road bed grade with heavy equipment would cause more issues than it solved. Though city-owned properties have not benefited from the same RMAP process, field investigations of orphaned road segments at South Lake Whatcom Preserve, Three Creeks Preserve, and Blue Canyon did not identify any immediate concerns. In other cases, such as North Beaver Creek Preserve and West Beaver Creek Preserve, old road grades have been repurposed as hiking and biking trails.

- **Fish Passage Issues**. Given the steep topography of the region, fish-bearing streams are generally limited, and only two potential fish-passage issues were identified. At Lookout Mountain Forest Preserve, the current Rufus Creek Trail repurposed a defunct forest road and uses an existing culvert to pass over a fish-bearing stream. Similarly, at Lake Whatcom Park, the Hertz Trail passes over a culvert containing a fish-bearing stream. Both of these culverts are failing and lack natural streambed material posing a potential barrier to fish passage.
- **Drainage Control Issues on Active Roads.** Several active roads were identified as suffering from deferred maintenance of their drainage control structures, primarily road grades, ditches, and cross-draining culverts. In some situations, this has caused water to enter the roadway resulting in minor channelization on the road surface. These issues primarily occur on the Lookout Mountain LM-2000 road and to a lesser degree on the Lake Whatcom Park Wickersham Truck Trail road where both road systems have likely suffered a reduction in maintenance staffing and spending since their transfer from the DNR to Whatcom County. Across the watershed, drainage control issues identified include:
    - **Inoperable Cross-Draining Culverts.** Over time culvert inlets can become obstructed by large woody debris or buried under sediment if not properly maintained. Steel culverts are also prone to rusting and culvert outfalls may cause erosion if energy dissipation devices, such as rock armoring or downflumes are not properly installed and maintained. Of the 184 drainage culverts surveyed across the watershed, 23 were partially plugged, 4 were completely obstructed, and 3 had energy dissipation issues.
    - **Obstructed Ditches.** Ditches become obstructed or otherwise inoperable for many reasons, including sloughing hillsides, large debris, and unsanctioned recreational use. Obstructed ditches force water onto the roadway, where it bypasses well designed cross-draining culverts and uncontrollably exits the roadway, causing erosion and/or delivering sediment into nearby streams. Over 38 observations of obstructed ditches were identified, the majority occurring at Lookout Mountain Forest Preserve.
    - **Improperly Maintained Road Grades**. When water does enter the road a properly maintained road grade ensures the water is shed quickly. With crowned or insloping roads the water is directly, at least partially, back into the ditch while outsloping roads

direct water downslope. When road grades are neglected, ruts can form, and the grade flattens out, failing to shed water and allowing it to form channels on the road surface. Over 12 observations of water on the roadway were identified, the majority once again occurring at Lookout Mountain Forest Preserve and to a lesser degree at Lake Whatcom Park.

- **Culvert Condition.** 184 cross-draining culverts and 41 stream-crossing culverts were evaluated during this assessment. Culvert diameter, material, and condition were noted and the bankfull width measured for stream crossings. As described earlier, though culvert inlets were partially obstructed as a result of deferred maintenance, the culverts themselves were generally in good condition. Though nine crossdrains were flagged as undersized according to Forest Practices Act requirements, the majority of culverts were 18 inches or larger as required by state regulations. Of the 41 stream-crossing culverts identified during this assessment, 25 had diameters less than the bankfull width of the stream they carried. While this does imply they are functionally undersized, additional analysis is required to determine if these culverts are appropriately sized to meet current WA DNR requirements. Over 75 percent of culverts inspected during this assessment were constructed from galvanized steel, which has a serviceable life from 20-40 years. Many of these culverts date from the RMAP process from the early 2000s and are likely around 20 years old, though some may be considerably older. During this assessment the majority of steel culverts surveyed were in good condition and only four steel culverts were identified as having rusted out and an additional two showed signs of ongoing corrosion. Still, culvert failures are predicted to increase in the future as steel culverts reach the end of their serviceable life.
- **Road Failures.** Several historic road failures and one active failure were identified during this assessment which are important guides to the types of future issues that this road system may experience.
  - In 2018, a large storm saturated the roadway and surrounding soils, causing uncontrolled water on the roadway and extensive erosion at the intersection of the LM-2000 and LM-2400 road at Lookout Mountain Forest Preserve, closing the LM-2400 road to vehicle traffic ever since. Repairs of the failed section, including upgraded drainage control systems, are currently underway with construction projected to finish in early 2026.
  - Another recent failure also occurred on the LM-2000 road where the northern fork of Austin Creek passes under the road in a large 6ft culvert. During a storm in 2021, this culvert became plugged and the river overtopped the road, eroding some of the road bed but leaving the culvert in place. Notably, the current culvert is considered appropriately sized to pass the volume of water calculated to occur during the 100-year flood event, but was unable to pass the large woody debris transported by this flood. Though repairs have been made, this failure indicates that this water crossing needs to be upgraded to handle future storm events and the County is planning to undertake this upgrade in 2026.

- During this assessment an acute issue was identified with another water crossing at the Lookout Mountain Forest Preserve. This crossing is on the current Rufus Creek Trail where a defunct forest road has been repurposed as a biking and hiking trail. The trail crosses over an existing road culvert on a fish-bearing stream that has rusted out, failing to contain the stream and causing erosion of the overlying road surface. Though this location is on very flat topography it has the potential to deliver sediment into the local watershed in the future.

Recommendations

The following are generalized management recommendations for forest roads and drainage structures. More detailed, site-specific recommendations are included in the property sections

- **Neglected and/or Improperly Abandoned Roads.** Neglected roads necessary for recommended forest management activities should be restored to active condition. Neglected or improperly abandoned roads that are not required, should be decommissioned following the DNR's abandonment procedures.
- **Drainage Control Issues on Active Roads.** Implement a maintenance plan for ditches, culverts, and road grades. See the best management practices identified below.
- **Culvert Condition.** Upgrade undersized culverts. Future culvert installation, particularly of cross-draining culverts, should prioritize modern, longer lasting HDPE plastic culverts. Culverts should be evaluated to confirm they are sized appropriately for their respective upstream basins.
- **Fish Passage.** Evaluate and rectify identified fish passage issues.
- **New Roads.** Without road access, heavy equipment cannot be used in forest management activities, and thinning recommendations must be implemented as non-commercial cut and drop. This greatly increases the cost of forest management and likely reduces the amount of the landscape that can be actively managed to reach its desired future condition. Given the challenges of properly maintaining roads on steep terrain, the decision to build new roads requires careful planning. New road construction, if any, should consider the following guidelines:
  - Absent a compelling reason, no new mainline roads should be built in the watershed. Though many areas of the current watershed are not currently accessible, building extensive mainline roads to reach these areas will be expensive and counterproductive to the management goals outlined in this plan.
  - Any new road segments should be short, temporarily constructed spurs off existing roads necessary for forest health improvement projects.
  - New roads should be situated in locations that are less likely to interfere with local hydrology and require reduced maintenance, such as along ridgelines and flat topographies.
  - New roads should consider re-using orphaned road grades in order to reduce the road footprint in the watershed. However, given that older roads were not built or located to modern standards, it may not be advisable to reuse old road beds in all circumstances.

- Roads should be decommissioned when no longer needed for forest management activities.

Best Management Practices

1. **Inspection and Monitoring**
    - Conduct regular inspections, especially before and after major storms or freeze–thaw cycles.
    - Implement a “storm watch” program that involves City and County staff actively monitoring forest roads during significant rain events.
    - Check critical points first: stream crossings, steep grades, road–ditch intersections, and known problem areas.
    - Record and prioritize findings—high-risk sites near streams or unstable slopes get top attention.
    - Inspect culverts, relief drains, ditches, and cross-drains for blockage, deformation, or erosion.
2. **Surface and Drainage Maintenance**
    - Maintain the road surface to shed water: regrade ruts and potholes, restore road grade as designed, and prevent ponding.
    - Keep ditches clear and functional—remove sediment, vegetation, or debris that blocks flow. Ditches should only be cleaned on an as-needed basis, versus on a strict schedule, when they no longer adequately carry drainage water. Excessive cleaning can lead to scouring of ditch and may compromise road integrity.
    - Clean or replace cross drains and relief culverts to ensure unimpeded water flow.
    - Install or refresh energy dissipators (rock aprons, slash mats, or sediment traps) where outflows discharge onto bare soil.
    - Break up long grades with additional water bars or dips to disperse runoff.
3. **Erosion and Sediment Control**
    - Stabilize exposed soil using native vegetation, straw mulch, or gravel armoring on problem spots.
    - Armor outlets and inlets to prevent scouring and sediment transport.
    - Minimize sediment delivery to water: divert ditch water onto stable, vegetated slopes instead of directly to streams.
    - Inspect and maintain erosion control structures and replace as needed.
4. **Culvert and Stream Crossing Maintenance**
    - Remove debris from culvert inlets and outlets regularly.
    - Check alignment and slope to ensure proper flow and prevent undercutting.
    - Repair eroded fill and armor with rock where necessary.
    - Maintain fish passage at all fish-bearing stream crossings—remove barriers and sediment deposits.
    - Replace undersized culverts as part of maintenance where chronic plugging or flooding occurs.

- Routinely inspect and replace metal culverts with plastic culverts as necessary. Metal culverts have a maximum lifespan of 40 years.

5. **Vegetation Management**
    - Control encroaching vegetation to maintain visibility and drainage function.
    - Retain ground cover on cut and fill slopes—avoid scalping vegetation that stabilizes soil.
    - Use native species for reseeding or slope stabilization after maintenance work.
6. **Road Use and Surface Protection**
    - Restrict hauling during wet periods to prevent rutting and road surface damage.
    - Use rock surfacing or temporary mats where soft or erodible surfaces are unavoidable. Road surfacing should include a combination of coarse (1”+) and fine (1”-) rock.
    - Limit traffic on closed or low-use roads to maintain stability and minimize maintenance needs.
7. **Road Abandonment and Decommissioning Maintenance**
    - For roads slated for temporary closure or abandonment, maintain stable drainage by installing or refreshing water bars, outsloping, and re-establishing natural drainage paths.
    - Monitor decommissioned roads until vegetation is well established and erosion potential is low.
8. **Lake Whatcom Watershed Considerations**
    - Apply maintenance BMPs more frequently and proactively than the statewide minimum.
    - Emphasize sediment source control near surface water.
    - Coordinate maintenance schedules with Lake Whatcom Management Program (LWMP) objectives and local road inventories.

Priority Road Maintenance Actions Summary Table

Focus Area	Maintenance Practice	Frequency / Trigger
Drainage	Clean ditches, culverts, and cross drains	After major storms, annually minimum
Surface	Grade and restore crown/outslopes	As needed, typically 1–2× per year
Erosion	Repair gullies, apply surface rock, reseed slopes	As needed
Crossings	Clear debris, inspect for erosion/fish passage	Before/after storm season
Slopes	Monitor for tension cracks or slides	Quarterly or post-storm
Vegetation	Clear brush in ditches/road shoulders	Annually or as needed

Climate Change Impacts

Climatologists predict that a warming climate will lead to more intense rainstorms, leading to higher peak run-off events. As a result, culverts and other drainage structures on road systems must be reevaluated for their capacity to withstand these higher-flow episodes. This may require the installation of larger culverts at stream crossings, and greater attention to waterbars, crowning, and rolling dips on improved forest roads.

Health and Resiliency

Overview

Forest health is an often used and misunderstood term, with at least two broad definitions. In terms of timber production, a healthy forest has vigorously-growing, commercially valuable trees that are free of insects, diseases and defects. However, this definition frames forest health solely in anthropogenic terms. Forest health can also be defined in ecological terms that consider how naturally occurring disturbance events shape the composition and character of a forest over time. Therefore, forests that contain dead, diseased, broken, old, and slow-growing trees of all species and ages, can also be considered healthy.

Forest resiliency means the capacity of a forest ecosystem to adapt to disturbances and retain its basic ecological functions and services over a specified timeframe and spatial scale. Averaged over large enough spatial and temporal scales, most forests are extremely resilient, but this may be inadequate for the landowner who wishes to maintain specific ecological function and services within a specific area over a specific timeframe. In these cases, forest resistance, the capacity for a forest to resist changes, may be a more appropriate metric.

Given these definitions, this plan considers a healthy forest one that is able to resist and/or rapidly recover from natural disturbances while maintaining ecosystem functions in line with its historical reference conditions. Broadly, structurally complex stands which include a diverse arrangement of trees of different sizes and species occupying multiple canopy positions, have more options to adapt to disturbances and changing growing conditions. As an example, an insect infestation may target all trees of a certain species but leave other species untouched; a windstorm may blow down the overstory, but a healthy cohort of midstory trees is ready to replace them; or hotter and drier conditions may cause the decline of a drought-intolerant species, but more drought-resistant species are present to continue the stand trajectory.

During the field assessment process, the forest was evaluated for a wide-range of potential forest health and resiliency issues, including insect and fungal infestations, storm damage, invasive species, drought-stress and overcrowding. These findings are summarized in the sub-sections below and make specific recommendations in each property-specific section.

Invasive Species

Overview

Invasive plant species are becoming increasingly common in Northwest forests, and frequently enter forests following disturbances that expose soils such as fire, development, and forest management activities. Invasive species frequently outcompete their native counterparts, disturb ecosystems, and can preclude the establishment of young forests. Invasive species spread in many ways, including by animals who consume their seeds and by human beings who transport their seeds on clothing, boots or tires. These seeds can remain dormant for years, waiting for the ideal conditions to sprout and begin establishing in the understory. Species like Himalayan blackberry and scotch broom grow quickly, suppressing native vegetation and tree seedlings. Species like Japanese honeysuckle and English ivy can grow up existing trees and, if left unchecked, can eventually smother the tree under their weight.

Assessment

The forested properties in this assessment are, like many others, impacted by a variety of common invasive plant species. As is now increasingly common in Washington state, English holly was observed at low levels throughout the understory of almost all forested properties within this plan. Likewise, Scotch broom was also common at low, sporadic levels along forest edges and roadways throughout the watershed. English ivy and Japanese honeysuckle were observed at several localized sites that had a history of residential use but were not widespread. The most common invasive species was Himalayan blackberry, which was found consistently growing at low background levels around road edges and clearings across the watershed. Though invasive species were identified across all properties, they are generally not affecting forest development. In only a few notable cases, such as Agate Bay Preserve, Agate Creek Preserve, and Olsen Creek Preserve, blackberry infestations were extremely dense and extensive, preventing the establishment of new forest cover.

Recommendations

Since invasive species eradication is not a major objective of this planning effort, recommendations to manage invasive species will only be made if invasive species are precluding the establishment of new forests or affecting the growth and development of existing forests. Treatment of invasive plant species should adhere to the Whatcom County Noxious Weed Program guidelines, which follows the directives of the WA State Noxious Weed Law (Chapter 17.10 RCW) and for those plant species adopted to the WA State Noxious Weed List (WAC 16.750). Property-level management recommendations are made later in this plan as appropriate and the following best management practices will guide the management recommendations made throughout this plan.

Best Management Practices

Though effective management of invasive species typically requires species-specific treatment plans, the following best management practices are generally advised:

- Maintain closed forest canopies that provide sufficient shade to suppress shade intolerant invasive plants (e.g., scotch broom, Himalayan blackberry).
- Regularly monitor the forest to detect new species and populations and create a plan for controlling and/or eliminating them.
- As time and resources allow, remove and destroy invasive plants, being sure to dispose of plants appropriately.
- Prevent non-native plant introductions during forest management projects by requiring all heavy equipment be pressure-washed before it enters the property.

Overstocked Stands

Overview

Following a natural disturbance, pioneer tree species can colonize the disturbed soils at unsustainably high density. In time, competition-induced mortality will eventually thin the forest naturally, but this process can take several decades or more, causing stress among trees which contributes to their susceptibility to disease and disturbance. Highly overstocked stands may experience the following;

- **Competition Mortality**. Competition for sunlight forces individual trees to grow as quickly as possible to avoid being suppressed in the shade of their neighbors. Faster growing trees taking up dominant canopy positions and slower growing trees falling back into intermediate or suppressed canopy positions. In the dense canopy of an overstocked forest, many of these suppressed and intermediate trees will eventually die from competition-induced mortality.
- **Reduced Growth and Vigor**. In overstocked stands, the extreme competition for sunlight, soil nutrients, and especially soil moisture during long, dry summers, stresses trees to their maximum. Even if trees don't die from competition mortality their growth stagnates and under these stressful conditions, they are more susceptible to disease or insect infestations.
- **Stand instability.** High canopy competition causes all trees to sacrifice diameter growth in favor of height growth as they compete for limited sunlight. This results in tall, skinny trees with high "height-to-diameter-ratios", which are unstable and can blow over or break apart during storms.
- **Wildfire**. High density forests produce large quantities of dead wood, either as small trees killed by competition, blown over in windstorms, or lower branches jettisoned in the race to grow, all of which increase fire risk.

Assessment

Broadly many of the stands in this assessment are overstocked and/or growing at unsustainable densities. This includes naturally regenerated stands that are in the Stem Exclusion phase of development as well as plantations that have experienced extensive infilling by natural regenerating hemlock and alder, thus increasing their densities to unsustainable levels. In some cases, stocking exceeds 600 trees per acre and relative densities of 75 or even higher are fairly common. At these densities, competition-induced mortality is rampant, stands are increasingly unstable, and dead material is accumulating as potential wildfire fuel. This overstocking is addressed in greater detail by property later in this plan.

Recommendations

In order to accelerate development towards later seral conditions and/or meet other management objectives, overstocked stands can be thinned to a residual density that is appropriate for the size of the dominant cohort of trees and the conditions of the site. As previously discussed, thinning to a relative density of 35 is a reasonable stocking target. In highly overstocked stands it may take two entries over a 10-year period to safely reduce density and establish stability in the stand. Specific property-level management recommendations are made later in this plan as appropriate.

Drought Vulnerability

Overview

Drought vulnerability is an increasingly important consideration for forest management in the Pacific Northwest as climate change brings hotter, drier summers and more variable precipitation patterns. Tree species vary in their ability to withstand drought, and those differences can shape long-term forest health and resilience. Some drought-intolerant species, such as western hemlock, often establish successfully under current conditions but are less likely to persist on dry sites as water availability decreases. In contrast, Douglas-fir demonstrates relatively high drought tolerance due in part to its deeper rooting capacity. Drought impacts also vary across the landscape, with shallow soils and south-facing slopes especially prone to moisture stress compared to cooler, wetter microsites. In addition, extended drought can interact with other disturbances, reducing tree vigor and increasing susceptibility to insects, pathogens, and wildfire. Stand density also plays a role, as higher densities intensify competition for limited soil moisture and increase stress across all species.

Assessment

Though they receive substantial winter rainfall, the steep terrain and shallow, glacially-derived soils common in the Lake Whatcom watershed increase the likelihood of summertime drought stress under warmer future climates. Moisture availability is generally lower on upper slopes compared to lower slope positions, creating site conditions that will become more limiting as summers grow hotter and drier. Currently, some of these upper slope areas—particularly near the top of Lookout Mountain on the west side of the lake and near the top of the Smith Creek drainage on the east side—are dominated by western hemlock and Pacific silver fir. Both species are relatively drought-intolerant, and while they are persisting under present conditions, they may be poorly suited to these terrain positions in a warmer, drier climate. Of particular concern are south and western facing aspects along these upper ridgelines which have the lowest moisture potentials and will face the most drought stress.

Recommendations

Broadly, overstocked stands growing on steep, south or southwest facing slopes, on the ridgelines of the watershed are of particular concern for drought tolerance and resiliency. This plan recommends reducing, but not eliminating, the dominance of western hemlock and silver fir in favor of more drought-tolerant redcedar or Douglas-fir.

Property-level management recommendations are made later in this plan as appropriate and the following best management practices will guide the management recommendations made throughout this plan.

Best Management Practice

- Managing species that are well matched to the growing conditions will be important under a warmer, drier climate. On sites with shallow, well-drained soils, south-facing or upper slopes that naturally retain less moisture, prioritize more drought-tolerant species to reduce the risk of long-term decline and mortality. You can see a full list of species tolerances in Appendix III.

- Drought-intolerant species should not be eliminated entirely, as they provide ecological and structural diversity. Instead, their presence should be concentrated in local microsites where soil moisture is naturally higher—such as riparian zones, wet depressions, or north-facing slopes—that can act as refugia under drier future conditions.

- Thinning to reduce stand density can improve resilience by lowering competition for limited water resources. This practice can enable drought-intolerant species to persist on drier terrain, while also promoting overall stand vigor, reducing stress, and providing a buffer against uncertain climate trajectories.

Fungal and Parasitic Pathogens

Overview

Naturally occurring root and stem funguses, parasitic infestations, and other pathogens are important agents of stand diversification, however, when pathogens have an adverse effect on the desired condition of a forest, they may be perceived as a problem. Most pathogens are host-specific, reducing growth and, in many cases, eventually causing mortality in the infected tree. In doing so, they contribute snags and downed logs that provide important habitat and nutrient cycling functions, create openings in the forest for other species to become established, and overall contribute to a highly heterogeneous and uneven-aged stand composition.

Assessment

Broadly, the observed level of disease and fungal pathogens in this forest is not excessively impacting the forest’s growth and productivity and is not a major concern at this time. Some localized pockets of laminated root-rot were observed sporadically across the forested properties in this assessment, but are operating within normal levels. Most notably, at Lookout Mountain, several large patches of hemlock dwarf mistletoe were observed. These observations are discussed in greater detail by property later in the plan.

Recommendations

Unless disease and fungal activity is excessively impacting the growth and objectives of a forest they should be accepted as part of the ecological processes of the forest and allowed to function as agents of stand diversification. Property-level management recommendations are made later in this plan as appropriate and the following best management practices will guide the management recommendations made throughout this plan.

Best Management Practices

Best management practices for containing larger outbreaks include:

- Large patch cuts that remove all trees out to 50ft from the last known infected tree in order to isolate the disease, but this produces large openings in the forest, leaves the land unproductive for many years, and does not work on all pathogens;
- In overstocked stands, thinning can sometimes reduce stress and improve the vigor of the remaining trees, thereby increasing resistance to the disease, but it will not alleviate the disease, only slow it;
- Since pathogens have preferred hosts, planting or promoting a mix of species, including non-susceptible tree species, will serve to gradually transition infected sites to a species composition that can tolerate the disease.

Insect Pests

Overview

Insects are an integral component of forest ecosystems and important agents of stand diversification, however, when insects have an adverse effect on the desired condition of a forest, they may be perceived as a problem. Most insects are host-specific, only targeting trees of a certain species and/or size. In the Pacific Northwest they commonly act on a small-scale to kill trees and thin out forests. Locally this creates snags and downed logs that provide important habitat and nutrient cycling functions. Across a larger area, these small-scale disturbances contribute to highly heterogeneous and uneven-aged forest structure. Notably, insect infestations are typically not the primary cause of decline in forest health, but rather a symptom of stress-causing conditions, such as overstocking or drought, that attract the insects or make their presence more impactful. Relative to timber production, severe insect infestations can severely decrease the growth rates of infected trees, and lead to excessive mortality that reduces future timber harvest volume.

Assessment

Low-level Douglas-fir beetle activity was observed sporadically in the older mixed-conifer forests and overstocked plantations around Lake Whatcom. Out of all the properties visited, only one, Brannian Creek Preserve, was suffering from a major insect infestation with elevated mortality levels that was dramatically impacting the forest’s growth and development. The majority of stands were only experiencing limited outbreaks that were serving to produce small canopy gaps consistent with management objectives. Additional details on observed insect infestations are available in the relevant property sections.

Recommendations

Unless insect activity is excessively impacting the growth and productivity of a forest they should be accepted as part of the ecological processes of the forest and allowed to function as agents of stand diversification. Property-level management recommendations are made later in this plan as appropriate and the following best management practices will guide the management recommendations made throughout this plan.

Best Management Practices

The presence of insects and their activities are usually kept in check in forests that are moderately stocked and include a diversity of tree species and ages. Some light infestations can be controlled or the impacts mitigated with silvicultural solutions, such as thinning or pruning. In severe cases, other options may be considered, including pheromone traps and insecticides, but a forest entomologist should be consulted to determine the appropriate course of action.

Chemical Use Guidelines

The application of any pesticide should be done in compliance with applicable county and city policies and adhere to the following guidelines:

- **Appropriate Use.** Noxious weeds and insects should be identified and treated in accordance with state noxious weed control board best management recommendations.
- **Judicious Usage.** Chemical pesticides, fungicides, and herbicides will be used only when and where research or empirical experience has demonstrated that less environmentally hazardous, non-chemical pest/disease management practices are ineffective.
- **Targeted Application.** The most environmentally safe and efficacious chemicals should be chosen, with an emphasis on narrowly targeted chemicals that minimize effects on non-target species.
- **Legal Application.** Chemicals should be applied in accordance with all state and federal pesticide laws, using the appropriate training and equipment to minimize health and environmental risks.
- **Protect Key Resources.** Chemicals should only be applied if they pose no threat to supplies of domestic water, aquatic and riparian habitats, or habitats of rare species.
- **Record Keeping.** Records should be kept of pest occurrences and an WSDA Pesticide Application Record should be filled out after each application which includes the method of application; type, brand, and concentration of pesticide; and area of coverage.
- **Adaptive Management.** Over time these records will help to identify the most effective control methods for this forest.

Climate Change Impacts

The effects of climate change on forest health are wide-ranging and, in some cases, currently unknown. The warmer and drier summer conditions forecasted under future climate scenarios will increase evapotranspiration and moisture competition among trees, resulting in a certain increase in competition-induced mortality in overcrowded stands. The resulting dead wood will increase forest fuel loadings and may locally increase the risk of wildfire severity. The ecosystem disruptions wrought by the changing climate may provide additional opportunities for the many exotic and weedy species already present in the landscape to colonize newly disturbed sites, leading to increased prevalence of invasive species.

Climate change may lead to increased drought stress and reduced resistance to fungal diseases and pathogens, as well as insect infestations. While the impact of climate change on many pathogens is unknown, specific effects of climate change on tree pathology may include:

- Root and canker diseases, such as Armillaria root disease and Cytospora canker, that are favored by warmer, drier summers may increase in presence and severity.
- Foliar and rust diseases favored by warmer and wetter winters, such as sudden oak death and Phytophthora root rot, may also increase.
- Swiss needle cast may also increase in areas where winter and spring temperatures are mild and where there is ample moisture.
- Warmer winters will likely lead to more insects successfully overwintering leading to potentially larger insect outbreaks in the future, though exactly which species will be favored under these changing conditions is currently unknown.

Wildlife and Fish Habitat

Overview

A well-managed forest can harbor numerous native animals, birds, reptiles, fish, and insects if sufficient habitat components are present to support each species' biological needs. These needs typically consist of some arrangement of food, water, and shelter or nesting sites. While some species may spend their entire lives in one habitat type, other species may make use of multiple habitats, such as nesting in a mature stand and foraging in a nearby meadow or shrubland.

Providing a diversity of habitats requires a diversity of forested areas in different stages of successional development. This can occur naturally through natural disturbance events, such as wildfire and windstorms, but also through appropriate disturbance-mimicking management practices, such as thinning or small-scale gap creation, which opens dense forest stands and introduces a new progression of vegetation types. Still, no single forest should be expected to provide the entire breadth of habitat diversity necessary to support all wildlife species in a particular region. Instead, managers should focus on actions that provide specific habitat features or functions that are missing or limited in the surrounding landscape.

An important habitat component often lacking in regional forests are large-diameter snags and decaying logs which provide important structures for cavity-dependent bird and small-mammal species, food sources for woodpeckers and other foragers, hunting perches for birds of prey, and slow-release nutrients for the forest in general. In the Pacific Northwest numerous species of birds, mammals, reptiles, and amphibians need snags for nesting, roosting, shelter, denning, and feeding. Snag recruitment occurs naturally as trees succumb to diseases or insects, or be subject to natural disturbance events such as wind and ice storms. While large-diameter snags can remain standing for decades, they eventually fall over, introducing large amounts of large woody debris on the forest floor. Large woody debris includes fallen trees and large branches as well as logs and large pieces of wood left from thinning and logging operations. This habitat component serves many of the same purposes as snags, providing many species with important food and shelter.

Assessment

The Lake Whatcom watershed supports an extraordinarily diverse array of habitat types. These include aquatic, such as the lake itself, the streams that feed it, and wetlands throughout the upland forest. The lake and streams directly support fish, amphibians, aquatic invertebrates, and waterfowl, while forested riparian areas along streams offer important cover, food resources, and movement corridors for many additional wildlife species. Upland habitats vary from moist, shaded lowland forests to drier slopes and ridgetops at higher elevations, creating a gradient of ecological niches. Steep slopes, rocky outcrops, and forest openings further diversify the landscape, allowing for species with differing habitat preferences to coexist within the watershed.

Small pockets of old-growth forest remain within the watershed, most notably in the Smith Creek drainage. These forests contain a diverse mix of tree sizes and multilayered canopies, along with large standing snags and fallen logs that support an array of plant and animal life. Large live trees provide substrate for epiphytes such as mosses and lichens, which in turn support invertebrate communities and are used by bird species, including the marbled murrelet, for nesting material. The structural complexity of old-growth stands creates abundant nesting, roosting, and foraging opportunities for birds, mammals, amphibians, and insects. Younger forests, which often develop after timber harvest or other disturbances, support dense growth of shrubs, grasses, and forbs. These areas provide critical forage for deer, small mammals, and insects, and offer thick cover that can protect wildlife from predators and harsh weather. Large portions of the watershed, particularly on Lookout Mountain, consist of second-growth forests in the Stem Exclusion forest stage. These stands, which regenerated at high densities following logging or other major disturbances, are dominated by uniform tree sizes and closed canopies, resulting in limited understory vegetation and relatively low habitat diversity. Although such forests currently provide less food and cover, they are gradually developing more wildlife features like large snags and downed logs as they age.

Streams and nearshore lake environments also provide habitat for cutthroat trout, sculpin, and other native fish species, as well as amphibians and aquatic invertebrates that form important links in the food web. Natural barriers, such as the series of waterfalls in Whatcom Falls Park, prevent fish from traveling between Bellingham Bay and Lake Whatcom, and no anadromous fish passage occurs within the streams of the watershed. Cutthroat trout and kokanee salmon are notable fish populations in the lake and streams. The kokanee salmon population, derived from sockeye salmon, completes its entire life cycle in freshwater, spawning in streams and gravel beds along the lakeshore. Several creeks, including Anderson, Olsen, and Austin are known to host spawning populations and a hatchery at Brannian creek has been operating for over 100 years, providing kokanee fry across the state and nation. While the lake supports healthy fish populations, the rapidly rising topography of the watershed means that most streams are rendered naturally impassable to fish only a few hundred feet uphill by physical barriers such as waterfalls and steep bedrock sections.

Several rare and sensitive species are likely present within the Lake Whatcom watershed, according to the Washington State Department of Fish and Wildlife (DFW) Priority Species Database. The marbled murrelet, listed as endangered in Washington, is known to nest in mature and old-growth conifer forests within approximately 50 miles of marine waters. These seabirds require large, moss-covered branches high in the canopy for nesting platforms, typically in trees over 200 years old. Townsend's big-eared bat, a candidate species in Washington, favors caves and large hollow trees for roosting. The little brown bat and Yuma myotis bat both utilize forest edges and riparian zones for foraging, feeding primarily on insects. Past observations of federally endangered gray wolves have been documented within the 23,000-acre township that contains part of the Lake Whatcom watershed on the east side of the lake, but the DFW does not consider there to be ongoing wolf presence in this local area.

Recommendations

Property-level management recommendations are made later in this plan as appropriate and the following best management practices will guide the management recommendations made throughout this plan.

Best Management Practices

Common management practices to optimize wildlife habitat and plant species diversity will include:

1. **Conserve and/or recruit snags and downed coarse woody debris.** A minimum of two snags and two downed logs per acre are recommended, with preference given to snags and logs over 12 inches DBH. Storm damaged trees will be retained to naturally recruit as snags. During commercial harvesting, unmerchantable trees can be girdled or cut at 20 feet above ground to manually create snags. Additionally, non-merchantable portions of logs can be scattered throughout the forest floor to augment coarse woody debris.

2. **Promote tree size and species diversity.** Manage for a 20/80 mix of hardwoods to conifer while planting and/or promoting the growth of more diverse conifer species. Retain trees over 36 inches DBH in most cases.

3. **Manage for variable densities and habitats.** Create and maintain spatial heterogeneity in order to ensure a mix of habitat niches exist - from open early seral shrublands to dark late-seral forests. Diverse and minimally disturbed vegetation along stream corridors provides wildlife corridors and additional habitat heterogeneity.
4. **Improve food and shelter availability.** Wildlife habitat piles and constructed logs can be created using woody material generated during thinning. A minimum of one habitat pile per five acres and two constructed logs per acre is recommended.

Climate Change Impacts

Changing climate conditions will likely impact many species, but predicting these changes is beyond the scope of this plan. Some species are likely to see reductions in available habitat and face increasing pressures on their survival, while other species may enjoy increases in foraging or nesting habitat and expanded ranges.

Wildfire Susceptibility

Overview

Fire has long shaped the forest dynamics of the Pacific Northwest. Given the great productivity of the region's forest, large quantities of biomass grow and die every year, leading to the buildup of vast quantities of burnable fuels. The high relative humidity of the region means these fuels remain damp and difficult to ignite most of the year. During summer, these fuels dry out and become increasingly combustible. Ignitions - either human or lighting caused - are common but the high humidity means most fires remain isolated surface fires consuming understory vegetation and intermittently torching a few trees. Occasionally, during periods of extreme fire weather, very dry air and fast winds can cause a normally benign surface fire to rapidly spread into running crown fires that blacken the forest for thousands of acres.

The impact of wildfires on forests is ranked by severity. Low-severity wildfires mostly stay on the surface, burning the understory but killing less than 25 percent of overstory trees. They scorch and char surface litter but leave the soil mostly intact. Conversely, high-severity wildfires typically involve both surface and crown fires, and over 75 percent of overstory trees are killed. The fire completely burns the understory, consuming small-diameter woody debris and surface organic matter, leaving behind exposed soils that are at increased risk of post-fire erosion during storm events. Mixed-severity wildfires fall in between and may involve a surface-fire with some limited torching of individual tree crowns or small groups of trees and soils may be partially burned and exposed. The natural fire regime in the Lake Whatcom watershed varies by vegetation zone previously described, but is generally thought to include smaller, moderate severity fires burning infrequently every 100 to 150 years punctuated by high-severity, stand-replacing fires every 300 to 1,000 years which reset the forest’s ecological succession.

Assessment

Wildfire susceptibility is a major concern in the Lake Whatcom watershed, where, depending on size and severity, future wildfires have the potential to reduce forest cover, increase erosion and reduce water quality, and potentially endanger the municipal drinking water supply for over 120,000 people. The impact of wildfires in the watershed is influenced by the following factors: probability of ignition, response effectiveness, and the size and severity of the burned area.

Most wildfires are started by human ignitions and the risk of ignition remains high in the watershed. This risk is particularly high at the northern end of the lake where residential development abuts many of the forested properties in this assessment. Here risk runs both ways - a wildfire could potentially enter a residential area causing destruction, or more likely, a structure fire or backyard burn could turn into a wildfire. Recreation is also a common cause of wildfire ignition, but since most recreation in the watershed is non-motorized and day-use only, these risks are reduced, but still remain substantial given the high amounts of recreational use.

Though wildfire ignitions do occur, In most scenarios, these fires can be quickly contained by modern firefighting, as long as extreme winds are not present. Firefighters can deploy aerial assets, such as helicopters and planes, to drop water on the advancing fire. In this scenario, Lake Whatcom itself is an enormous asset that helps reduce the spread of wildfires in the watershed. Though water drops are an important strategy, containment of any fire also requires ground crews to dig containment lines and mop up hot-spots. As a result, roads and trails that increase firefighting access throughout the forested properties of the lake help put out fires sooner. Though firefighting response can limit the size of burned areas, it has little impact on the burn severity.

Once ignited, a combination of weather and forest conditions determine if the fire will burn at low, mixed or high severity. Weather is one of the most important determinants of wildfire severity. When extremely dry and windy weather is present, low-severity surface fires are accelerated into high-severity running crown fires and firefighting effectiveness can be extremely limited. At Lake Whatcom these extreme summertime winds typically come from the northeast out of the Fraser River Valley and have the potential to funnel north to south down the lake. These winds hit as recently as the summer of 2021, but no fire was burning at that time and the watershed escaped unscathed.

After fire weather, fuel loading plays a major role in determining wildfire severity. The more surface fuels present, such as dead branches, needles, and downed logs, the hotter and more intense surface fires can burn. Ladder fuels, such as small trees, shrubs, or branches, increase the chance that a surface fire spreads to the upper canopy. Once in the canopy, a crown fire can spread rapidly in forests with dense, interlocking crowns.

Finally, individual tree qualities such as size and bark thickness, can influence fire severity. Bark thickness insulates the living tissue of a tree against the killing heat of forest fires. Larger trees typically have thicker bark and are able to resist wildfire better than small trees. And some species, such as Douglas-fir are famous for their extremely thick bark and can exhibit impressive fire scars, but emerge largely unscathed as long as crowns and living foliage are not burned. Deciduous hardwood trees with their large water-laden leaves and lower content of resin and pitch are less likely to burn in a fire and their low-density crowns can reduce the chance of a crown fire spreading.

A forest's susceptibility to high-severity wildfire shifts throughout its stages of development. Young, dense stands or plantations in the Stem Exclusion phase of development can be more susceptible to high-severity fire as they have high levels of fine woody debris, lack larger trees that are more resistant to fire, have low canopies and many potential ladder fuels. As stands exit Stem Exclusion and enter the Mature-I phase of stand development they are perhaps the least vulnerable to high-severity fire. The competition of Stem Exclusion has caused crowns to rise significantly and dead branches to drop, preventing ground fires from easily entering the canopy. In addition, much of the dead wood generated during Stem Exclusion has rotted away and lower densities reduce fuel loads. Without significant midstory trees, ladder fuels are mostly absent, and larger diameter trees are more resistant to the effects of fire. Susceptibility increases slightly during the Mature-II stage of development as the new cohort of trees entering the midstory now serves as potential ladder fuels, but the increasingly large diameter trees and lower canopy densities are increasingly resistant to fire. Though ladder fuels continue to increase as canopy complexity improves in older stands, the increasingly lower overstory densities, larger trees, and increased spatial variation present at this stage of development reduce fire susceptibility overall.

The recent Blue Canyon Fire in 2023 is a recent example of potential wildfire activity in the watershed, highlighting several of the factors discussed above. The fire was ignited in late-August by lightning and burned 30-40 acres in steep terrain on the southeast side of the lake. The firefighting response was rapid, involving helicopter water drops every five minutes and ground crews making short hikes to engage the fire from nearby road access points. This fire was notable for burning in an older, naturally-regenerated forest that had a high-level of species and age diversity prior to the fire. This forest is generally around 100 years old but contains a large component of much older Douglas-fir trees that are over 400 years old and have survived prior fire events. While the fire primarily operated as a surface-fire, ladder fuels did enable the fire to occasionally enter the canopy, scorching and killing some trees. Given the lower densities of this stand these crown fire events were not sustained and fire severity was low to moderate across much of the fire. While many smaller diameter trees died in this blaze, most of the medium to large-sized trees are still alive two years later and ground-cover has re-established in many areas. Though the fire burned at a lower severity, the site was not immune to erosion and some soil instability was observed on these steep slopes, likely causing sediment delivery into the lake.

Recommendations

Though fire risk can never be fully eliminated, and small, low-severity fires will likely occur again in the watershed over the coming decades, management should focus on reducing the forest’s susceptibility to high-severity wildfire. Although management recommendations by stand type are made later in this document, thinning is the primary strategy for reducing stand densities and accelerating the transition to later stages of stand development that are more resistant to high-severity wildfire. Removing smaller, suppressed trees through thinning reduces the potential for a surface fire to reach the canopy by increasing the spacing between trees, creates larger, more vigorous, and fire-resistant trees, and raises the base of tree crowns, thus reducing ladder fuels. Lastly, maintaining at least 10-20 percent of the forest composition in deciduous hardwoods will help reduce fire risk and accelerate forest recovery following fire.

After thinning highly stocked stands, a large amount of woody debris may be left on the ground. This can elevate fire susceptibility in the short term, but as debris decays, the stand will experience lower, long-term susceptibility. Fine woody debris under 4 inches diameter is the most flammable, and slash mitigation efforts should therefore focus on this category of slash, as described above in the "Thinning Considerations" section. Because smaller diameter slash decay faster than larger diameters it is often prudent to schedule a thinning entry sooner than later, all other factors being equal.

Reducing the forest's susceptibility to fire deserves special attention in areas adjacent to residential development, along public roads, and in recreation zones, as these are the most likely to experience ignition in the coming years. In particular shaded fuel-breaks are recommended within 100 feet of publicly accessible roads and buildings. Access-restricted roads, such as gated forest roads, pose a low risk for fire ignition and do not require shaded fuel breaks. Given the restrictions on motorized use, fuel breaks are also not necessary along recreational trails, but may be prudent on highly accessible Class A trails (e.g. Hertz Trail) where past human-caused fire ignitions have been known to occur.

When properly installed, these fuel breaks increase the likelihood that fire remains on the ground (instead of spreading into the canopy), and slows the fire's spread until firefighting resources arrive. A modified[6] shaded fuel break can be created by implementing the following practices:

- Thin overstory trees to 80-110 TPA.
- Cut small-diameter and/or standing dead trees to eliminate ladder fuels, and prune overstory trees to a minimum of 15 feet high or three times the height of the dominant shrub layer to reduce the potential spread of surface fires into the canopy.
- Reduce shrubs to small clumps (e.g., 6-12 feet wide). Separate the clumps by a distance equal to the width of the clump.
- Remove all slash that is less than four inches in diameter from this zone. Slash can be chipped, or burned in small piles outside of fire season as air quality conditions allow.

Best Management Practices

Managing for lower forest densities, minimizing woody fuels after thinning, and maintaining fuel breaks are all strategies for mitigating the risk of fire. Additional best management practices include:

- Maintain seasonal forest road access that is sufficient to allow emergency vehicle access (e.g., 4-wheel drive trucks).

[6] Fuel breaks which include 10 feet of spacing between live crowns are the most effective at stopping the spread of crown fires, but this requires significant reduction in canopy density. The recommended "modified" fuel break achieves the objective of slowing fire spread and preventing surface fires from easily reaching the canopy, without excessively reducing canopy density.

- Minimize logging slash left in the woods and/or accelerate the decomposition of slash by getting as much ground contact as possible with woody debris.
- Over time, manage for older, larger diameter trees with thicker bark that are more fire resistant.
- Managing potential ladder fuels by reducing understory tree and shrub density and by pruning overstory trees (up to 15 feet or three times the height of the dominant shrub layer), in particular along edges of forest and/or forest roads.

Climate Change Impacts

Climate change is altering how forests currently burn, and forests are increasingly at risk of large-scale high-severity wildfire events. Fuel loading will increase as dry summer conditions increase mortality among drought-intolerant trees and within overstocked forests. In addition, the growth of shrubs and other understory vegetation may increase due to heavier spring rains, creating more biomass that is susceptible to drying out during prolonged summer droughts. The warmer, drier conditions associated with climate change will lead to vegetation drying out quicker and is likely to increase the length of the fire season. While the frequency of extremely fast and dry eastern wind events is likely to remain the same, when these wind events occur, they are likely to encounter more fire-prone conditions, leading to the likelihood that a small surface fire blows up into a major stand-replacing high-severity wildfire.

Carbon Storage

Overview

Forests are one of the largest natural stores of terrestrial carbon. Broadly the forest carbon cycle can be characterized as carbon gained through biomass growth and carbon lost through decay or combustion and conceptually organized into three pools: living biomass, naturally decaying biomass (i.e. dead wood), and wood products. Carbon is sequestered by growing trees and stored in their living biomass, which includes any living vegetation, such as trees, shrubs, branches, foliage, and bark, as well as below ground biomass such as roots. Eventually, natural processes or management interventions cause this biomass to die at which time it either begins to decay naturally, slowly releasing its carbon to the atmosphere, or is removed from the forest and processed into durable wood products.

Natural processes, such as dead branches, seasonal litterfall, and sporadic mortality resulting in standing snags and downed logs move carbon stored in living biomass into the dead wood pool. Likewise, management activities, such as pruning or tree felling, cause living tree biomass to die, and, if extracted from the forest, some of this biomass ends up in wood products. Over time, the carbon in the dead wood pool is released back to the atmosphere through decay, typically by fungi, or chemical combustion by fire. This rate of decay is dependent on species characteristics that give wood more or less microbial protection as well as diameter, with larger pieces of dead wood taking much longer to decay than small pieces. Likewise, carbon stored in wood products also decays, with different wood products decaying at different rates depending on how long they are used before being sent to the landfill or burned.

Forest management can improve carbon storage in several ways. Actions that improve site-productivity or growth - such as maintaining optimal densities, choosing long-lived and well-suited species, and improving soil moisture or nutrient availability - increase the rate of carbon sequestration into the living biomass pool. Similarly, interventions to increase stocking, reforest unforested areas, or shift stand composition from shorter-lived species to longer-lived species ensure the growing space is fully utilized to sequester and store carbon. When harvesting does occur, managers can design carbon-optimal harvests that produce a higher proportion of large, long-lived wood products, thus increasing storage in the wood products pool. Likewise, managers can employ logging methods that reduce soil disturbance and retain partial canopy cover, thus slowing the decay rate of carbon stored as dead biomass.

Assessment

Though a full carbon accounting is beyond the scope of this management plan, broad trends in carbon storage have been assessed across the forest properties in this plan. Carbon storage is particularly high on properties where historical disturbance patterns have resulted in the establishment of highly-stocked and long-lived conifer forests. Many of these forests are overstocked with slowing rates of carbon sequestration and growing rates of mortality, which in time will reduce carbon storage unless intervention occurs. A small minority of sites have been recently disturbed by clearcut logging or are being reforested following previous residential or agricultural uses and are often understocked but growing rapidly. These young forests will continue to sequester carbon for years to come, but are currently holding very little stored carbon. Finally, sites stocked with a high proportion of short-lived hardwoods are currently storing an average amount of carbon, but will see reductions in total carbon stored as these overstory trees die off in the coming years.

Recommendations

Though carbon storage is not a primary objective of this management plan, the following best management practices will generally improve carbon storage:

- **Plant Trees.** Reforestation of understocked or unforested areas is an excellent way to increase carbon storage.
- **Manage Competition.** Manage forest density to ensure optimal growth and reduce mortality, thus ensuring more carbon is sequestered into living biomass where it remains safe from decay. Periodic commercial thinning entries improve stand productivity and capture imminent mortality, storing carbon as durable wood products.
- **Consider Species Suitability and Longevity.** Manage forest composition to include a mixture of species well suited to current and future growing conditions and sufficiently long lived to continue growing and maintaining forest cover at the site for years to come.
- **Grow Bigger Trees.** Extending final harvest timing and growing older and larger trees give forests enough time to hit their maximum growth rates, leading to more carbon stored in living biomass.

Likewise, larger trees, when harvested produce a higher proportion of durable wood products, locking away carbon for longer periods of time.

- **Grow Complex Forests.** Stands with multiple canopy layers and a mixture of species with complementary growth patterns, better utilizes the growing space, leading to greater total biomass accumulation and, over time, higher carbon storage per acre.

Climate Change Impacts

In general, forest productivity, and therefore carbon storage, is likely to decrease across the Pacific Northwest as higher temperatures increase evapotranspirative demand and reduce the effective growing season of many moisture-limited sites. Increased winter temperatures may increase background decomposition rates, especially on colder sites, potentially decreasing carbon storage potential. Species composition may change under future climate conditions, favoring species from growing zones further to the south, but long-lived and fast-growing conifers should maintain their dominance across the region and continue to store carbon at some of the highest rates in the world.

Cultural Resources

Overview

The Lake Whatcom watershed is a landscape rich with cultural significance for Indigenous peoples. Coast Salish peoples, including the Lummi, Nooksack, and Swinomish tribes have long stewarded this landscape, maintaining deep spiritual, cultural, and subsistence connections to the lands and waters of the region. Though the arrival of Euro-American settlers in the 19th century and subsequent development have transformed the region, tribes continue to steward the land and tribal cultural resources in the watershed remain an essential part of regional heritage and ongoing tribal identity.

Prior to European-American colonization, the Lake Whatcom area was home to a thriving network of villages and seasonal camps used by Coast Salish peoples for fishing, hunting, gathering, and ceremonial purposes. Archaeological evidence, oral histories, and traditional ecological knowledge indicate that the watershed supported a diverse array of plants, animals, and aquatic species that were managed and used in sustainable ways. The arrival of non-Indigenous settlers in the 19th century transformed the region and led to treaties signed in the 1850s, including the Treaty of Point Elliott, which reserved the tribes’ rights to fish, hunt, and gather in traditional areas, rights which continue to be defended today through legal and political means.

Today, the lake and surrounding areas continue to contain culturally significant sites. These places are considered part of the tribal cultural landscape with important meaning that is passed down through generations. Many of these sites remain undocumented or are protected by tribal knowledge holders to preserve their integrity in the face of modern development[7]. Safeguarding the watershed's cultural

[7] As documented in the Final Environmental Impact Statement for the 2004 Lake Whatcom Landscape Plan.

resources is essential not only to honor this history but also to ensure a more inclusive and respectful future for all who depend on its waters and lands.

Other historic resources also exist and are protected under existing regulations and laws in the Lake Whatcom Watershed, including historic mining and forestry, as well as early homesteads, logging camps, transportation corridors such as historic rail grades and wagon roads, and the remnants of company towns like the Blue Canyon Coal Mine settlement. These resources are recognized for their cultural significance and are subject to protection under local, state, and federal historic preservation laws.

Assessment

Though this management planning effort did not assess cultural resources present within the watershed, the region's history suggests sensitive cultural resources and sites exist in the watershed for both Tribal and other historic items. The Final Environmental Impact Statement for the 2004 Lake Whatcom Landscape Plan identified a wide range of sensitive cultural resources and sites exist in association with lands previously owned by the DNR.

The Forest Practices Act requires that cultural resources be protected during forest management activities. Actions identified in this management plan often trigger a regulatory nexus for Cultural Resource review, but some actions do not have a formal regulatory connection.

Recommendations

Whatcom County and the City of Bellingham are committed to working with tribes and others to ensure that historic and current cultural resources and uses of the Lake Whatcom watershed are conserved and improved. This plan recommends the following:

- For proposed forest management activities that do not trigger a regulatory nexus but that include ground disturbing activities, forest management activities should be screened for sensitivity to cultural resources, which may result in tribal review and consultation and require identification of a plan to ensure the protection of these resources.
- For proposed forest management activities that trigger a regulatory nexus, city and county staff will follow all existing state and federal rules, regulations, and agreements around the protection of historical, archaeological and cultural resources.

Recreation

Overview

The Lake Whatcom watershed is a treasured natural asset for outdoor recreation. Spanning over 14 miles in length and surrounded by forested hills and mountainous terrain, Lake Whatcom and its surrounding watershed offer a diverse array of recreational opportunities that attract residents and visitors alike.

Over the years, the balance between recreation and environmental stewardship has become a central theme in managing this sensitive and heavily used watershed.

Lake Whatcom itself provides numerous water-based recreational activities, particularly during the warmer months. Boating, kayaking, paddleboarding, and swimming are among the most popular activities. Public access is available at several points around the lake, including Bloedel Donovan Park, the Sudden Valley Marina, and on a more limited basis, at Lake Whatcom Park and South Fork Park. Anglers frequent the lake for its populations of kokanee salmon, cutthroat throat, and other species.

On land, the Lake Whatcom watershed supports a network of trails and parklands that appeal to hikers, mountain bikers, trail runners, and nature enthusiasts. The Lake Whatcom Park and Lookout Mountain Forest Preserve areas, managed by Whatcom County Parks, feature well-maintained trails that meander through old forests, wetlands, and along scenic ridgelines. Many of these trails make use of old road and railroad grades previously used for logging and mining activities and are maintained to high standards to prevent erosion.

In recent years, mountain biking has become a common recreational activity within the watershed. The North Beaver Preserve, owned by the City, includes a trail network that allows residents to access the bike trail system at Galbraith Mountain. The Lookout Mountain Forest Preserve, a portion of which is under joint ownership, contains both hiking and designated downhill bike trails and provides eastern access to Galbraith Mountain. These forestlands are managed for both recreation and conservation, with trail development carried out in coordination with local organizations such as the Whatcom Mountain Bike Coalition and the Washington Trails Association. Sanctioned trails are designed to account for environmental impact, using established practices to reduce erosion and protect sensitive habitats and water quality.

Assessment

Recreational activities within the forested landscape of the Lake Whatcom watershed offer valuable community benefits, but also present several environmental challenges that require careful management to protect water quality and ecological health. Lake Whatcom is the drinking water source for over 120,000 people, and activities that disturb soil, increase runoff, or introduce invasive species can compromise this critical resource.

Recreational trail building and use within the watershed have the potential to cause soil erosion and sedimentation, particularly on steep slopes or as a result of poorly designed trail systems. When vegetation is disturbed or compacted by repeated foot or bike traffic, exposed soil can wash into nearby streams and ultimately the lake, carrying sediment and phosphorus that degrade water quality. While many trails are formally maintained by groups such as the Whatcom Mountain Bike Coalition in coordination with land managers, unofficial trails can bypass environmental review and create unintended impacts to sensitive ecosystems, wetlands, and riparian zones. Unauthorized trail building has been a major occurrence in the Lookout Mountain Forest Preserve area and to a lesser degree at Lake Whatcom Park, Lake Geneva Preserve, and South Lake Whatcom Preserve. The extent of unauthorized trail building cannot be overstated, particularly at Lookout Mountain, where trail building seemingly facilitates the descent of mountain bikes down almost every major ridgeline in the forest.

The risk of human-caused wildfires also increases as recreational uses expand throughout the watershed, particularly during the dry summer months when vegetation is more flammable. Although recreation on publicly owned lands within the watershed are limited to nonmotorized activities only, unauthorized campfires, discarded cigarettes, or use of fireworks can ignite fires in forested areas that are often difficult to access for firefighting. With more people on trails and in remote parts of the watershed, the likelihood of accidental ignition rises, posing a serious threat to public safety, forest health, water quality, and critical infrastructure.

Recreation management in the watershed is increasingly a collaborative effort involving the City of Bellingham departments, Whatcom County departments, state agencies, and local nonprofit organizations. Policies such as dog waste bag stations, signage, waste disposal facilities, and restrictions on new development in sensitive areas help minimize human impact. Public outreach and stewardship programs encourage responsible recreation and volunteerism to maintain trails and restore habitats.

As previously referenced, the basis for reconveyance of Lookout Mountain Forest Preserve and Lake Whatcom Park was their need for public park purposes, and as such, maintaining appropriate recreation with these properties is a high priority for Whatcom County. To this end, in 2016 the County developed a recreational trail plan for Lookout Mountain and Lake Whatcom Park which identifies strategies for managing and developing recreational amenities on those properties. Conversely, the City of Bellingham has acquired the properties in this plan for preservation purposes, and recreation is not the primary goal. The City allows limited recreation consistent with the Lake Whatcom Property Acquisition Program land management policy.

Recommendations

Making recommendations about the management of recreational access or the development of recreational amenities is outside the scope of this plan. Current recreational development planning on County properties is addressed in the 2016 Lookout Mountain Forest Preserve & Lake Whatcom Park Recreational Trail Plan. For City properties, recreational planning is addressed on a case-by-case basis consistent with the Lake Whatcom Property Acquisition Program land management policy. As identified in these planning documents, when recreational trails are developed, they should employ best management practices to reduce erosion and sediment delivery to the watershed.

Active forest management involves practices such as thinning, invasive species control, and habitat restoration. These actions are designed to improve forest resilience, reduce wildfire risks, protect water quality and biodiversity, but can also improve aesthetics and recreational opportunities as well. Many forest management activities can be safely integrated with recreation, but some may require temporary access closures to ensure public safety. Communication and collaborative planning among land managers, recreation groups, and community stakeholders helps ensure successful outcomes for the forest and those who recreate within it. Some strategies include:

- Educational signage and outreach efforts can help users understand the benefits of forest management and why short-term inconveniences may be necessary for long-term forest health;
- Scheduling management activities to account for recreational use patterns;
- Aligning forest treatments to improve recreational experiences by opening or preserving scenic views;
- Capitalizing on the heavy equipment used during some forest treatments to commission new trails or access points, while restoring or decommissioning unauthorized trail access.
- Limiting recreational activities in sensitive areas. For instance, temporary or permanent trails closures, and other measures may be necessary to prevent impacts to forest resources

Certain forest management activities will result in higher impacts to recreational infrastructure than others. Forest thinning that involves tree cutting and removal typically requires large equipment that may disrupt trails and render a site less suitable for near term recreational use. After thinning, recreational amenities should be assessed for impacts and slash and debris chipped or piled away from public areas to reduce fire risk and improve aesthetics. Any disturbed soils should be stabilized to prevent erosion. Trails impacted by logging can be restored, potentially needing regrading of surfaces and drainage repair. This is also an opportunity to choose which trails should remain on the landscape. Unauthorized trails can be abandoned under logging debris and/or actively decommissioned. Finally, before public access is allowed, the site should be accessed for hazardous trees left by the thinning operation to ensure public safety.

SECTION 3: FOREST TYPES & MANAGEMENT RECOMMENDATIONS

Forest Types

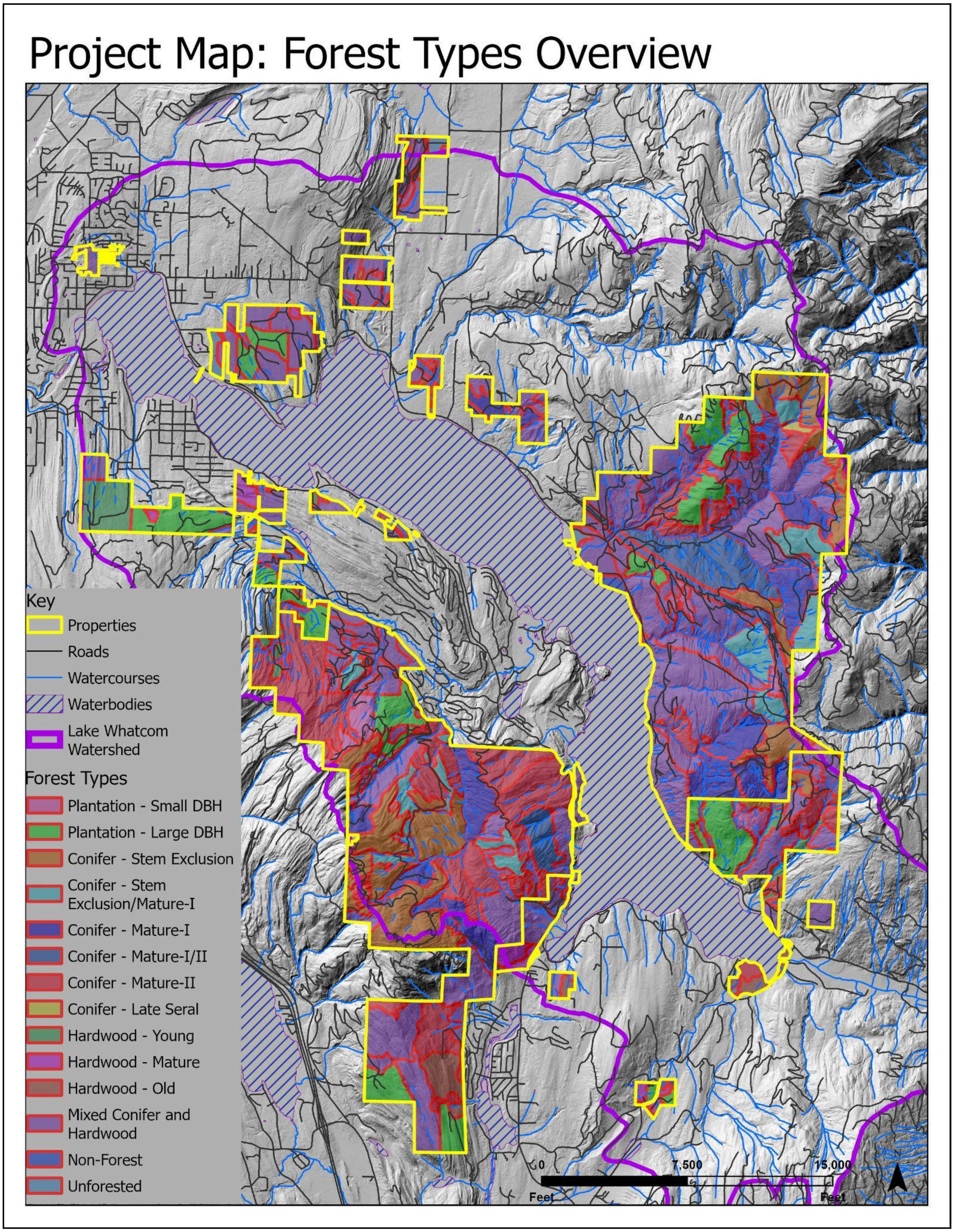
During the forest management planning process forest cover in the Lake Whatcom watershed was delineated into several broad forest types. Individual forest types are determined based on similarities in species composition, age, or other characteristics that forest stands share in common. When a forest type is compared to the objectives of the County and City, they are useful for determining where and when active management may be necessary to meet those objectives. Operationally, forest types are further delineated into *forest management units* for which specific management recommendations are then made. The forest types identified in the Lake Whatcom watershed are defined below, along with general management recommendations for each forest type. Management recommendations that are unique to individual forest management units are addressed in property-specific sections later in this plan.

Forest Types Summary Table

Forest Type	Acres	Proportion
Conifer Plantation - Small DBH	242	2%
Conifer Plantation - Large DBH	1,013	8%
Mixed Conifer - Stem Exclusion	1,402	11%
Mixed Conifer - Stem Exclusion/Mature-I	446	4%
Mixed Conifer - Mature-I	1,091	9%
Mixed Conifer - Mature-I/Mature-II	438	4%
Mixed Conifer - Mature-II	1,745	14%
Mixed Conifer - Late Seral	17	0%
Mixed Conifer and Hardwood	4,475	37%
Mixed Hardwood - Young	235	2%
Mixed Hardwood - Mature	95	1%
Mixed Hardwood - Old	168	1%
Unforested	44	0%
Non-Forest (Powerline, Water)	228	2%
Pending	565	5%
Total	**12,205**	**100%**

Acknowledging that resources are limited, this plan proposes prioritizing management activities into four categories from high priority (level 1) to low priority (level 4) based on biological development and management priorities.

Forest Types Overview Map



Mixed Conifer

Overview

Stands dominated by multiple conifer species are the most common forest type in the Lake Whatcom watershed. These stands naturally regenerated following logging over the last 125 years, although several stands appear to have originated following wildfires within the last 200 years or more. The defining characteristic of these stands is an overstory dominated by a variety of conifer tree species, chiefly Douglas-fir, western hemlock and western redcedar. Other conifer species that occur less abundantly include silver fir, white pine, Sitka spruce, and grand fir. This forest type does not include conifer plantations which are addressed separately.

Assessment

The natural lifespan of the conifer species that occupy the Lake Whatcom watershed can be quite long, with all species capable of reaching 300 years old or more. Although drought tolerance varies significantly by species, conifer needles are an adaptation to growing in drier climates, and Douglas-fir in particular, is well suited to the droughty soils that occur across much of the watershed. Because many of the forests in the watershed regenerated naturally and have been growing for decades with little to no active management, they generally occur at high densities and exhibit many signs of competition including reduced live crown ratios, high height to diameter ratios, significant mortality across suppressed and intermediate trees, limited understory plant diversity, and limited regeneration of new cohorts of understory trees.

Mixed conifer stands are further delineated into the following developmental stages:

Stem Exclusion

Stands in the Stem Exclusion phase are growing at high densities that result in a high degree of competition between the individual trees. These stands tend to be structurally simple in that they are dominated by a single species (e.g. Douglas-fir) and age of trees, exhibit limited diameter ranges, and have almost no understory or regeneration of new seedlings. These stands are dominated by a single canopy stratum, and any trees occurring in the midstory are either extremely shade tolerant (e.g. western hemlock) or are suppressed trees of the same age cohort as the canopy trees.

Without understory vegetation or large diameter snags and downed wood, these stands provide considerably less habitat opportunities than more structurally complex stands. When these stands are in a young phase of growth they use more water than older stands, thereby reducing downstream water availability. As the trees compete, lower branches die off, leaving behind a ladder of small fuels which, coupled with high initial stocking densities, and lower canopies can increase susceptibility to wildfire. These homogenous stands are also more susceptible to disease outbreak, and are generally less resilient to disturbance than more complex, multi-species and multi-aged stands.

Mature-I

As stands self-thin they gradually leave the Stem Exclusion phase and enter the first stage of maturity, which is often characterized by an initiation of tree regeneration in the understory. Though overall stand density begins to decrease, density still remains sufficiently high to continue to drive competition-induced mortality. Stand structure remains very simple, the overstory canopy remains homogenous, and species diversity is low as the dense canopy only allows for the regeneration of the most shade tolerant understory species. Although the stand begins to recruit an increasing volume of small diameter snags and downed logs, it remains lacking in large diameter dead wood that provides critical habitat for many wildlife species. Although lower densities reduce drought stress, the homogenous stand may remain susceptible to disease and insect outbreaks, as well as high wind events.

This stand type has a relatively low susceptibility to fire as compared to other stand types given the lack of ladder fuels (e.g. dead lower branches, understory trees and shrubs, etc.), and dominance by thick-barked Douglas-fir.

Mature-II

The Mature-II stage of development is characterized by increasing structural complexity as continued density-dependent competition further thins the stand, thereby opening the canopy and supporting the presence of shade-tolerant trees in the midstory. Understory plants and shrubs are present, and canopy gaps are beginning to emerge and be filled by new trees, thereby increasing species diversity. As varying natural mortality agents, such as disease, kill older trees, larger diameter snags and downed logs are recruited into the stand and wildlife habitat is broadly improved, with multiple habitat niches emerging. Compared to Mature-I, midstory trees in Mature-II stands can serve as ladder fuels, thereby increasing the potential for fire to reach the canopy of the forest. However, larger diameter and thicker barked trees are also less susceptible to lower intensity fires.

Older Stands

Older stands are characterized by increasing levels of vertical and horizontal heterogeneity as localized disturbance agents continue creating gaps and new shade-tolerant trees grow into upper canopy positions. The original pioneer cohort has now grown very large and tall, creating extensive nesting platforms, and in death, large diameter standing snags and downed wood habitat. The multi-aged and multi-species stand is very resilient to pest and disease outbreaks as well as changing climate conditions. Though ladder fuels are prevalent, lower densities and large diameters reduce the forest’s susceptibility to high severity wildfire.

Management Recommendations

The target density for dominant trees within mixed conifer stands is 80-110 TPA. At this density natural tree regeneration should occur throughout the understory contributing new cohorts and species of trees to the stand. Natural mortality agents will continue to reduce and adjust canopy density and species composition, with understory cohorts gradually replacing canopy trees.

Ecologically-based thinning is recommended for mixed conifer stands that exceed this density. The purpose of thinning is to reduce competition in the overstory, create the opportunity for natural understory tree regeneration, accelerate the development of stand complexity, and increase resilience to drought and wildfire. Building off the thinning considerations previously discussed, a sequence of thinning entries and associated density targets are defined below.

Stem Exclusion

Mixed conifer stands that exceed 200 TPA tend to be in the Stem Exclusion phase of development. Because this growth phase meets few management objectives and can last for decades to centuries, thinning is an effective tool for accelerating stand development towards later-seral conditions. A sequence of variable density thinning entries are recommended aimed at reducing competition and increasing species diversity and structural complexity. Thinning entries should be spaced at least 10 years apart in order to minimize soil compaction and to allow the stand to redevelop wind firmness.

Stands Exceeding 340 TPA

Mixed conifer stands with extremely high densities that exceed 340 TPA should be thinned from below with no more than 50 percent of the individual trees cut. Thinning should focus on suppressed, intermediate, and codominant trees. Given the very high stocking density, this is a high priority (level 1) management recommendation.

Stands Between 200-340 TPA

Mixed conifer stands with 200-340 TPA should be thinned to 140-170 TPA. If this is the first thinning of a stand, thinning should be from below, prioritizing the removal of suppressed, intermediate, and codominant trees. If this is the second thinning of the stand, thinning can occur across diameters and species. Dominant trees should only be removed where they will release vigorously growing understory trees. Given the high stocking density, this is a moderately-high priority (level 2) management recommendation.

Stands Less Than 200 TPA

Mixed conifer stands with less than 200 TPA in the overstory should be assessed for the following conditions to determine the need for thinning:

1. Are there a minimum of 50 TPA naturally regenerating seedlings or saplings throughout the understory of a species that is suitable for the site?
2. Does the overstory contain at least 2-3 species of conifers and/or hardwoods?

If either condition is not met, the stand should be thinned to 80-110 TPA. Thinning can occur across both diameters and species of trees to enhance uneven-aged structural complexity and biological diversity. No more than 30 - 40 percent of dominant overstory trees should be removed in order to protect the wind firmness of the stand. From this residual density the stand can be allowed to develop under normal succession pathways. Natural disturbance agents (e.g. disease, pests, storms) will continue to induce mortality amongst overstory trees, thereby further reducing canopy density, supporting regeneration of new cohorts in the understory, and adding to dead wood structures in the stand. Given the moderate stocking density, this is a moderate priority (level 3) management recommendation.

Mature-I

Though this phase of development meets more management objectives, these early maturation stands may still benefit from thinning in order to further reduce density, shift species composition and accelerate the transition towards later-seral conditions. Because this stand type has already begun to exhibit an understory, the priority of action is lower across all recommendations.

<u>Stands Exceeding 200 TPA</u>

Mature-I mixed conifer stands that exceed 200 TPA should be thinned to 140-170 TPA. If this is the first thinning of a stand, thinning should be from below, prioritizing the removal of suppressed, intermediate, and codominant trees. If this is the second thinning of the stand, thinning can occur across diameters and species. Dominant trees should only be removed where they will release vigorously growing understory trees. Given the moderately-high stocking density and initial understory regeneration, this is a moderate priority (level 3) management recommendation.

<u>Stands Less Than 200 TPA</u>

Mixed conifer stands with less than 200 TPA in the overstory should be assessed for the following conditions to determine the need for thinning:

1. Are there a minimum of 50 TPA naturally regenerating seedlings or saplings throughout the understory of a species that is suitable for the site?
2. Does the overstory contain at least 2-3 species of conifers and/or hardwoods?

If either condition is not met, the stand should be thinned to 80-110 TPA. Thinning can occur across both diameters and species of trees to enhance uneven-aged structural complexity and biological diversity. No more than 30 - 40 percent of dominant overstory trees should be removed in order to protect the wind firmness of the stand. From this residual density the stand can be allowed to develop under normal succession pathways. Natural disturbance agents (e.g. disease, pests, storms) will continue to induce mortality amongst overstory trees, thereby further reducing canopy density, supporting regeneration of new cohorts in the understory, and adding to dead wood structures in the stand. Given the moderate stocking density and initial understory regeneration, this is a low priority (level 4) management recommendation.

Mature-II

This phase of development meets a wide range of management objectives and in most cases requires little to no management intervention. In some cases, snag creation or opportunistic light thinning in stands adjacent to other thinning projects can be used to fine-tune stand composition, but these are low priority interventions and any recommendations will be custom-tailored to the stand conditions.

Older Stands

This phase of development meets most management objectives and no management is recommended in these stands.

Mixed Hardwoods

Overview

Hardwood-dominant stands occur across the Lake Whatcom basin. These stands naturally regenerated following clearcut harvests of the previous forest. Many of these stands are quite young, having originated after recent disturbances, while other or older stands, established after initial logging or land clearing 75-125 years ago. The defining characteristic of these stands is an overstory dominated by hardwood species, such as red alder, bigleaf maple, black cottonwood, bitter cherry and paper birch. Conifer trees are notably absent in these stands, often as a result of rapid, post-disturbance site colonization by hardwoods, but also because many of these stands occur in riparian and wetland floodplains where high water tables favor water-tolerant species such as cottonwood and red alder. Because of the deciduous canopy, more light is able to reach the forest floor, and strong shrub understories are common, even in highly stocked stands.

With the exception of bigleaf maple, which is moderately long-lived and can reach 200-300 years of age, the other hardwood species have relatively short natural lifespans. Bitter cherry has the shortest lifespan, frequently dying off around 30-40 years of age. Red alder and paper birch are considered quite old at 80 years of age and rarely live beyond 100 years old. Cottonwood lives a little longer, but typically dies by the time it reaches 150 years. As a result, many older hardwood-dominant forests are well on their way to reaching later stages of stand development, including pioneer cohort loss, where the early pioneer species die off and are replaced by new cohorts of trees.

Assessment

In general, hardwood trees have lower fire risk as they contain more water in their foliage, have a lower content of flammable resins than conifers, and their lower density canopies rarely support crown fires. Drought tolerance varies by species, but given the large foliage of broadleaf trees, is lower than most conifers. Importantly, most hardwood species have some capacity to establish sprouts from their stumps in the event of a catastrophic windstorm or wildfire, thus providing additional resiliency. Most notably, the aforementioned shrub layer common to these stands can preclude establishment of new tree species, which, coupled with their relatively short lifespans, means these forests can become dominated by persistent shrubs for many decades to come. Otherwise, this strong shrub layer provides excellent wildlife forage for many species as well as cultural uses, such as berry picking.

Management Recommendations

The major concern for mixed hardwood stands in the Lake Whatcom watershed is ensuring that a smooth transition is made between relatively short-lived hardwood trees and longer-lived conifers, thus ensuring that the stand remains forested into the future. As a result, a common management recommendation is to underplant these forests with shade-tolerant conifers. Any time planting occurs in established shrub layers, care is needed to prepare planting spots and maintain the plantation until the trees reach a free to grow height above the existing shrub canopy. See the section on Planting Considerations for additional information on successful planting.

In some circumstances, overstory densities should also be reduced to decrease competition and improve the growing conditions for understory trees. Given the relatively shorter lifespans of these forests as well as their multiple benefits, including critical wildlife habitat and increased fire resistance, actively managing to accelerate stand development stages, as is recommended for mixed conifer stands, is not recommended and instead these stands should be allowed to naturally develop.

Mixed hardwood stands and their management recommendations are delineated into the following categories:

Riparian Sites

If a site is very wet, commonly with a perched winter water table, it may simply be too wet for many conifer species to establish. In these cases, the stand is likely to remain a hardwood-dominated forest, and management interventions should focus on monitoring and invasive species management as needed to ensure a healthy forest.

Maple Stands

Mixed hardwood stands with more than 50 percent bigleaf maple by overall species may require some additional consideration. Since maples are moderately long-lived, they provide a much longer window under which a new cohort of trees can establish, and they ensure that the stand retains some hardwood component for years to come. Given these considerations, maples are a preferred species to retain during thinning entries in mixed hardwood stands. They are also difficult to successfully thin once over 5-10 inches DBH, as they sprout prodigiously from cut stumps and almost always produce new coppiced stems that quickly fill the growing space after thinning.

As a result, if a young stand contains more maple than desired, thinning is recommended before maples get too large to easily manage with a moderately-high (level 2) priority. Once maple exceeds ten inches in diameter, thinning efforts should be focused on other short-lived hardwoods within the stand and preferentially retaining maple in most cases. In completely maple-dominated forests, monitoring stand development is recommended, and underplanting with shade-tolerant conifers may occur once density has been sufficiently reduced through natural mortality of the overstory trees.

Young Stands

Young hardwood stands, typically in the Stem Exclusion phase or younger, are often growing at high natural densities that preclude the establishment of a new cohort of trees. There are two management options to consider in this scenario:

1. **Pre-commercial thinning and underplanting with shade-tolerant conifers** is a good choice for hardwood stands that exceed 340 TPA and average less than 10 inches DBH where ensuring the future establishment of conifer trees is a priority. In addition, pre-commercial thinning when trees are small can be cheaper than non-commercial thinning at a later date.
2. **Allowing stand development to progress naturally and monitoring natural tree regeneration** is a good choice when resources are limited or the stand is growing at moderate densities. In many cases, simply waiting will allow natural processes sufficient time to reduce stand density and establish conifers on the site.

Pre-Commercial Thinning & Underplanting

Pre-commercial thinning of early seral hardwoods should target residual densities of 150-200 TPA in order to reduce the growing space sufficiently for successful underplanting efforts. Thinning should be from below, removing small, suppressed and damaged trees in order to release and retain the most vigorous, dominant, and highest-quality trees of each species that are suitable for the site. All mixed hardwood species can be targeted for removal, but retain all conifers and target at least 10-20 percent of the retained species composition in bigleaf maple if present. Thinning before the stand grows into a larger diameter class is a moderately-high priority (level 2) management recommendation.

Following thinning, underplant the site with a mixture of suitable conifer species. Prepare planting spots in the shrub layer and plant 150 TPA under the existing canopy and up to 250 TPA into more open canopy gaps. After planting, manage competing vegetation until the trees are taller than the shrub layer.

Mature Stands

If a forest is older, such as the early stages of maturation, and still doesn't have new tree establishment, then management may be necessary to open the canopy, remove the persistent shrub layer, and establish conifer trees through manual planting. Since there is a long window to execute this recommendation, it is a low priority (level 4) management recommendation.

Thinning & Underplanting

If mature hardwood stands exceed 200 TPA then should be thinned to a residual density of 150-200 TPA. Thinning can either be done uniformly from below or utilize variable density thinning to create a spatially-variable patchwork of densities, including heavily thinned areas that are more suitable for the establishment of less shade tolerant species. All mixed hardwood species can be targeted for removal, but as previously mentioned, thinning of bigleaf maple over 10 inches can prove to be ineffective in the long run without subsequent herbicide treatment of cut stumps. Retain all conifers and target at least 20 percent of the retained species composition in bigleaf maple if present.

Following thinning, underplant the site with a mixture of suitable conifer species. Prepare planting spots in the shrub layer and plant around 150 TPA under the existing canopy and up to 250 TPA into more open canopy gaps. After planting, manage competing vegetation until the trees are taller than the shrub layer.

Older Stands

Older hardwood stands tend to diminish in density as the pioneer cohort dies off, and no thinning is therefore typically needed.

Underplanting

Underplant these stands with a mixture of suitable conifer species. Prepare planting spots in the shrub layer and plant 150 TPA under the existing canopy and up to 250 TPA in more open canopy gaps which can support less shade-tolerant species. After planting, manage competing vegetation until the trees are taller than the shrub layer. Underplanting before forest cover is lost is a high priority (level 1) management recommendation.

Mixed Conifer and Hardwood

Overview

Stands with overstories composed of both conifers and hardwoods are also present across the Lake Whatcom watershed. Depending on their species mix, they may share characteristics of either hardwood-dominated or conifer-dominated stands as previously described.

Assessment

Broadly, these stands are some of the most resilient forests on the landscape. The hardwood component of these stands reduces fire risk and allows for healthy understory vegetation, providing wildlife habitat. The conifer component increases the stand's longevity and, depending on the species, also its drought tolerance, while typically preventing the establishment of extensive shrub layers that can be common in hardwood-only forests. Because of the increased species diversity, these stands have a high resiliency to disturbances and are at a greatly reduced risk of insect or disease outbreaks. Given their species diversity, these stands have the potential to exhibit high structural complexity, though in younger stages of development, this complexity may not have developed yet.

Management Recommendations

Depending on the ratio of hardwoods to conifers, these stands may be managed on a conifer trajectory (if the stand is >75% conifer) or on a hardwood trajectory (if the stand is >75% hardwood). Management recommendations for these stands are site and stand specific, and typically focus on addressing forest health concerns, such as overstocking, invasive species, and species suitability. Some species, while growing on a site at the moment, may be deemed poorly suited to future growing conditions and action - such as selective cutting and underplanting of more tolerant species - can be taken to mitigate this risk. Management may also be useful, but not necessary in order to introduce more complexity into a young stand - such as thinning from above to remove overstory trees and recruit midstory trees into the upper canopy.

In the Lake Whatcom watershed, active management within these stands is not recommended except for occasional forest health concerns. Property-specific recommendations will be made as appropriate.

Conifer Plantations

Overview

Conifer plantations are the most common form of silviculture in the Pacific Northwest and excel at producing the most timber value per acre in the shortest time. The conventional management of these plantations generally starts with site preparation to remove competing vegetation, followed by planting at initially high stocking densities of 350-400 TPA. Douglas-fir is by far the most common species planted, though occasionally hemlock, noble fir, or cedar are also planted given site conditions or management objectives. Natural infilling by hemlock and hardwoods, such as red alder and cottonwood, is common and, without management, stocking can rise above target densities. After planting, the stand is commonly pre-commercially thinned at a young age to reduce density below 300 TPA (or lower depending on future thinning plans). After that, the forest is typically left to grow unimpeded before a final harvest between 35-50 years of age.

Assessment

Given that these stands were designed for the single objective of timber production, they fall short of the multiple benefits that diverse forests can provide. Since plantations never leave the Stem Exclusion stage of development, they lack major components of stand complexity, such as multiple canopy layers, multiple species, or a mixture of age and size classes. Without understory vegetation or large-diameter snags and downed wood, these stands provide habitat to only a limited number of species. In addition, these fast-growing young stands also use more water per acre and can reduce water availability in their local watershed compared to older, more complex stands. As the trees compete, lower branches die off, leaving behind a ladder of fine fuels which, coupled with high initial stocking densities, make these stands more likely to burn at high severity than other more structurally complex forests. Finally, because plantations consist of single species growing at around the same diameter in a single canopy layer, these stands are more susceptible to disease outbreaks. Additionally, though Douglas-fir is quite drought-tolerant, the high stocking levels commonly present in these stands can lead to drought stress on water-poor sites and may be more of a concern in warmer and drier future climates.

Management Recommendations

Almost all plantations are good candidates for periodic thinning designed to reduce density, accelerate the development of stand complexity, increase resilience to drought, and improve fire resistance. Building off the thinning considerations previously discussed, a sequence of thinning entries and associated density targets are identified below. Given high-levels of homogeneity and the likelihood that multiple entries are needed to restore forest function, thinning plantations is one of the highest priority management recommendations made in this plan.

Small Diameter

Stands Exceeding 340 TPA

Plantations with trees less than 10 inches DBH that exceed 340 TPA should be pre-commercially thinned to 250-300 TPA after canopy closure. The lower target density is preferable in most cases as it provides more growing space and buys time before the next thinning entry is required. The retained trees will grow rapidly and, depending on site-class, the now larger-diameter stand will require additional thinning in 10-20 years. Given the high stocking density and plantation structure, this is a high priority (level 1) management recommendation.

Large Diameter

Stands Exceeding 340 TPA

Plantations with trees larger than 10 inches DBH that exceed 340 TPA should be commercially or noncommercially thinned to 140-170 TPA. The lower target density is preferable in most cases as it provides more growing space and buys time before the next thinning entry is required. The retained trees will grow rapidly and, depending on site-class, the now larger-diameter stand will require additional thinning in 10-20 years. Given the high stocking density and plantation structure, this is a high priority (level 1) management recommendation.

Stands Between 200-340 TPA

Plantations with 200-340 TPA should be thinned to a residual density of 140-170 TPA. Wait at least 10 years after thinning for stand conditions to stabilize before thinning again. Given the moderately-high stocking density and plantation structure, this remains a high priority (level 1) management recommendation.

Stands Less Than 200 TPA

Plantations with less than 200 TPA should be thinned to a final residual density of 80-110 TPA. This "final target" is an excellent density to achieve the management objectives articulated in this plan. Regeneration is almost certain to occur and new seedlings and midstory trees will grow quickly at these reduced density levels, quickly increasing stand complexity and resiliency. Given the moderate stocking density and plantation structure, this is a moderately-high priority (level 2) management recommendation.

Unforested

Overview

After a disturbance, forests can fail to naturally regenerate and establish on the newly disturbed site for several reasons. In the Lake Whatcom watershed, these unforested areas are common on old residential homesites recently purchased by the City of Bellingham, where previously cleared land has been abandoned. It is also a common condition in logged areas where legally required reforestation was not undertaken or where a plantation was started, but ultimately failed to establish. Today these areas are typically dominated by grass and shrub layers and frequently colonized by invasive species that make the regeneration of a future forest difficult.

Assessment

Given the broad objective to maintain forest cover, these unforested stands are not meeting management objectives.

Management Recommendations

In these situations, reforestation is recommended using the previously discussed sequence of site-preparation, manual planting, and post-planting vegetation management. Since these are open areas, planting should target densities between 250-300 TPA, including a mixture of species well-suited to the site. See the earlier discussion on Planting Considerations for additional details.

Management Summary by Forest Type

Acknowledging that resources are limited, this plan proposes prioritizing management activities into four categories from high priority (level 1) to low priority (level 4) based on biological development and management priorities. A summary of management recommendations by stand type is given below.

Management Summary Table

Mixed Conifers			
Stand Type	**Characteristics**	**Recommendations**	**Priority**
Stem Exclusion	High-density, simple structure, limited understory, high wildfire and disease risk.	If >340 TPA thin by removing up to 50% of trees.	1
		If 200-340 TPA, thin to 140-170 TPA	2
		If <200 TPA, thin to 80-110 TPA*	3
Mature-I	Densities decreasing, some regeneration, simple structure, few large snags.	If 200-340 TPA thin to 140-170 TPA	3
		If <200 TPA, thin to 80-110 TPA*	4
Mature-II	Increased structural complexity, presence of midstory, gaps forming, more habitat.	Minimal management; allow natural progression; consider low-impact thinning if necessary.	4
Older Stands	Multi-aged, resilient, large dead wood, complex habitat.	No active management recommended.	NA
*Thinning to 80-110 TPA is not necessary if both of the following conditions are present: 1) minimum of 50 TPA naturally regenerating seedlings / saplings suitable to the site and 2) the overstory contains at least 2-3 species of conifers and/or hardwoods.			
Mixed Hardwoods			
Stand Type	**Characteristics**	**Recommendations**	**Priority**
Hardwoods & Conifer Regen	>50 TPA conifer regen in understory.	No Management	NA
Older Stands	Vigor and density are declining due to age. No conifer regen.	Underplant with shade tolerant conifers	1
Young Stands	<10” DBH and >340 TPA. No conifer regen.	PCT to 150-200 TPA. Underplant with shade tolerant conifers.	2
Maple	>50% stocking in maple.	Thin if maple is <10” DBH. Underplant with shade	2

Dominant	No conifer regen.	tolerant conifers.	
Mature Stands	Mixed mature hardwoods. No conifer regen.	If >200 TPA thin to 150-200 TPA. Underplant with shade tolerant conifers.	3
Riparian	Adjacent to streams and wetlands. No conifer regen.	No management. Monitor for invasive plant species. Consider underplanting with shade tolerant conifers.	4
Mixed Conifers and Hardwoods			
Stand Type	**Characteristics**	**Recommendations**	**Priority**
Mixed Conifer and Hardwood	Mixed species stands of varying densities and composition.	In more than 75% conifer, follow mixed conifer management recommendations. If more than 75% hardwood, follow mixed hardwood management recommendations. Otherwise, active management is not recommended except for forest health concerns.	NA
Conifer Plantations			
Stand Type	**Characteristics**	**Recommendations**	**Priority**
Smaller Diameter, High Stocking	Trees <10” DBH & >340 TPA	PCT to 250-300 TPA.	1
Larger Diameter, High Stocking	Trees >10” DBH & >340 TPA	CT or NCT to 140-170 TPA.	1
Larger Diameter, Moderately High Stocking	Trees >10” DBH & 200-340 TPA	Thin to 140-170 TPA.	1
Larger Diameter, Moderate Stocking	Trees >10” DBH & <200 TPA	Thin to 80-110 TPA.	2
Unforested			
Stand Type	**Characteristics**	**Recommendations**	**Priority**
Unforested	Unforested	Plant with mixed hardwoods and conifers at 250-300 TPA.	1

SECTION 4. PROPERTY DESCRIPTIONS & MANAGEMENT RECOMMENDATIONS

County Owned Properties

Detailed assessment and recommendations for County-owned properties can be found in the accompanying PDF and will be copied here in the final draft.

City Owned Properties

Detailed assessment and recommendations for County-owned properties can be found in the accompanying PDF and will be copied here in the final draft.

SECTION 5. APPENDICES

Appendix I. Economic Analysis of Management Recommendations

Forest management activities in the Lake Whatcom watershed to address management objectives including water quality and ecological health should be economically viable. Ecologically-based forest management aims to maintain water quality, protect ecosystems, and support sustainable human uses of the watershed, and revenue generation is subordinate to these primary goals. In order to achieve the goals and objectives of this forest management plan, a broad range of forest management activities have been proposed, including commercial ground-based and cable logging, non-commercial thinning, precommercial thinning, tree planting, fuels reduction, and forest road construction and maintenance, each with specific costs and economic implications.

Determining the costs of the specific management activities proposed in this plan, or the revenue that can be generated from commercial logging operations, is beyond the scope of this plan and are best determined during the planning stage of an actual forest management activity. Factors such as road construction costs, hauling or travel distances, fluctuating regional timber markets, available labor, and the design of either commercial or noncommercial forest management activities all influence both the cost of the activity and the potential revenue that can be generated. Therefore, the following analysis provides estimated costs, as well as current log values, as of 2025.

Commercial Logging: Ground-Based and Cable Systems

Commercial logging is proposed for areas of the forest that are readily accessible by road and where there will be minimal impacts to surface water and unstable slopes. As implied by the term, commercial logging produces merchantable timber that is sold to local mills, thereby offsetting the cost of removing the trees from the forest. Ground-based logging, typically used on gentle slopes of less than 40 percent gradient, can cost between $250 to $500 per thousand board feet (MBF) depending on the size and value of the timber and the harvest method used for removing the timber. Cable logging, suited for steeper terrains, is more expensive, averaging $450 to $650 per MBF due to specialized equipment and lower productivity. The timber revenue from these operations varies with market conditions; based on regional timber prices average around $400 to $800 per MBF. Cable logging's higher costs are offset by its ecological benefits, including reduced soil disturbance and sedimentation—crucial for maintaining water quality. Properly managed, commercial harvests can sustainably support local economies while providing forest products and generating jobs.

Non-commercial Thinning

Non-commercial thinning involves cutting merchantable size trees and leaving them to lay on the ground. This practice is rare, but can be an option for forest stands that are either inaccessible or occur in sensitive areas such as steep or unstable slopes. Costs for non-commercial thinning are highly variable and depend on access to the site, terrain, the density of the stand and size and quantity of trees to be cut, and the thinning prescription. Costs can be as low as $250/acre for young stands consisting of small diameter trees or in excess of $3,500/acre for stands of mature trees.

Precommercial Thinning

Precommercial thinning (PCT) involves removing young, competing trees to promote healthier growth of residual trees. The costs range from $250 to $450 per acre depending on the size and density of the trees and the steepness of the terrain. Although PCT does not generate immediate revenue, it enhances future timber yields by promoting faster growth and higher quality wood, potentially increasing long-term revenues by 20–30 percent. Additionally, PCT reduces fire risk and improves habitat quality, adding ecological value that aligns with watershed protection goals.

Tree Planting

Reforestation costs approximately $1,200 to $1,500 per acre, including tree seedlings, site preparation and planting labor (~$400 per acre), and materials (e.g. tree protectors). Following tree planting, seedlings must be maintained for a period typically of at least three years to ensure they achieve a free-to-grow height above competing vegetation. Annual seedling maintenance costs average $250/acre.

Fuels Reduction Practices

Fuels management involves a range of practices that can include thinning, pruning, and slash abatement. As such, costs will vary depending on the range of activities, the composition of the forest being treated, access and terrain. Costs for these treatments can be as low as $750/acre (pruning only) to more than $3,000/ acre (thinning, pruning, and slash abatement), depending on complexity and scope. Although not commercially productive in the short term, fuels reduction prevents wildfire damages—potentially saving millions in suppression costs and ecological restoration.

Forest Road Maintenance and Construction

Forest road maintenance will likely be one of the most expensive forest management activities within the Lake Whatcom watershed. By way of example, the WA DNR spent an average of $113,000/year between 2004-2011 on forest road maintenance alone across the 9,000 acres of former state-owned land in the watershed (Source: 2011 Landscape Management Plan). The majority of currently operable roads within the watershed are in good shape for day-to-day forest maintenance and monitoring purposes. The forest road survey conducted as part of the development of this plan did not identify any high priority road maintenance issues that require attention in order to maintain routine forest management operations. However, in order to support commercial timber harvest operations, or other forest management operations that require the use of heavy equipment, road improvements may be necessary in certain locations (see Roads section of this plan). Common road maintenance practices include: road resurfacing ($1,000/100’ of road), mowing of road margins ($2,600/mile - required every 2-3 years), and ditch cleaning ($3,000 - $4,000/mile - required every 5-10 years).

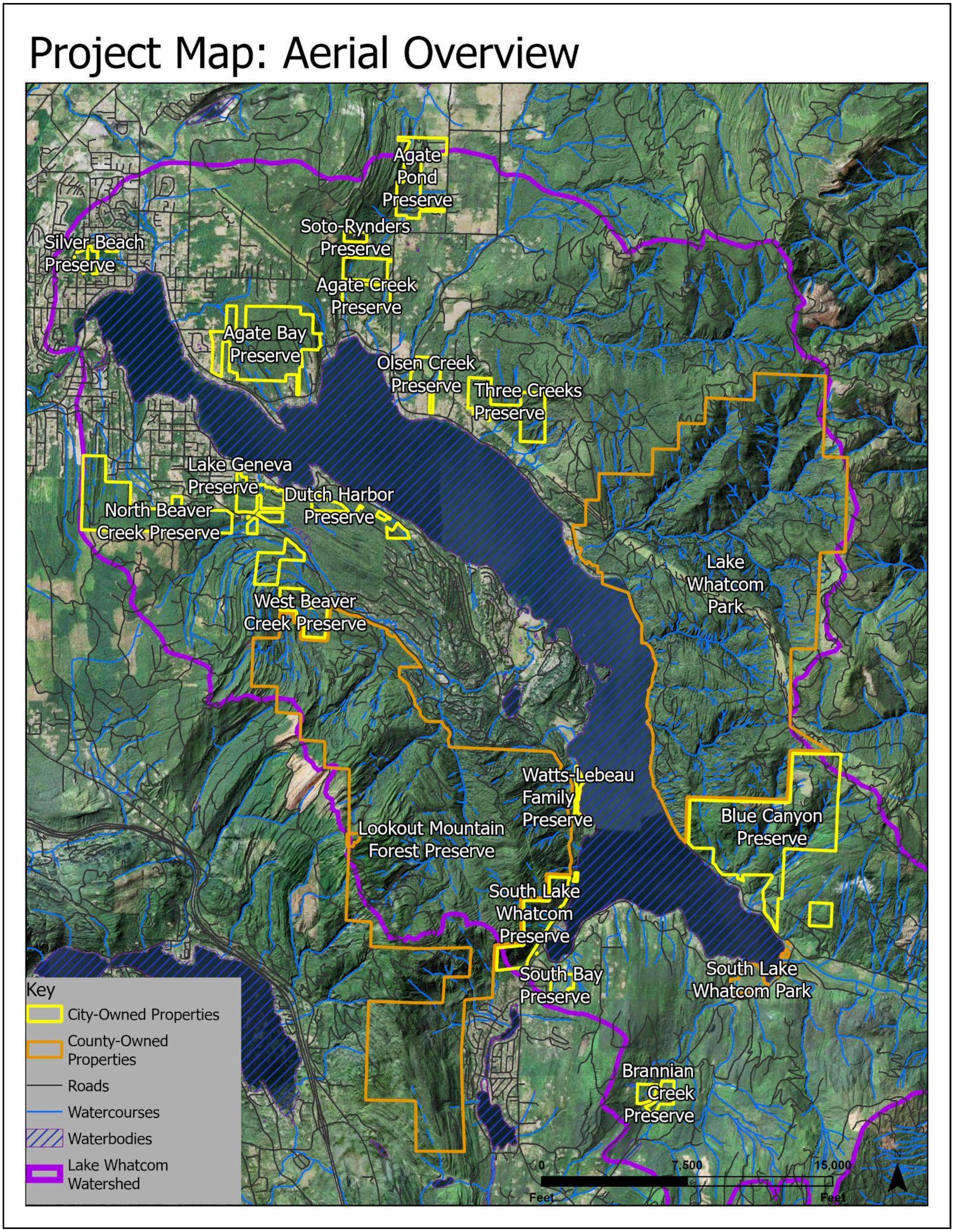
The cost of forest road construction, which may be necessary to open access to currently inaccessible areas of the forest, varies considerably depending on terrain, soil type, and whether the road will be designed for permanent, ongoing use, or only short-term use followed by decommissioning. Road construction for the purposes of conducting commercial timber harvesting is typically included in the timber sale bid, and the cost of construction deducted from the value of the harvested timber.

Economic Integration and Balancing Conservation with Revenue

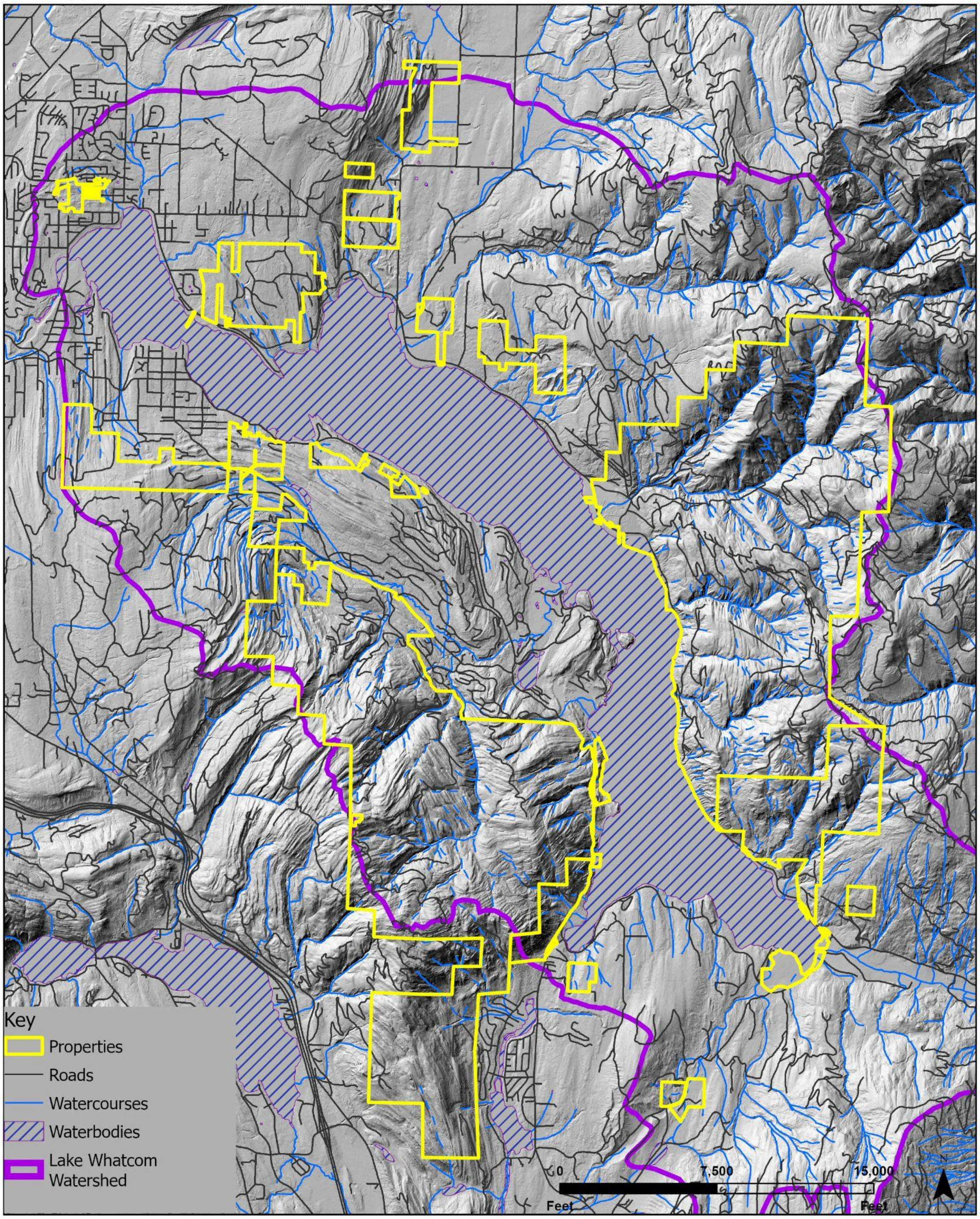
Effective forest management in the Lake Whatcom watershed requires integrating these practices to optimize ecological and economic outcomes. Commercial thinning provides direct revenue but must be balanced against the costs of other management activities and environmental protection. For example, investing in precommercial thinning and fuels reduction may incur costs ($300–$1,500 per acre), but these expenditures mitigate larger ecological and economic risks associated with erosion, sedimentation, and wildfire damage.

Given the complexities of managing forests in remote and steep terrain, such as occurs within the Lake Whatcom watershed, and the focus on least impactful forest management activities, it is unlikely that the sale of merchantable timber resulting from the ecologically-based thinning proposed in this plan will be sufficient to offset the total costs of forest management operations. The Lake Whatcom Management Program 2025 - 2029 Workplan estimated a $2.14 million forest management budget ($427K/year). Additional policy tools such as grant programs, carbon markets, and ecosystem service payments can further enhance economic sustainability. Overall, sustainable forest management in the watershed hinges on a strategic approach that aligns short-term economic gains with long-term ecological resilience and water quality protection.

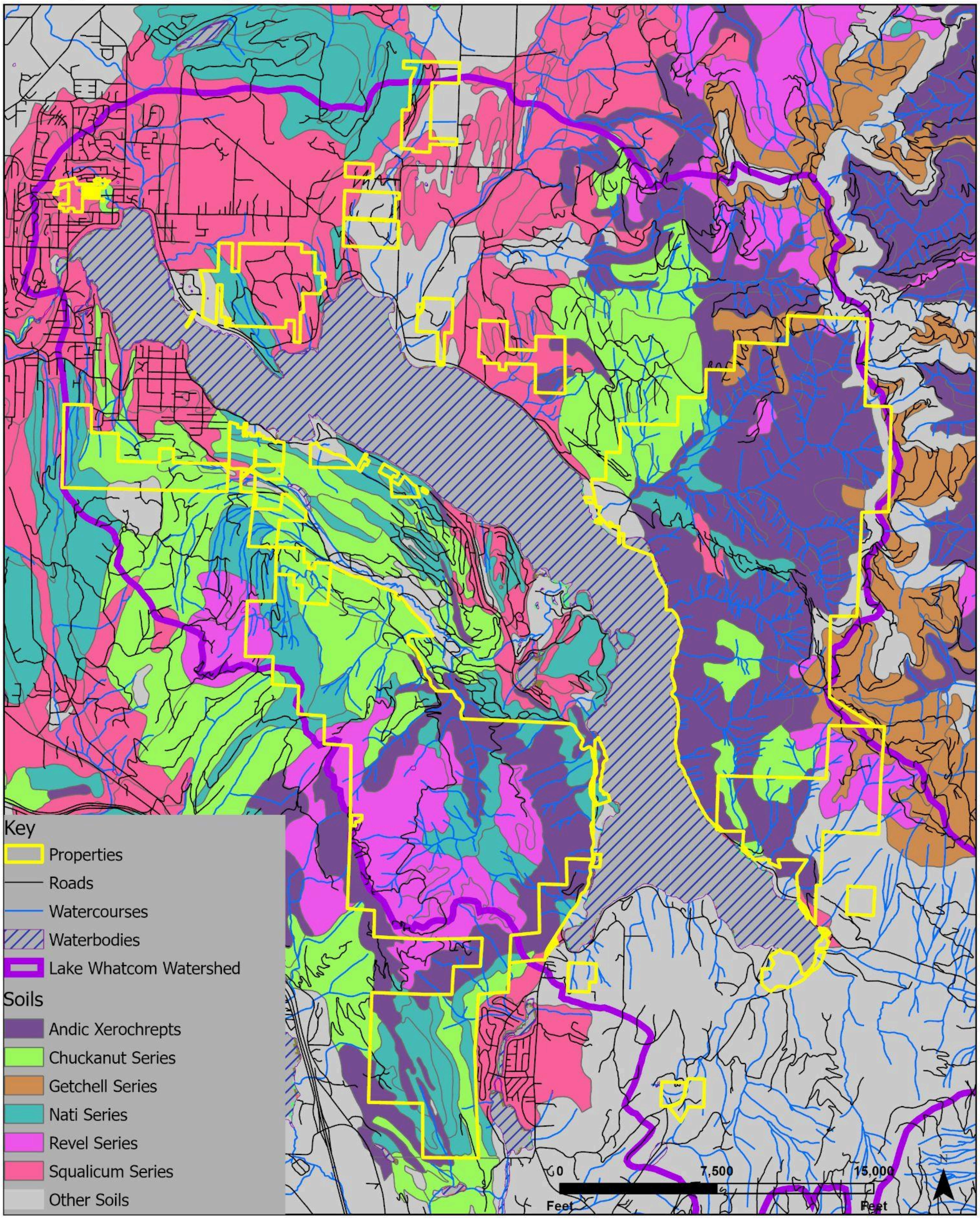
Appendix II. Project Maps



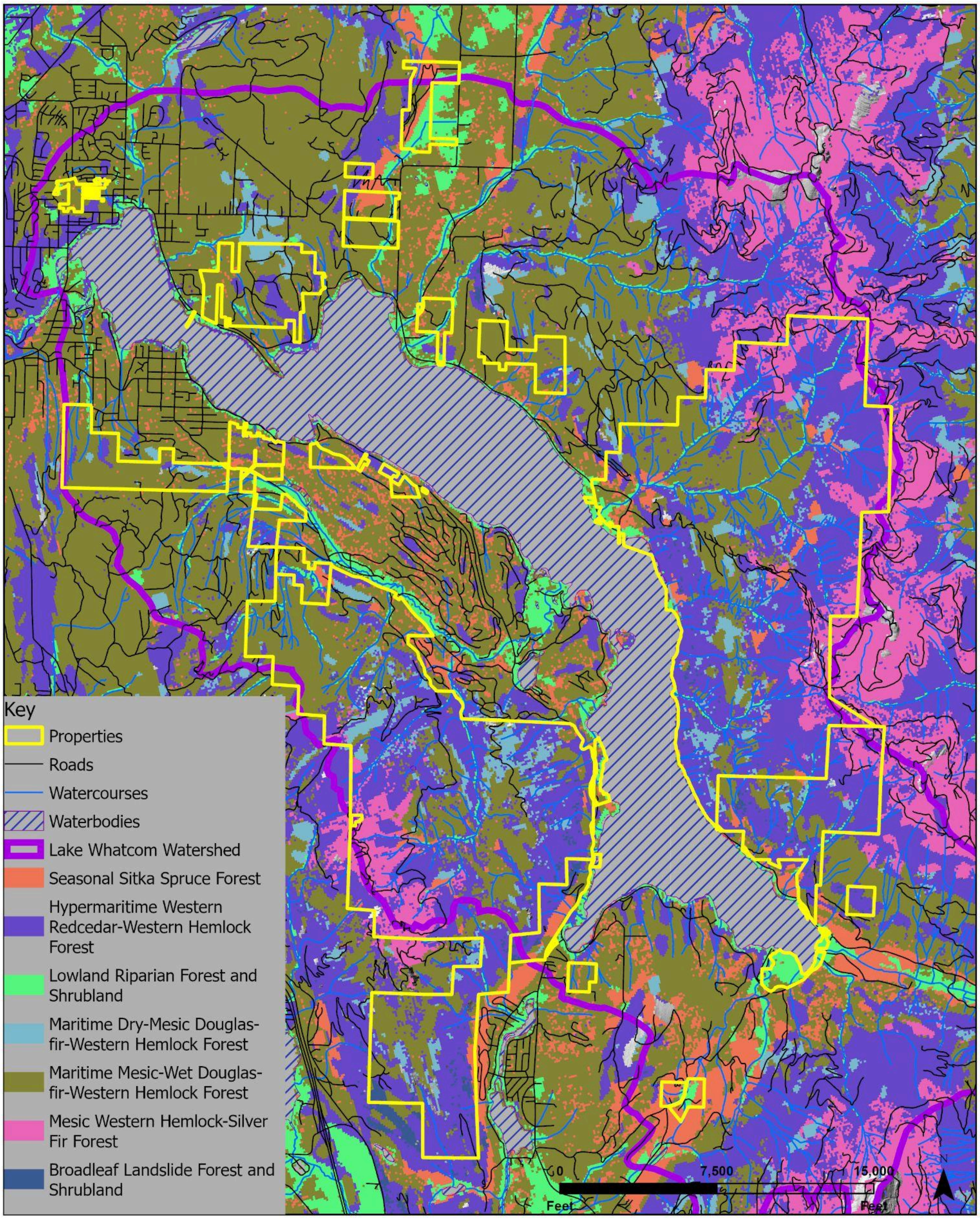
Project Map: Topographic Overview



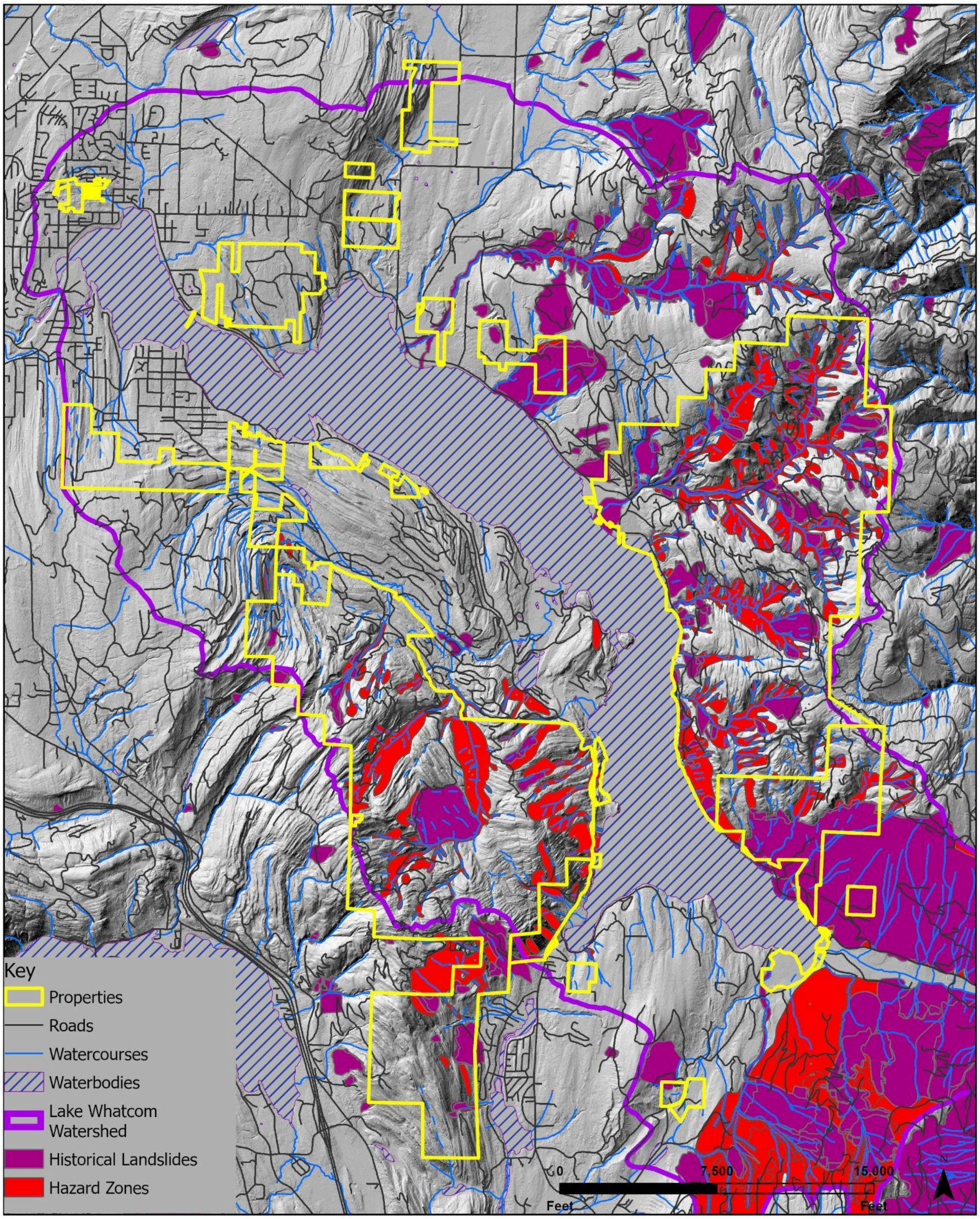
Project Map: Soils Overview



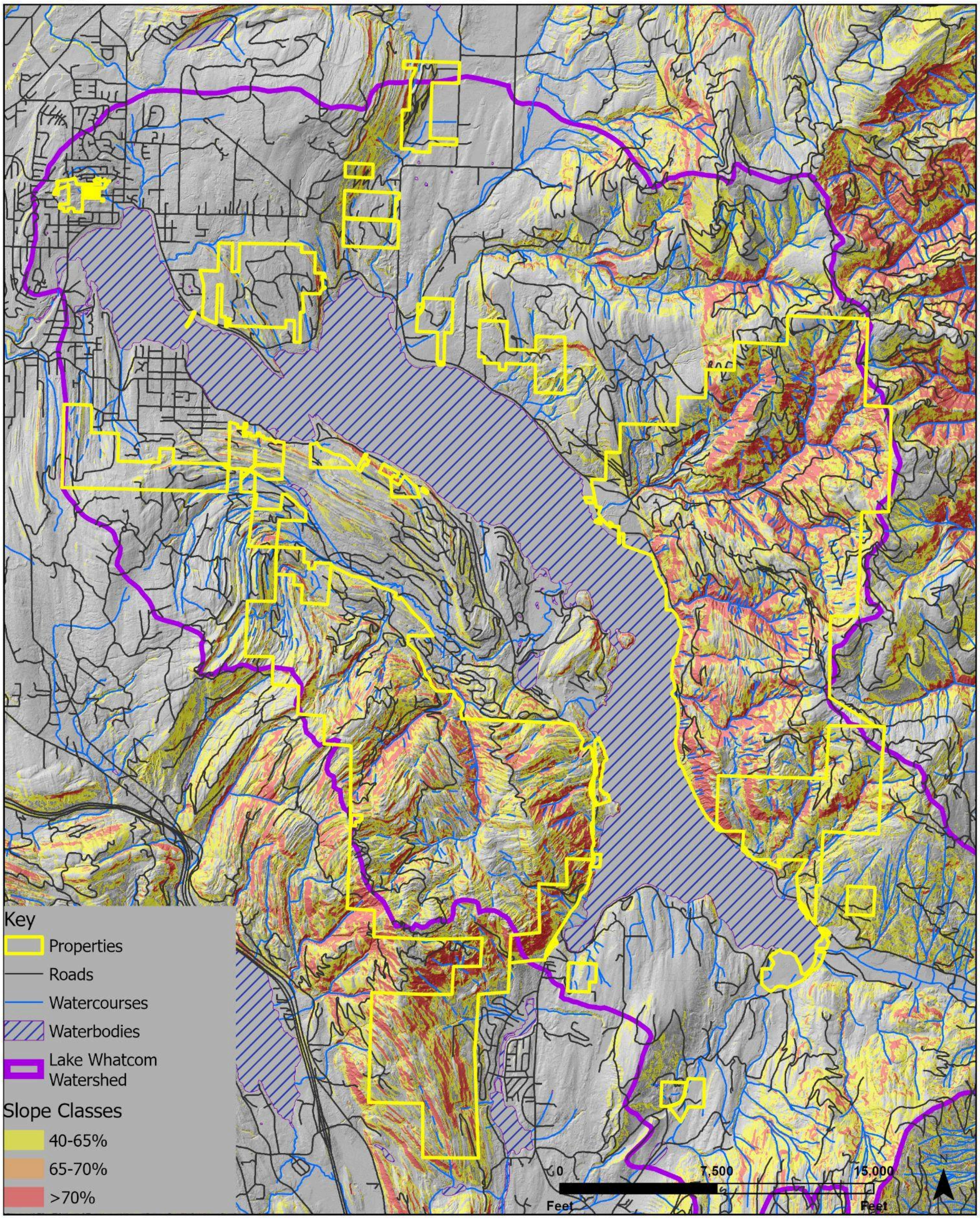
Project Map: Vegetation Zones Overview



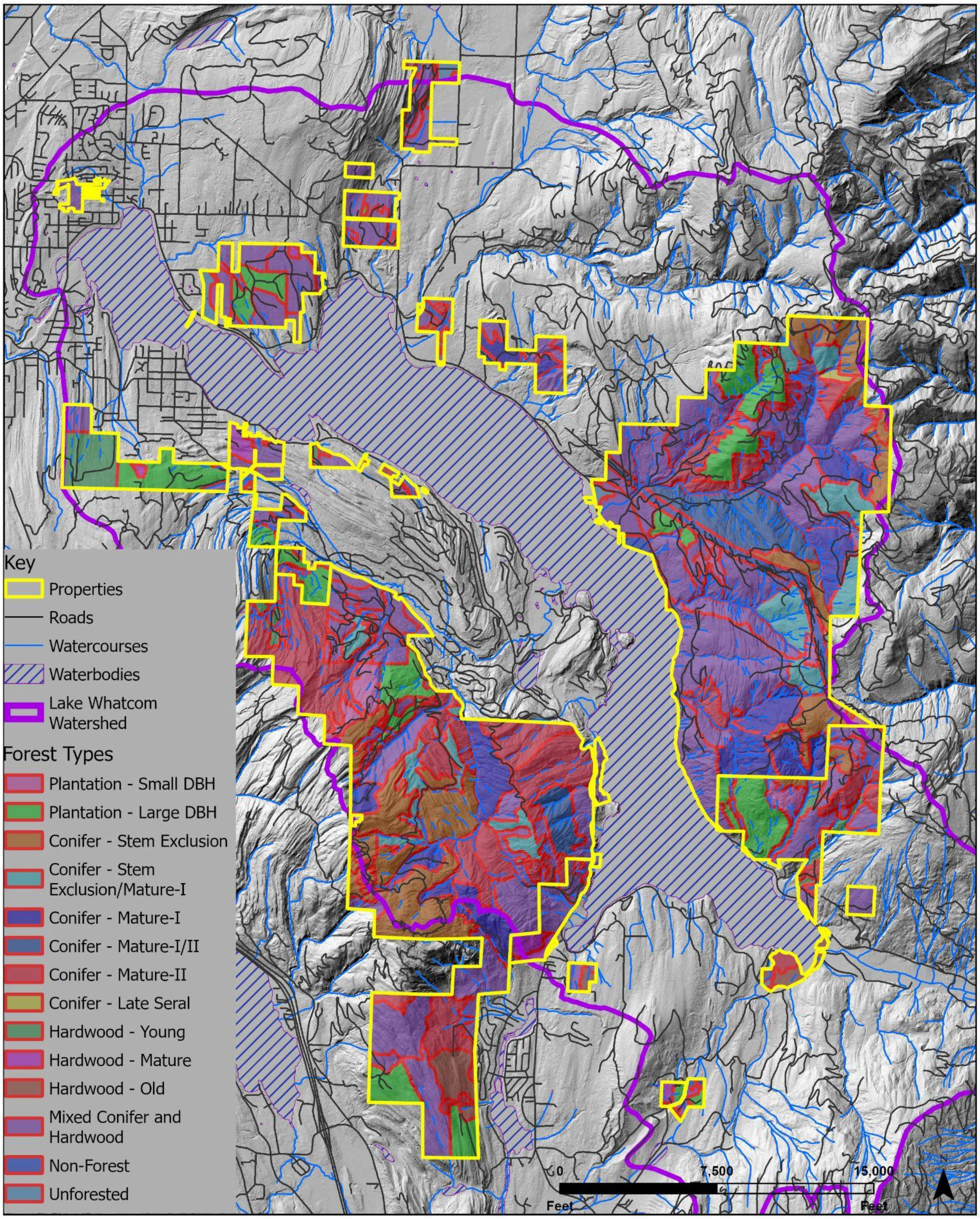
Project Map: Slope Stability Overview



Project Map: Slope Angle Overview



Project Map: Forest Types Overview



Appendix III. Drought and Shade Tolerance of Common Pacific Northwest Tree Species

Species	Drought Tolerance	Shade Tolerance
Garry Oak	High	Medium
Pacific Madrone	High	Medium
Douglas Fir	High	Medium
Lodgepole / Shore Pine	High	Low
Pacific Yew	Medium	High
Western Redcedar	Medium	High
Bigleaf Maple	Medium	High
Noble Fir	Medium	Medium
Red Alder	Medium	Medium
Western White Pine	Medium	Medium
Grand Fir	Medium	Medium
Oregon Ash	Medium	Medium
Paper Birch	Medium	Low
Western Hemlock	Low	High
Pacific Silver Fir	Low	High
Sitka Spruce	Low	Medium
Black Cottonwood	Low	Low

Appendix IV. Tree Species Codes

Code	Species
BM	Bigleaf Maple
CH	Bitter Cherry
CW	Black Cottonwood
DF	Douglas Fir
GF	Grand Fir
LP	Lodgepole / Shore Pine
PB	Paper Birch
PM	Pacific Madrone
RA	Red Alder
RC	Western Redcedar
SF	Pacific Silver Fir
SS	Sitka Spruce
WH	Western Hemlock
WO	Garry Oak / Oregon White Oak
WP	Western White Pine

Appendix V. Glossary of Forestry Terms

Age class: The organization of trees in a forest into discrete age intervals, usually 10 or 20 years.

DBH (diameter at breast height): The measurement of tree diameter at four and one-half (4.5) feet above the ground on the uphill side.

Buffer: A protective area of land or forest adjacent to an area requiring protection (e.g. stream, wetland, unstable slope, etc.).

Canopy: The uppermost layer in a forest formed collectively by tree crowns.

Canopy layers: The different horizontal layers of a forest comprised of multiple heights, ages or species of trees.

Clearcut: A timber harvest technique whereby all trees are removed from an area.

Coarse woody debris (CWD): Large sections of dead trees (e.g. logs) that provide wildlife habitat, nutrient retention, and other ecological functions.

Codominant trees: Trees that occupy the upper strata of a forest's canopy, but are subordinate in height to dominant trees.

Commercial thinning: Cutting and removing trees that have merchantable value.

Competition: The struggle for resources (e.g. water and light) between neighboring trees.

Conifer: A cone-bearing tree with needles, such as pine, spruce, fir, and larch.

Cover: Vegetation or other natural shelter serving to conceal wildlife from predators. Also refers to the protective shade that vegetation provides to wildlife, fish, and the forest floor.

Crown: The branches and foliage of a tree. The "live crown" refers to the portion of tree with living branches, needles or leaves.

Crown class: A relative designation of the crowns of individual trees by height in the forest canopy.

Crown or canopy closure: The growth phase of a forest (typically young) when the crowns of individual trees grow wide enough to begin to touch neighboring trees, and the canopy of the forest becomes increasingly dense.

Deciduous tree: A tree that loses its leaves or needles during the fall and winter.

Defect: That portion of a tree or log that makes it unusable for the intended solid wood product. Defects include rot, crookedness, cavities, and cracks. Severe defects cause the log to be classified as a cull.

Density: The number of trees per unit of area.

Dominant trees: Trees that occupy the uppermost horizontal strata of a forest's canopy.

Even-aged management: Forest management strategy to grow the same age, and typically the same species, of trees in a stand. Most trees are within 5 - 20 years of the same age.

Evergreen tree: A tree that retains some or most of its leaves, or needles, throughout the year.

Firebreak: A wildfire mitigation strategy that involves thinning the forest canopy to reduce connectivity between individual tree crowns, pruning the lower limbs on the remaining trees, removing fine woody fuels, and reducing the height and/or abundance of understory vegetation.

Forest Management Unit (FMU): A group of tree species, or area of forest, that is managed together.

Habitat: The environmental conditions that support a species or community of plants and animals.

Hardwood: A term describing broadleaf trees, usually deciduous, such as oaks, maples, cottonwood, ashes, alders, and elms.

Harvest: Cutting and removing trees for sale or use.

Herbicide: Chemical used for killing or controlling plants.

Intermediate trees: Trees that are subordinate in height to both dominant and codominant trees, but are taller than suppressed trees in the forest canopy.

Invasive species: An insect, plant, or animal that dominates an area and typically has a suppressive effect on other species.

Live crown ratio (LCR): A measure of the length of a tree's living branches relative to the total tree height.

Mature forest: The growth phase of a forest typically comprised of older trees and increasingly complex forest structure.

MBF: Abbreviation for *thousand board feet.*

Merchantable: The part of a tree that can be manufactured into a salable wood product.

Natural Regeneration: The natural process of seeding and tree establishment.

Old growth: A tree or forested area that has never been cut, harvested, cleared, or converted from its natural state.

Overstocked: A stand condition where high tree densities lead to increasing competition between individual trees.

Overstory: The horizontal layer of tree crowns that comprise the uppermost portion of a forest’s canopy. Typically composed of dominant and codominant trees.

Perennial stream: A stream that contains flowing water throughout the year.

Pioneer species: Species of fungus, insects, plants, and animals that are the first to colonize a recently disturbed site.

Pruning: Removing the lower branches of trees.

Resilience: The ability of a forest ecosystem to adapt to and recover from a disturbance.

Riparian: The zone of land and ecosystem adjacent to surface water such as lakes, streams, and wetlands.

Second growth: The second generation of forest to grow on a site following the disturbance or removal of the first generation of forest.

Shade tolerance: Trees and shrubs adapted to growing in low light conditions, such as the understory of a forest.

Shrub: A low-growing perennial plant with a woody stem and low branching habit.

Site class: A quantification of soil productivity typically expressed on a scale of 1-5 where site class 1 soils are the most productive and site class 5 soils are the least productive.

Slash: Small diameter woody material resulting from forest thinning.

Slash reduction: The burning, crushing, or scattering of woody material produced during thinning. This practice is typically used to prepare a site for tree planting or to reduce wildfire risk.

Snag: A standing dead tree.

Soil compaction: The process by which soil particles are squeezed or compressed, reducing air and water spaces.

Structural complexity: A forested area featuring large, old trees; multi-layered canopies; abundant standing dead wood and downed logs; and rich understory diversity.

Wetlands: An area of land where water accumulates creating hydric soils and hydric plant communities.

Appendix VI. Summary of Lake Whatcom Forest Management Plan Public Comments (April - July 2025)

Project Overview

The Whatcom County Parks and Recreation Department (County) and the City of Bellingham (City) are partnering with ecological forestry consultants from Northwest Natural Resource Group (NNRG) to create a long-term Lake Whatcom Forest Management Plan (Plan). This Plan will protect water quality, improve forest health, and support responsible recreational access (where applicable) by guiding forest management across more than 13,000 acres of forests that the City and County collectively manage in the Lake Whatcom watershed. This Plan also helps advance the Forest Management program area within the 2025-2029 Lake Whatcom Management Program Work Plan.

Community Engagement Opportunities

Plan development began in April 2025 and is expected to continue through the end of the year. Community input has been a key part of shaping the Plan from the start. Public comments were first invited in April to help inform the Plan's goals and recommendations. Additional feedback will be invited on the draft Plan when it's available in fall 2025.

Community feedback on the Plan's priorities was collected between April and July 2025 through:

- Engage Bellingham (online platform)
- Community meeting at Silver Beach Elementary School (May 2025)
- Two community forest tours (June and July 2025)

Project staff also met with Tribal partners, Lake Whatcom stakeholders, and recreation stakeholders in the early planning stages to understand their priorities and concerns.

On Engage Bellingham, community members could choose to provide comments on the overall Plan or provide specific comments about County-managed park properties or City-managed protected properties.

Public Comment Summary

Between April and July 2025, 56 comments were shared by community members via Engage Bellingham and the May community meeting. While comments from the forest tours were not formally recorded, many of the same themes emerged during those events.

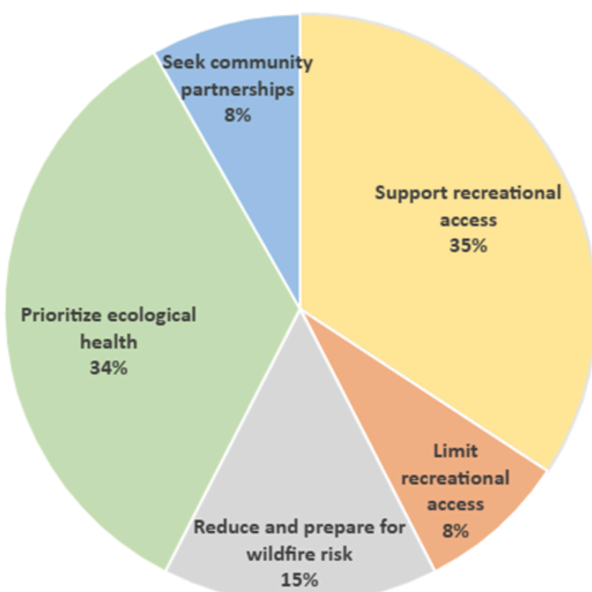
Input from public engagement activities, along with feedback from stakeholders and partners, will help shape the goals and recommendations of the Plan. It's important to note that while the Forest Management Plan will consider how recreation and forest health can coexist, the Plan's primary focus is on long-term forest stewardship – not on proposing new trails or recreation projects. However, the feedback gathered during this engagement process may help inform future recreation planning or property management efforts led by the County or City in the Lake Whatcom watershed.

Comment Themes

This section highlights the themes that were most prevalent throughout the 56 comments. There were five overarching themes mentioned most frequently:

1. Prioritize ecological health (25 comments)
    a. Emphasis on limiting development, protecting water quality, and long-term forest resilience.
2. Support recreational access (25 comments)
    a. Calls for continued or expanded access to trails and natural areas, with an emphasis on balancing recreation with forest health.
3. Reduce and prepare for wildfire risk (11 comments)
    a. Interest in improved wildfire access and planning in the watershed.
4. Seek community partnerships (6 comments)
    a. Suggestions to collaborate with local organizations.
5. Limit recreational access (6 comments)
    a. Concerns about overuse, added infrastructure, and lake impacts.

Public Comments by Overarching Theme



Public Comments by Overarching Theme

Theme	General Comments (Engage Bellingham)	County-Managed Lands (Engage Bellingham)	City-Managed Lands (Engage Bellingham)	In-Person Community Meeting	Total
Prioritize ecological health	13	3	4	5	25
Support recreational access	13	9	3	0	25
Reduce and prepare for wildfire risk	5	2	2	2	11
Limit recreational access	0	1	5	0	6
Seek community partnerships	1	3	0	2	6

Under each overarching theme, there were also many sub-themes mentioned.

Prioritize Ecological Health Sub-Themes

Theme	General Comments (Engage Bellingham)	County-Managed Lands (Engage Bellingham)	City-Managed Lands (Engage Bellingham)	In-Person Community Meeting	Total
Limit development in the watershed	5	0	2	0	7
Protect water quality	2	0	1	1	4
Decrease extractive use of land (logging, etc.)	3	0	0	1	4
Reduce climate change risks	2	1	0	0	3

Theme	General Comments (Engage Bellingham)	County-Managed Lands (Engage Bellingham)	City-Managed Lands (Engage Bellingham)	In-Person Community Meeting	Total
Expand public ownership of land in watershed	1	0	2	0	3
Use thinning as a tool to improve forest health	0	0	0	2	2
Remove invasive plants	1	1	0	0	2
Integrate indigenous knowledge into plan	1	0	0	0	1
Purchase Sudden Valley forests for protection	0	0	1	0	1
Decrease impacts from existing development	1	0	0	0	1
Prioritize wild land	0	0	1	0	1
Minimize soil disturbance	0	0	0	1	1
Minimize management activities	1	0	0	0	1
Minimize thinning	0	0	0	1	1
Improve management of existing public land	0	0	1	0	1
Monitor progress over time	0	0	0	1	1

Support Recreational Access Sub-Themes

Theme	General Comments (Engage Bellingham)	County-Managed Lands (Engage Bellingham)	City-Managed Lands (Engage Bellingham)	In-Person Community Meeting	Total
Balance recreation and environment	5	5	4	0	14
Increase non-motorized access	7	4	2	0	13
Increase mountain bike trails	3	3	2	0	8
Protect recreational access	1	2	1	0	4
Improve trail maintenance and building process to protect forest health	0	3	1	0	4
Increase trails (general)	1	1	1	0	3
Improve trail connectivity	2	1	0	0	3
Increase motorized access	2	0	0	0	2
Consider a paid pass for accessing watershed recreation	1	1	0	0	2
More government financial support for recreation	1	0	0	0	1
Revive the Mount Baker Ultra Marathon	0	1	0	0	1

Reduce and Prepare for Wildfire Risk Sub-Themes

Theme	General Comments (Engage Bellingham)	County-Managed Lands (Engage Bellingham)	City-Managed Lands (Engage Bellingham)	In-Person Community Meeting	Total
Improve wildfire access	1	1	1	1	4
Reduce public access in remote areas	0	1	1	0	2
Add emergency services	1	0	0	0	1
Prioritize education and outreach about fireproofing	1	0	0	0	1
Add fire breaks when building trails	1	0	0	0	1

Seek Community Partnerships Sub-Themes

Theme	General Comments (Engage Bellingham)	County-Managed Lands (Engage Bellingham)	City-Managed Lands (Engage Bellingham)	In-Person Community Meeting	Total
More partnerships with recreation groups	2	3	0	0	5
Increase community involvement in recreation projects	2	2	0	0	4
Include Sudden Valley in forest management	0	0	0	2	2
Try a Natural Capital Project approach	1	0	0	0	1

Limit Recreational Access Sub-Themes

Theme	General Comments (Engage Bellingham)	County-Managed Lands (Engage Bellingham)	City-Managed Lands (Engage Bellingham)	In-Person Community Meeting	Total
Prohibit motorboats on Lake Whatcom	1	1	1	0	3
Do not use City-owned protected properties for recreation	0	0	3	0	3
Reduce costs associated with infrastructure required for recreation access	0	0	2	0	2
Reduce motorized access	0	2	0	0	2
No new roads	0	0	2	0	2
Require safety inspections for boats	0	0	1	0	1

Next Steps

NNRG staff are using the comments and themes collected through community engagement, coupled with the data collected through their summer 2025 field assessments, to help draft the Lake Whatcom Forest Management Plan. The draft is expected to be ready to review in fall 2025 with opportunities for additional public input. The plan will be shared with Bellingham City Council and Whatcom County Council before being finalized.