NATURAL RESOURCES

Forest Health Assessment and Treatment Framework 2020

RCW 76.06.200

WASHINGTON STATE DEPT OF NATURAL RESOURCES

Forest Health Assessment and Treatment Framework

RCW 76.06.200

Prepared by
Washington State Department
of Natural Resources

Office of the Commissioner of Public Lands, Hilary Franz
Forest Health and Resiliency Division – Planning, Science, and Monitoring Section
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On the cover (clockwise from top left): Commercial thinning to improve forest health on state trust lands in the Methow Valley priority planning area, photo by John Marshall; aerial view of recently thinned forest on state trust lands in the Methow Valley priority planning area, photo by John Marshall; northern spotted owl in the Upper Swauk priority planning area, photo by Danielle Munzing; post-fire field monitoring, photo by Derek Churchill; aerial view of untreated dense forest (left) and recently thinned open forest (right), photo by John Marshall; and a prescribed burn in the Stemilt-Squilchuck priority planning area, photo by Erin McKay with Chelan County.

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Executive Summary

Washington's forests are an integral part of the state's landscapes and communities, providing sustainable timber and jobs, clean air and water, carbon sequestration, and world-class outdoor recreation. Forests, however, face unprecedented threats that require bold action. Scientific analyses state that millions of acres of forests in eastern Washington (east of the Cascades crest) require natural disturbance or active management to become more resilient to insects, disease and wildfire. Climate change is expected to greatly exacerbate these risks. Recent wildfire seasons made clear the need to improve forest health on a meaningful scale.

This report provides key information on the state's progress to create resilient forests in the face of these challenges, as well as new evaluations showing the restoration needed in many of these landscapes. Such reporting is due to the Washington State Legislature every two years as mandated by RCW 76.06.200.

In 2016, the Legislature directed the Washington State Department of Natural Resources (DNR) to develop a forest health strategic plan to "treat areas of the state forestland that have been identified by the department as being in poor health." DNR determined that to meet this intent, and to address the forest health issue in a meaningful way, it was necessary to take a broad view of "treat areas of state forest lands," and to adopt a guiding philosophy of "all lands, all hands." DNR endeavors to improve forest health at a landscape scale to ensure treatments advance in a coordinated, strategic fashion.

The 20-Year Forest Health Strategic Plan: Eastern Washington is the high-level framework guiding efforts to improve forest health, help forests adapt to climatic change, and achieve forest-related ecological, economic, and social benefits. Created with numerous partners, the overarching strategy maximizes effectiveness of forest health treatments by coordinating, planning, prioritizing, and implementing forest management activities across large landscapes.

This year's Forest Health Assessment and Treatment Framework report includes:

- Treatment need assessment results across 30 priority areas (3.37 million acres) during the past two biennia, greatly exceeding the statutory requirement of analyzing 200,000 acres of fire prone land each biennium.
- A landscape evaluation summary for 21 of 30 priority areas, providing a scientifically grounded blueprint of forest health treatment need and scale. Landowners can use these evaluations on a voluntary basis to improve their forests, and DNR can use them to track benchmarks and progress across each landscape.
- A commitment by DNR to analyze nine more priority areas next biennium, representing an additional 1.06 million acres. This will provide a powerful footprint to continue implementing the forest health plan with partners.

- Important new landscape evaluation components, including: prioritization of forest health treatments in a landscape, an assessment of forest treatment type based on operational and economic feasibility, and identification of forests where managing for closed canopy, large tree forest structure will be most sustainable over time.
- Prioritization of forest health treatments for the dual benefit of forest health and wildfire response, as required by HB 1784.

Landscape evaluations for the 30 priority planning areas identified a need to conduct forest health treatments on 807,720 to 1,162,620 acres overall to transform these landscapes into resilient forests, using a combination of tools. These include mechanical treatments, prescribed fire, and managed wildfire. In each priority planning area, the pace and scale of accomplishing this work will depend on factors such as the ratio of commercial versus non-commercial treatments, forest product markets, access, land manager capacity, and funding levels.

To monitor forest conditions, assess progress, and reassess strategies over time, DNR also developed a monitoring framework. Monitoring is essential for accountability and reporting, building shared understanding and trust across land ownerships, and increasing effectiveness of forest health treatments into the future. Thus far, DNR has tracked 256,387 acres of forest health treatments in eastern Washington and 122,827 acres of forest health treatments in priority planning areas reported by landowners and managers as completed since the start of 2017. Legislative investments in forest health for the current biennium are leveraging additional resources in thousands of acres of forest health treatments underway.

The scale of the forest health crisis is immense, but with a strong legislative, scientific, and collaborative foundation, the state has made meaningful progress over the past two biennia. To build on this progress in the face of COVID-19 and wildfire destruction, DNR's 2021-23 budget requests address the extraordinary need for job creation as well as landscape and community resilience. This includes $25 million to invest in cross-boundary forest health projects as guided by the 20-Year Forest Health Strategic Plan and the Forest Health Advisory Committee, including thinning, prescribed burning, and Good Neighbor Authority projects.

Introduction

The purpose of this report is to provide a progress review on the 20-Year Forest Health Strategic Plan: Eastern Washington and meet the statutory reporting requirements of RCW 76.06.200.

In 2004, the Commissioner of Public Lands was designated as the state's lead to improve forest health (RCW 76.06). Concurrently with this designation, the Washington State Legislature emphasized the need for coordination across land ownerships – federal, state, local, private, and tribal – in recognition that forest conditions on one property can pose risks to adjacent properties. In 2016, the Legislature passed a provision in House Bill 2376 Section 308 that provided funding and direction to the Washington State Department of Natural Resources (DNR) to develop a 20-Year Forest Health Strategic Plan to "treat areas of state forestland that have been identified by the department as being in poor health."

Forest health is defined as the condition of a forest ecosystem reflecting it s:

- ability to sustain characteristic structure, function, and processes;
- resilience to fire, insects and other disturbances;
- adaptability to changing climate and increased drought stress; and
- capacity to provide ecosystem services to meet landowner objectives and human needs.

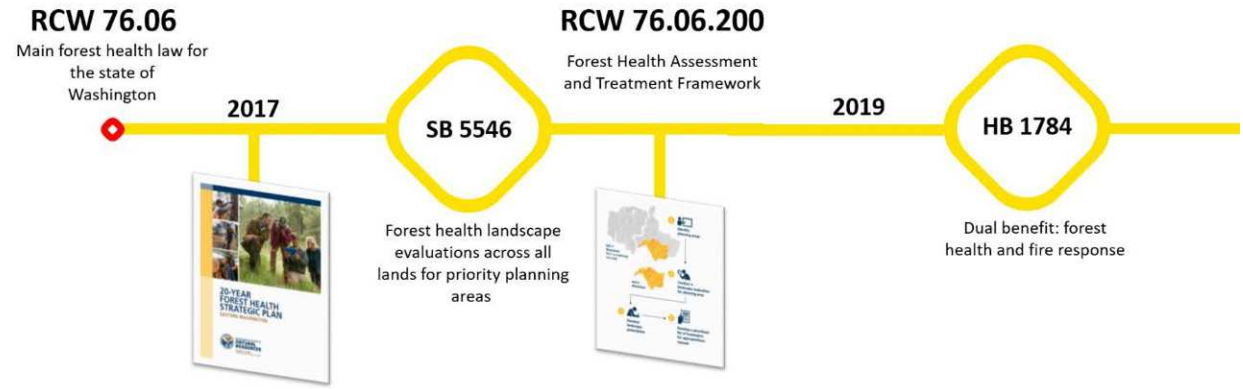
In 2017, the Legislature passed several forest health laws related directly to DNR (Fig.1). Senate Bill 5546 directed DNR to develop an assessment and treatment framework designed to proactively and systematically address forest health issues facing the state. Specifically, the framework must endeavor to achieve an initial goal of assessing and treating 1 million acres of land by 2033. DNR must use the framework to assess and treat acreage in an incremental fashion each biennium and consists of three elements: assessment, treatment, and progress review and reporting. Meanwhile, Engrossed Second Substitute House Bill 1711 directed DNR to develop and implement a policy for prioritizing forest health treatment investments on state trust lands to reduce wildfire hazards and losses from wildfire, reduce insect and disease damage, and achieve forest health and resilience at a landscape scale. The law established a forest health revolving account that permitted depositing revenue from forest health treatments on state trust lands and applying funds toward future forest health treatments on those lands. Finally, the Legislature directed DNR to utilize and build on forest health strategic planning

initiated under HB 2376 Section 308 to the maximum extent practicable to promote efficient use of resources.

In 2019, the Legislature passed House Bill 1784 (Fig. 1) requiring DNR to prioritize treatments for the dual benefit of forest health and wildfire response into the all-lands Forest Health Assessment and Treatment Framework in support of the 20-Year Forest Health Strategic Plan: Eastern Washington (forest health plan). HB 1784 amends RCW 76.06.200, Forest Health Assessment and Treatment Framework (treatment framework), to require prioritization of forest health treatments that maximize forest health outcomes and planned tools for wildfire response operations. Specifically it directs DNR to:

> *"Prioritize, to the maximum extent practicable … forest health treatments that are strategically planned to serve dual benefits of forest health maximization while providing geographically planned tools for wildfire response (and) … attempt to locate and design forest health treatments in such way as to provide wildfire response personnel with strategically located treated areas to assist with managing fire response. … These areas must attempt to maximize the firefighting benefits of natural and artificial geographic features and be located in areas that prioritize the protection of commercially managed lands from fires originating on public lands."*

Figure 1. Legislative context for forest health assessment work within this report



This report builds upon the 2018 SB 5546 legislative report that described DNR's forest health prioritization process across all lands, detailed the approach taken to evaluate forest health treatment needs across large landscapes, and shared results of forest health landscape evaluations for 2018 forest health priority planning areas. It describes how requirements of HB

1784 have been integrated into the treatment framework and meets the statutory requirements of RCW 76.06.200 to provide:

- A list and summary of treatments conducted under the framework in the preceding biennium.
- A request for appropriations to implement the framework in the following biennium, including assessment work and conducting treatments identified in previously completed assessments.
- A summary of forest health treatment needs and forest health treatment spatial priorities for the forest health priority planning areas.

Creating a Forest Health and Resiliency Division

In 2019, DNR created the Forest Health and Resiliency Division – a recognition that structural reorganization was necessary to achieve the agency's mission to manage, sustain, and protect the health and productivity of Washington's lands and waters to meet the needs of present and future generations.

The Forest Health and Resiliency Division works across all lands and in the interest of all Washingtonians to sustain and increase health and resilience of forests, local communities, and the values forests support for the well-being of people, communities, wildlife and landscapes today and into the future (Fig. 2). The division comprises four sections: Planning, Science and Monitoring; Landowner and Community Assistance; Federal Lands Program; and Prescribed Fire Program. It is a combination of existing agency programs focused on insect and disease monitoring, landowner assistance, wildfire preparedness, urban forestry, and forest stewardship, as well as new programs focused on prescribed fire, federal lands restoration, forest planning and landscape ecology. The division consists of staff based in Olympia as well as regional staff.

Planning, Science and Monitoring: The Planning, Science and Monitoring Section continues to provide forest health insect and disease monitoring, including aerial surveys of forest health conditions that results in the annual Forest Health Highlights report. This team of forest pathologists, forest entomologists, and forest health specialists also provide technical assistance to forest landowners. This section includes new forest health scientists and planners to analyze treatment needs across large landscapes and work with partners to plan, implement, and monitor treatments and changing conditions in support of the forest health plan. Section staff oversee revision and monitoring of the state's Forest Action Plan and supporting elements of DNR's climate change mitigation and preparedness. This section oversees coordination of the Forest Health Advisory Committee and stewardship of spatial data to support the division's work.

Landowner and Community Assistance: The Landowner and Community Assistance Section combines four existing DNR programs: Urban and Community Forestry, Community Wildfire Preparedness, Landowner Assistance and Forest Stewardship. The Urban and Community Forestry Program provides urban forestry technical, educational and financial assistance to Washington's cities, towns, counties, tribal governments, nonprofit organizations and educational institutions. The Community Wildfire Preparedness Program helps communities prepare for wildfires and works with local fire districts, conservation districts, counties, and extension programs to help residents benefit from Firewise USA®, as well as the Fire Adapted Communities Learning Network. The Landowner Assistance Program is focused in northeast and southeast regions, supporting cost-share forest health treatments for small, private landowners with a focus on reducing wildfire risks. The Forest Stewardship Program provides technical assistance to small forest landowners to help make informed land management. The Landowner Assistance and Forest Stewardship programs work closely with Forest Practices Division's Small Forest Landowner Office, which provides additional cost-share opportunities and assistance to ensure landowners successfully meet applicable forest practices rules while managing their forests and addressing wildfire risk. Significant forest health and resilience work by DNR is also accomplished through partnerships with the U.S. Department of Agriculture Forest Service and other private and government entities implementing Cooperative and State and Private Forestry programs.

Prescribed Fire: The Prescribed Fire Program is a new program focused on increasing safe and effective prescribed fire in Washington State to restore forests and other ecosystems. The program focuses on prescribed fire training, funding prescribed burns, working with partners to promote and implement prescribed fire across all-lands and monitoring the effects of prescribed fire and wildfire. The program engages with partners to learn and train in the use of prescribed fire through a formal Prescribed Fire Training Exchange (TREX) sponsored by the Fire Learning Network, as well as leadership in the Washington Prescribed Fire Council.

Federal Lands Program: The Federal Lands Program uses state expertise, resources and mechanisms to increase work primarily on National Forest System land through use of DNR's Good Neighbor Authority Agreement (GNA) with the federal government. This section works directly with Forest Service personnel to implement restoration projects such as decreasing stream barriers for fish and other aquatic organisms, addressing forest road issues, timber sales, wildlife habitat enhancement and more. This program also coordinates with other programs to provide input on federal projects as well as National Environmental Policy Act (NEPA) planning support. The program is funded through a variety of sources including state and federally appropriated funds and revenue derived from restoration projects with commercial timber as a component.

Figure 2. Staff from the DNR Forest Health and Resiliency Division and partners touring a forest health treatment on Washington Department of Fish and Wildlife land in the Methow Valley forest health priority planning area

20-Year Forest Health Strategic Plan: Eastern Washington

The forest health plan was developed with over 30 organizations participating in its creation. Organizations represented a diverse range of perspectives and expertise, including state and federal land management agencies, county government, timber industry and environmental group members, and forest collaboratives. There was consensus among participants to advance a landscape-scale, cross-boundary strategy to achieve healthy, resilient forests through coordinated efforts. The overarching strategy is to maximize effectiveness of forest health treatments by coordinating, planning, prioritizing, and implementing forest management activities across large landscapes.

The forest health plan vision and mission statements are:

Vision: Washington's forested landscapes are in an ecologically functioning and resilient condition and meet the economic and social needs of present and future generations.

Mission: Restore and manage forested landscapes at a pace and scale that reduces the risk of uncharacteristic wildfires and increases the health and resilience of forest and aquatic ecosystems in a changing climate for rural communities and the people of Washington state.

The five major goals of the forest health plan are:

Goal 1: Conduct 1.25 million acres of scientifically sound, landscape scale, cross-boundary management and restoration treatments in priority watersheds to increase forest and watershed resilience by 2037.

Goal 2: Reduce the risk of uncharacteristic wildfire and other disturbances to help protect lives, communities, property, ecosystems, assets, and working forests.

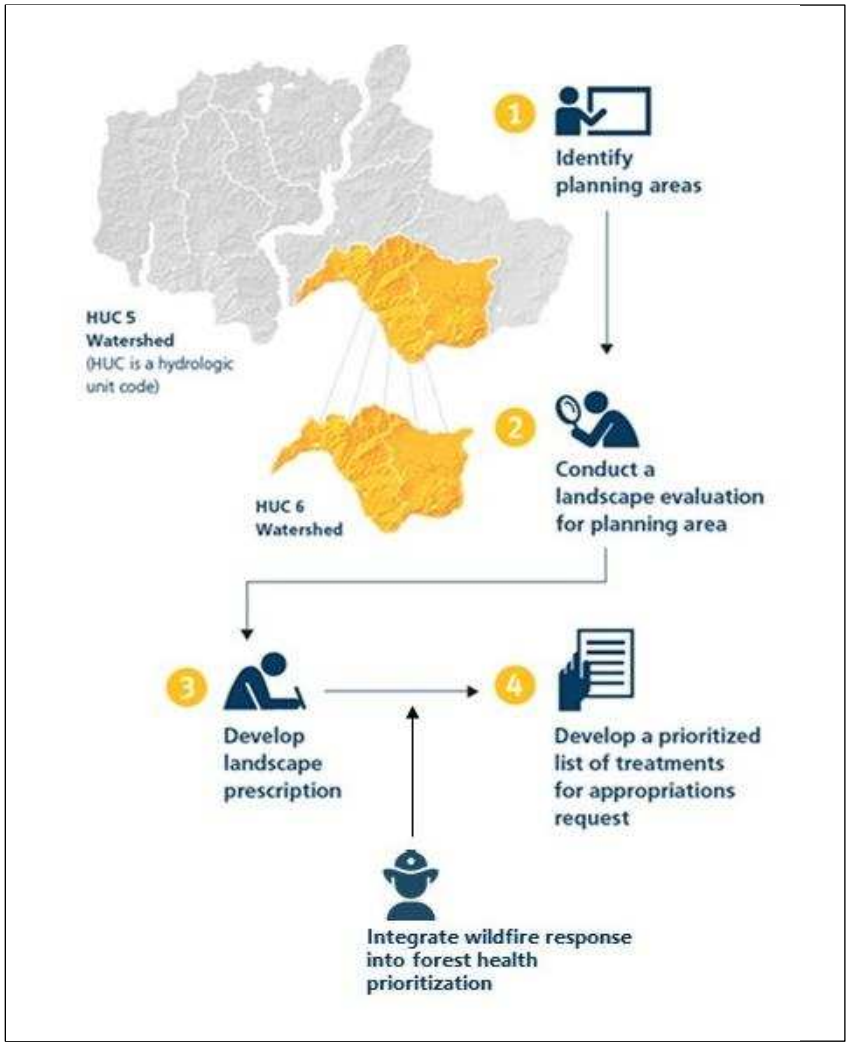
Goal 3: Enhance economic development through implementation of forest restoration and management strategies that maintain and attract private sector investments and employment in rural communities.

Goal 4: Plan and implement coordinated, landscape-scale forest restoration and management treatments in a manner that integrates landowner objectives and responsibilities.

Goal 5: Develop and implement a forest health resilience monitoring program that establishes criteria, tools, and processes to monitor forest and watershed conditions, assess progress, and reassess strategies over time.

The forest health plan is the high-level framework guiding Washington's work and investments to improve forest health and achieve forest related ecological, economic and social benefits. Identifying forest health treatment needs and locations to accomplish the goals of the forest health plan and meet the requirements of the Forest Health Assessment and Treatment Framework (RCW 76.06.200) follow the general steps shown in Fig. 3.

Figure 3. Major steps of the Forest Health Assessment and Treatment Framework (RCW 76.06.200) to accomplish the 20-Year Forest Health Strategic Plan treatment goals



Understanding the Scale of Forest Restoration Need in Eastern Washington

The scale of the forest restoration need in eastern Washington to create healthy forests and resilient landscapes is vast. In 2020, the University of Washington completed an analysis of forest restoration need in eastern Washington using the latest methods and most current vegetation datasets (Appendix A). This analysis assessed forest restoration need in a consistent manner across eastern Washington annually from 1986 to 2017. This analysis provides both the absolute amount of acres needing forest restoration and trends over the last 30 years.

The analysis found that the active forest restoration need (disturbance only, and disturbance plus growth) in eastern Washington for 2017 was 3.07 million acres (Table 1). Over 75 percent of the total disturbance need (2.35 million of the 3.07 million acres) is in dry mixed conifer and ponderosa pine forests. These landscapes have an overabundance of mid-aged forests with

closed canopies (more than 40 percent canopy cover). They also have a deficit of mid-aged and older forests with more open canopies.

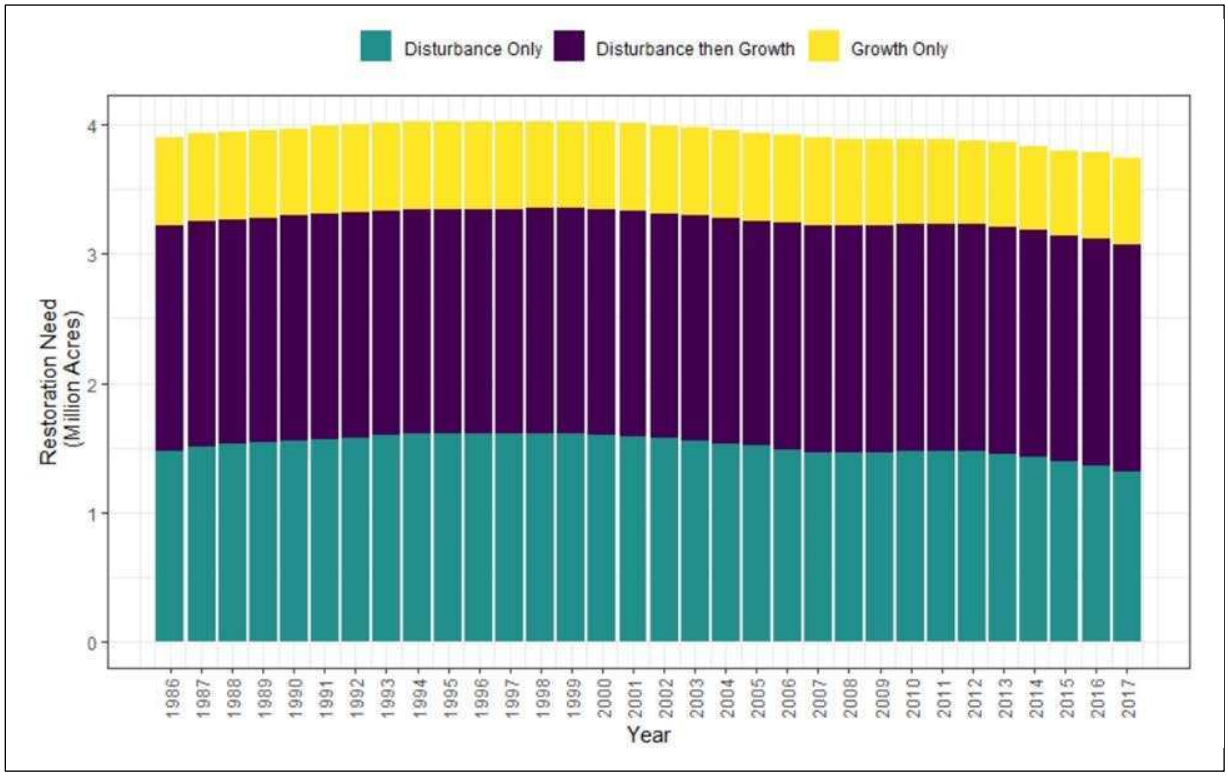
Since 2006, the total active forest restoration need (disturbance only, and disturbance plus growth) in eastern Washington has decreased by 5 percent from 3.23 million acres (2006) to 3.07 million acres (2017). Restoration need has decreased every year since 2012 (Fig. 4), likely due to the increase in acres burned by wildfires and treatments. However, the rate of decrease is only around 1 percent per year. Individual watersheds in Okanogan County saw up to a 16 percent decrease in disturbance need, driven primarily by the 2014 and 2015 wildfires. These fires reduced forest density, but they also killed large trees and thereby increased the need for growth-based restoration.

Table 1. A high-level estimate of 2017 active restoration need (acres) by land ownership within eastern Washington. Disturbance may be mechanical treatments or fires that reduce tree density. Growth indicates that time is needed so existing trees can grow larger or canopy cover can increase.

Landowner	Active Restoration Need (Disturbance Only, and Disturbance + Growth)	Percentage of Active Restoration Need
Federal	1,330,000 acres	43%
Private, industrial	583,000 acres	19%
Tribal	494,000 acres	16%
Private, small non-industrial	288,000 acres	9%
DNR	285,000 acres	9%
Department of Fish and Wildlife and other state agencies	74,000 acres	2%
Other	14,000 acres	0.5%
Total	**3.07 million acres**	

NOTE: The restoration need numbers for land ownership are proportionally allocated based on how much area each land ownership occupies within strata (biophysical setting by landscape level), as was done previously (Haugo et al. 2015, DeMeo et al. 2018). For example, if a given stratum needs 100,000 acres of total disturbance restoration need, and 60% of the forested area is DNR land and 40% is federal land, then 60,000 acres of total disturbance restoration need are distributed to DNR lands and 40,000 to federal lands. This is repeated for each stratum, and then the areas are summed to produce the table above. This estimate results in the restoration need across eastern Washington being distributed largely based on the proportion of land ownership in eastern Washington. It is not possible to determine exact restoration need acres by landowner. Table 1 should not be interpreted as the exact restoration need for each landowner, rather it is a high-level estimate based on the proportion of land ownership in eastern Washington.

Figure 4. Long-term trends in disturbance only, disturbance then growth, and growth only restoration need (acres) across forested areas of eastern Washington



Overall, active restoration need is trending in the right direction but is not changing fast enough to meet the goals of the forest health plan or to keep pace with climate change projections. The need to increase the pace of active forest restoration in eastern Washington is clear.

Shared Stewardship

In May 2019, in recognition of the need to address forest health issues across ownership boundaries and at a landscape-scale, DNR entered into a Shared Stewardship Investment Strategy Memorandum of Understanding (MOU) with the Washington Department of Fish and Wildlife (WDFW) and the Forest Service. The intent of the MOU is to "collectively focus investments on identified land management priorities in areas with promise to achieve the greatest benefit" and establishes a framework for continued partnerships and collaboration to address challenges related to forest health, including "catastrophic wildfires, invasive species, degraded watersheds, lost scenic and recreation integrity, and epidemics of insects and disease."

The statewide 2020 Forest Action Plan, released in October 2020, identifies priority areas to implement Shared Stewardship collectively, including the forest health plan's priority planning areas, which focus forest heath and landscape resilience work in eastern Washington.

20-Year Forest Health Strategic Plan Priority Planning Areas

Forest health and wildfire risks in eastern Washington are so widespread that it is logistically impossible to address them all at once. A prioritization process was essential to focus state and partner resources in high-priority landscapes and to successfully implement the treatment framework. Authority and direction contained in the framework directs DNR's efforts to improve forest health across all ownerships in large landscapes.

The first step of the framework is to select which priority watershed(s) will form the planning landscapes to analyze for forest health treatment need across all lands and focus investments. Priority planning areas (also sometimes referred to as priority landscapes or forest health planning areas) consist of one or more watersheds. DNR identifies priority planning areas through a data driven prioritization process at the watershed scale, followed by stakeholder feedback and engagement. Once a priority planning area is selected, DNR commits to conduct the forest health assessment across all land ownerships in that landscape as well as partner to implement and monitor forest health treatments and forest conditions over time.

2018 and 2020 Priority Planning Areas

In March of 2018, DNR finished identifying the first set of priority planning areas to evaluate for forest health treatment needs under the treatment framework in the 2018 and 2020 planning cycles (Fig. 5).

To guide this process, in 2017 DNR first completed a data driven prioritization of watersheds. Watersheds were scored based on a variety of forest health, wildfire risk, and value-based variables. The process to prioritize watersheds used two groups of metrics, or tiers:

- Tier 1 included metrics that represent forest health and wildfire risks: fire risk (fire probability and fire intensity), insect and disease risk, forest restoration opportunity, and projected increase in drought stress (climate change effects).
- Tier 2 included metrics that represent values at risk: aquatic resources (cold-water stream miles in 2040, habitat condition, and stream miles with threatened or endangered fish), wildlife habitat, wildland urban interface proximity, clean drinking water, and timber.

Scores for each metric were derived from one or more datasets that represent the best available current science. Watersheds were prioritized at both the HUC 5 (an average HUC 5 watershed is 150,000 acres in size) and HUC 6 (an average HUC 6 watershed is 20,000 acres) scales. DNR used

the HUC 6 watershed prioritization results to help inform the selection of the forest health priority planning areas. A detailed description of the methodology and results of the watershed prioritization process are available in Appendix 1, pages 42-52, of the 20-Year Forest Health Strategic Plan (HUC 5 watershed prioritization) and Appendix A of the 2018 Forest Health Assessment and Treatment Framework Report (HUC 6 watershed prioritization).

Robust stakeholder feedback and engagement built off the watershed prioritization process to identify state and local high-priority forest health needs and opportunities. The watershed prioritization informed boundaries of priority planning areas, but community and resource managers in each landscape ultimately determined final lines on the map. The forest health priority planning areas that have been established as part of the forest health plan will need to be adjusted over time due to changes in forest conditions and alignment with local and state priorities.

RCW 76.06.200 requires DNR to assess a minimum of 200,000 acres of fire prone lands each biennium to identify forest health treatment needs. DNR recognized that providing these assessments — high-level, scientifically grounded blueprints that identify the need and scale of active management — would be key to catalyzing action in each priority planning area. DNR, therefore, chose to exceed the minimum legislative assessment requirement in the first two biennia following legislation. Thirty-three initial priority planning areas were selected to focus all-lands forest health analysis, treatment, monitoring, and coordination efforts (Fig. 5). Three planning areas have been delayed for assessment until 2022 due to COVID-19 safety restrictions that prevented adequate field validation of data, and budget constraints that required changes and adjustment of science staff workloads. These three planning areas are called Highway 97, Asotin, and Touchet-Mill.

2022 New Priority Planning Areas

Applying previous watershed prioritization work, ongoing collaboration, and focused stakeholder outreach, DNR identified six additional priority planning areas to be assessed by December 2022 (Fig. 5). The new priority planning areas identify forests where active management and investments can improve forest health conditions based on scientific analysis and where partnerships and projects already exist to maximize strategic use of resources.

In total, DNR has selected 39 priority planning areas representing 4,434,008 acres to focus forest health assessments and investments. The priority planning areas provide a powerful footprint to continue implementing the forest health plan with partners in the biennia ahead (see Fig. 5 and Table 2).

Figure 5. Priority planning areas for 20-Year Forest Health Strategic Plan (RCW 76.06.200)

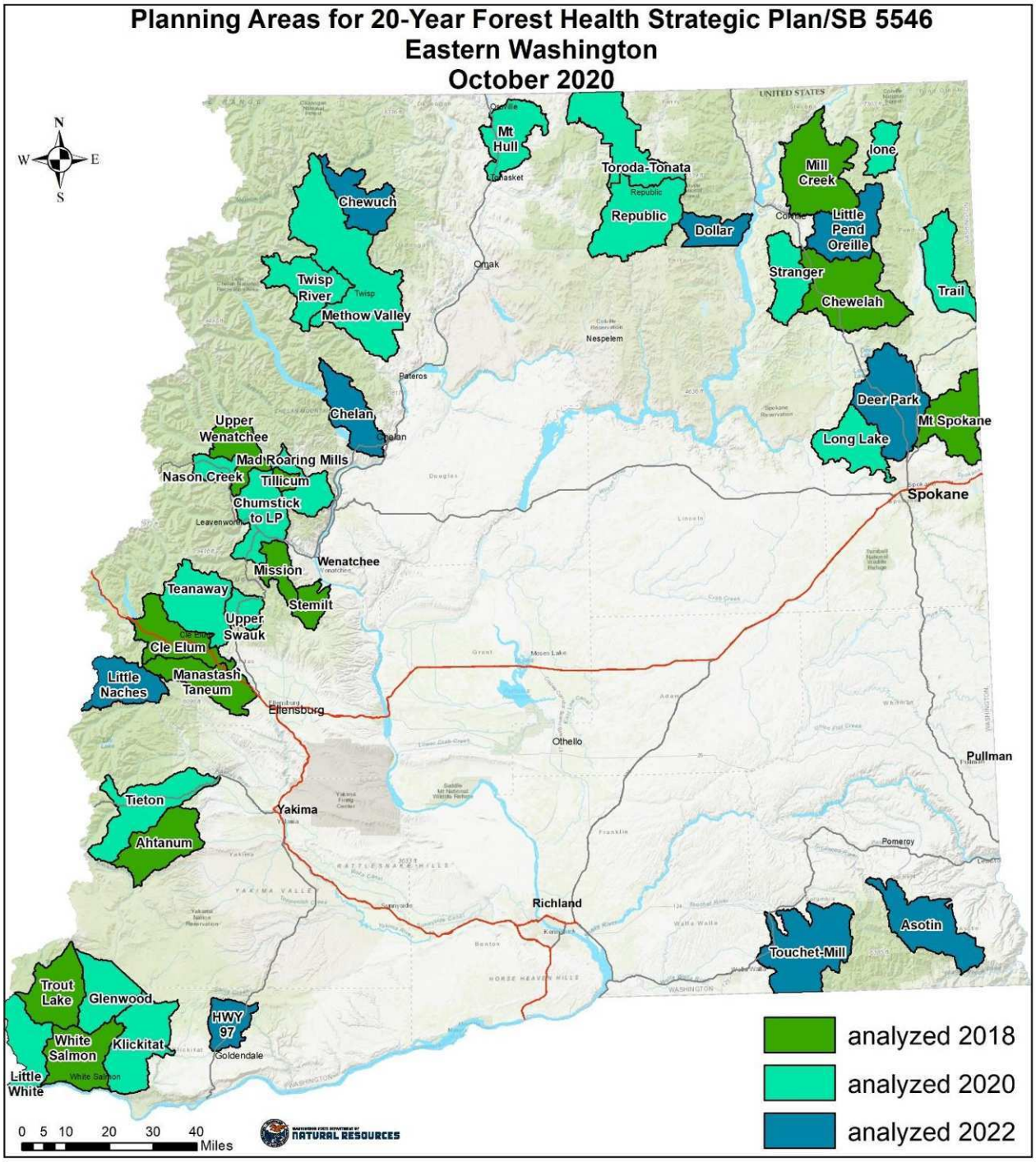


Table 2. Initial assessment year, acreage totals and forested acres by land ownership class for all 39 priority planning areas of the 20-Year Forest Health Strategic Plan

Planning Area	Year	Total Acres	Forested Acres	Total Forested Acres by Ownership Class					
				Federal	State	Private	Municipal or NGO	Tribal	Other
Ahtanum	2018	120,477	89,217	722	54,671	8,089	2,783	22,905	46
Asotin	2022	149,152	93,329	61,444	7,327	24,547	10	0	0
Chelan	2022	98,051	31,342	26,390	409	4,326	0	0	218
Chewelah	2018	195,408	158,352	83,667	7,068	67,026	387	145	58
Chewuch	2022	94,250	83,846	83,286	525	36	0	0	0
Chumstick to LP	2020	115,333	84,216	50,092	4,716	29,278	13	0	116
Cle Elum	2018	109,396	80,300	20,608	6,298	39,306	13,243	0	844
Deer Park	2022	181,171	90,497	0	5,014	82,795	2,436	0	252
Dollar	2022	61,238	50,767	45,873	442	4,325	0	117	10
Glenwood	2020	104,501	83,758	2,439	35,401	38,064	118	7,736	0
HWY 97	2022	60,398	37,415	12	116	35,760	1,104	423	0
Ione	2020	44,248	41,784	28,407	3,729	9,424	0	0	224
Klickitat	2020	149,649	103,274	2,205	19,962	78,127	1,403	1,576	0
Little Naches	2022	95,433	92,914	87,238	0	21	5,653	0	2
Little Pend Oreille	2022	117,820	105,372	50,770	25,122	29,255	0	0	226
Little White	2020	95,750	84,705	65,764	3,955	14,632	330	0	23
Long Lake	2020	103,291	41,253	279	7,315	32,443	620	6	590
Mad Roaring Mills	2020	65,008	33,325	24,340	3,129	5,796	0	0	59
Manastash Taneum	2018	104,072	65,833	25,272	31,312	2,019	7,228	0	1
Methow Valley	2020	338,246	182,937	147,457	16,699	18,722	3	0	58
Mill Creek	2018	186,306	162,060	50,337	18,477	93,112	0	0	133
Mission	2018	49,121	32,743	21,353	859	10,356	125	0	50
Mt Hull	2020	105,431	34,809	18,248	1,347	14,758	4	201	252
Mt Spokane	2018	121,767	95,814	0	19,463	75,873	353	0	124
Nason Creek	2020	31,679	29,243	17,640	491	10,975	0	0	136
Republic	2020	180,553	144,350	92,220	6,394	34,976	17	10,631	112
Stemilt	2018	38,961	22,613	2,463	9,648	7,665	2,828	0	9
Stranger	2020	89,904	72,061	547	17,798	53,697	0	0	19
Teanaway	2020	132,120	111,696	56,024	46,130	6,749	2,738	0	55
Tieton	2020	148,634	117,781	100,139	12,618	4,449	446	106	23
Tillicum	2018	14,326	11,241	9,190	145	1,905	0	0	0
Toroda-Tonata	2020	153,611	117,345	82,816	8,361	26,068	0	45	55
Touchet-Mill	2022	203,750	110,794	39,354	1,486	59,987	1,298	8,669	0
Trail	2020	105,242	94,948	40,033	8,400	41,596	1,140	3,728	51
Trout Lake	2018	117,153	105,015	65,443	18,290	21,278	0	4	0
Twisp River	2020	111,918	82,349	78,623	826	2,697	0	0	204
Upper Swauk	2020	39,175	35,450	34,524	31	747	0	0	147
Upper Wenatchee	2018	74,777	66,277	56,254	862	8,900	0	0	261
White Salmon	2018	126,688	104,022	6,260	27,174	69,822	181	164	421

NOTE: Private land includes both industrial and non-industrial private lands. Report generated based on October 2020 priority planning areas, forested raster layer form May 2020 and ownership layer from July 2020. NGO is nongovernmental organization.

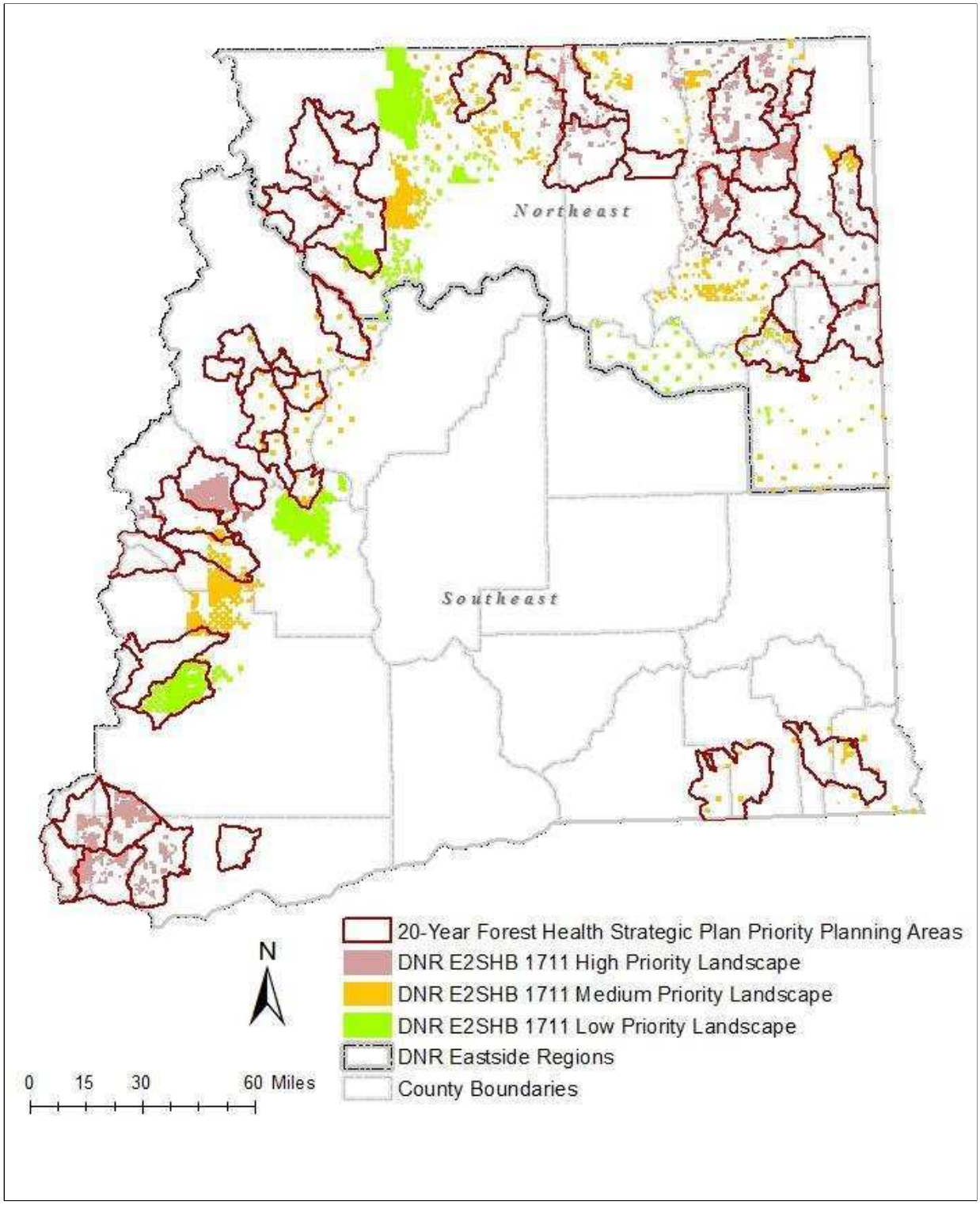
Overlap of priority planning areas with Engrossed Second Substitute House Bill 1711 DNR Priority Landscapes

The all-lands process that led to the identification of priority planning areas for implementation of RCW 76.06.200 through the forest health plan is different from DNR state trust lands' prioritization process to implement E2SHB 1711. Under E2SHB 1711, DNR's obligation is to prioritize state trust lands for forest health treatment according to its own values and goals within a collaboration and landscape-scale context. E2SHB 1711 prioritization identifies high, medium, and low priority landscapes for forest health treatment to inform treatment needs for the next two, six and 20 years (Fig. 7). Many of the state trust lands prioritized treatments occur in the forest health plan's priority planning areas, ensuring that DNR's work to fulfill legislative direction is done in concert for landscape-level change (Fig. 6). For details on the prioritization process and treatments on DNR state trust lands, see this year's E2SHB 1711 legislative report.

Figure 6. DNR state trust lands Virginia Ridge forest health treatment project in 2019 in the Methow Valley priority planning area within a shared priority geography

(John Marshall Photography)

Figure 7. Map showing priority planning areas of the 20-Year Forest Health Strategic Plan and DNR state trust lands priority landscapes



Forest Health Assessment and Treatment Framework Methodology

Landscape evaluations and prescriptions

Following identification of priority planning areas, DNR assessed the current condition of each landscape and its level of resilience to future disturbances and climatic change using a terrestrial landscape evaluation. DNR is employing the landscape evaluation and prescription process described below to assess and prioritize the forest health treatment needs in the forest health priority planning areas as required by RCW 76.06.200. The landscape evaluation serves as the assessment component of the Forest Health Assessment and Treatment Framework.

A landscape evaluation is a data driven approach to understanding the current condition of a landscape, its level of resilience to disturbances and climatic change, and its ability to provide an array of ecosystem services over time (Hessburg et al. 2015). Ecosystem services are commonly defined as the benefits people obtain from ecosystems including cultural values, regulation of climate, and provision of food, fresh water, fuel, fiber, and other goods. An evaluation includes detailed information about vegetation departure from resilient landscape conditions, fire risk, projected climate change effects and associated drought stress, wildlife habitat, and other resources. Evaluations are first conducted ownership-blind (without knowledge of who owns the land), and management objectives of different public and private landowners are later incorporated into the evaluation process.

DNR defines resilience as the ability of a landscape (or ecosystem) to sustain desired ecological functions, robust native biodiversity, and critical landscape processes over time and under changing conditions. In terms of wildfire, a resilient landscape is able to adapt to a warming, drying climate and increases in wildfire by shifting to more drought- and fire-tolerant tree species, fuel structures, and landscape patterns that are aligned with future climate and fire regimes. A resilient landscape is resistant to large-scale, high severity fires and drought-induced tree mortality that can lead to rapid, destabilizing shifts in conditions that make adaptation much more challenging.

A primary output of the landscape evaluation is a summary of vegetation conditions (e.g., forest structure and composition) that are under- or over-represented relative to historical and future reference conditions, current fire and drought risk, and wildlife habitat needs. Landscape patterns are also analyzed to assess whether vegetation is overly fragmented or aggregated, which affects habitat suitability, and fire and insect behavior. In addition to terrestrial conditions,

an aquatic evaluation is done to summarize conditions and prioritize restoration of the stream network and associated fish habitat, riparian vegetation, and road related effects. Opportunities to reduce road related effects, floodplain restoration, and in-stream habitat enhancements are identified and prioritized. Due to a lack of capacity, DNR relies on collaborative partners to complete aquatic evaluations, in some cases with grant support from the agency.

Landscape evaluations are utilized to both estimate overall treatment needs and to prioritize treatments based on fire risk to forest ecosystems, current and future drought vulnerability due to climate change, and forest structure types that are overabundant relative to desired reference conditions. This information and data are then synthesized into a landscape prescription that is a key part of a landscape evaluation. The landscape prescription quantifies the shifts in vegetation conditions and patterns that are needed to create a landscape that is resilient to wildfire, drought, and drought related insect outbreaks (Hessburg et al. 2015). Overall treatment needs are estimated in the landscape prescription and then broken down by specific forest types (e.g., cold, moist, or dry), structure (tree size and density), and species composition in some cases.

Locations within the target landscape are then prioritized for treatment based on fire risk to forest ecosystems, current and future drought vulnerability due to climate change, and forest structure types that are overabundant relative to desired reference conditions. Wildfire transmission to homes is then added to highlight locations where fire starts pose the highest risk to homes. The goal of the landscape treatment prioritization is to identify where treatments will accomplish the greatest amount of fire risk reduction and climate adaptation work, while also reducing fire risk to communities. In addition, locations best suited to sustain and manage for large tree, closed canopy forests over time are identified in a companion layer to help managers meet wildlife habitat, timber production, and carbon storage objectives.

This landscape evaluation process, described later in more detail, is utilized by DNR to assess and prioritize forest health treatment needs in priority planning areas as required by RCW 76.06.200. This process provides a common scientific basis, set of data products, and a language for landowners to understand current conditions, risks to different resources, and future trends. It further encourages cross-boundary coordination, builds consensus around treatment targets, and maintains social license for the long-term goals of the forest health plan. Evaluations provide a benchmark to track progress towards achieving desired forest health conditions.

It is important to note that landscapes evaluations are living documents – wildfires and other major natural disturbances will occur in planning areas at all stages of the planning and implementation process; indeed wildfires in 2018 affected several 2020 planning areas. Given current trends, it is highly likely that wildfires (managed or unmanaged) will burn more acres

than can be treated over the life of the forest health plan and will thus shift vegetation conditions over hundreds of thousands of acres in both positive and negative directions. Ideally, planning areas can be treated before a major wildfire occurs to help ensure positive outcomes and provide fire managers with options to allow wildfires to do good work under safe burning conditions. Methods are currently being developed to quickly assess wildfire effects and update landscape evaluations and prescription to include post-fire treatments, as well as revised targets for the unburned portion of the planning area.

Finally, updates to landscape evaluations will occur as treatments, other natural disturbances, and growth change conditions on the ground; as input datasets for current conditions are improved; and as methodologies are refined based on new science and monitoring results. As completing the recommended treatments in any one planning area will take five to 15 years, stakeholders and landowners should expect several updates to the landscape evaluation for a specific planning area. These updates may include changes to treatment targets.

Landscape evaluations have evolved since the 2018 report

Over the past two years, DNR scientists have added important new components to the landscape evaluations based on feedback from partners and legislative requirements. On the forest health side, these include treatment spatial prioritization, assessment of treatment type based on operational and economic feasibility, and identification of locations where managing for closed canopy and large-tree forest structure will be most sustainable over time. To integrate community wildfire protection and other goals of House Bill 1784, a wildfire response benefit component was added to landscape evaluations. This includes an analysis of locations where fuel treatments could provide benefits for wildfire operations in addition to forest health benefits, hereafter referred to as dual benefit. This dual benefit means that treatments in these prioritized areas will address forest health needs but also provide strategic locations for firefighters conducting suppression actions, prescribed fire, or managed wildfire. In addition to new components, many of the methods and datasets described in the 2018 report have been upgraded or improved. These components and improvements are briefly described below (methodology items 1-9) followed by new components (methodology items 10-14).

House Bill 1784 pilot project priority planning areas

- Methow Valley
- Twisp River
- Chumstick to LP
- Nason Creek
- Upper Wenatchee
- Cle Elum
- Manastash Taneum
- Teanaway

The process to develop a collaborative framework that prioritizes for the dual benefit of forest health and wildfire response occurred from spring to fall

of 2020 in eight priority planning areas that are part of the House Bill 1784 pilot project. As such, only priority planning areas included in the HB 1784 pilot have had the full landscape evaluation analysis completed following the 2020 methods version of the landscape evaluations. The remaining priority planning areas, including 2018 priority planning areas, will be updated to the full 14-point analysis over time. A detailed description of the methods is provided in Appendix B, and a description of the HB 1784 pilot project is described in Appendix C.

Methodology

The methods used to conduct landscape evaluations and prescriptions are based on the best available science regarding landscape restoration (Hessburg et al. 2015, Spies et al. 2018), quantitative wildfire risk assessment (Scott et al. 2013), analysis of cross-boundary wildfire transmission (Ager et al. 2019a) and climate change adaptation strategies (Halofsky et al. 2016, Littell et al. 2016). The approach utilizes the framework for landscape evaluations developed for the Okanogan-Wenatchee National Forest (OWNF) Restoration Strategy (Hessburg et al. 2013). In addition, input from local land managers and stakeholders was incorporated at various stages of the process for a specific planning area. A summary of the core components is provided below. A full description of the methods is in Appendix B.

1. **Identify ownership types and management objectives:** Spatial distribution of different ownership types and corresponding management objectives provides important context for types of treatments and long-term forest structures that are possible in different parts of a priority planning area. DNR updated its ownership layer for eastern Washington based on 2019 county parcel Geographic Information System (GIS) layers, DNR State Uplands ownership information, Forest Service ownership layers, and other sources.

2. **Map vegetation and forest types:** A consistent vegetation-type layer was built across eastern Washington. First, an improved forest mask was built from a combination of LANDFIRE, NLCD (National Land Cover Dataset), and Nature Serve. Forest type (potential vegetation type) was derived for forested areas from 2012 Integrated Landscape Assessment Project (ILAP) potential vegetation type layer (Hemstrom et al. 2014). Improvements to ILAP done by Jan Henderson of the Forest Service from 2012 to 2014 for much of northeast Washington and the eastern Cascades were included. For non-forest areas, LANDFIRE existing vegetation type data were used. To simplify results, vegetation types were grouped into cold, moist, and dry forests. Dry forests are ponderosa pine and Douglas-fir dominated forests that historically had low severity fires every five to 25 years. Moist forests historically had mixed severity fires. They include sites in draws, north facing aspects, and valley bottoms that had fire return intervals of

80-200 years or more and were typically dominated by fire intolerant conifers such as grand fir or western red cedar. They also include sites that historically had more frequent fire (about every 30-100 years) and were typically dominated by Douglas-fir, western larch, and ponderosa pine. Cold forests are mid- to upper-elevation forests that historically had high severity fires every 80-200 years or more and were dominated by subalpine fir, Engelmann spruce, lodgepole pine, as well as other conifers.

3. **Map current forest structure and species composition:** Current condition information for forest structure and composition was obtained in two ways based on the systems used in the national forest in that area. For priority planning areas in northeast Washington and south and east of Mount Adams, 2015-2017 Light Detection and Ranging (LiDAR) or 2017 Digital Aerial Photogrammetry (DAP) data were used. The DAP process produces forest structure data from National Agriculture Imagery Program (NAIP) aerial imagery similar to those produced with LiDAR, and the methods used to analyze these data are identical. Gradient nearest neighbor (GNN) data was used to fill in small portions of planning areas where LiDAR or DAP does not exist. Eight structure classes were defined based on canopy cover classes (open: less than 40 percent cover; moderate: 40 to 60 percent cover; closed: more than 60 percent cover); and three tree size classes (large: overstory diameter (OD) greater than 20 inches; medium: OD of 10 to 20 inches; small: OD under 10 inches). For reporting, the eight classes were condensed. Data for planning areas along the eastern Cascades was obtained through photo-interpretation of digitized, stereo imagery using the OWNF Restoration Strategy (USFS 2012) approach. To ensure consistency in evaluation summaries, results for seven structure classes used in this photo interpretation (PI) system were condensed into the same classes used in the LiDAR based approach.

4. **Assess departure from reference conditions:** Current forest conditions are compared with historical and future reference conditions to assess how healthy, or out of whack, the priority planning area is. This does not mean that these reference conditions are the end goal. Instead, they provide a baseline for conditions DNR scientists think are resistant and resilient to large-scale, high-severity disturbances while providing a range of other ecosystem services such as clean water, recreation, and wildlife habitat (Franklin and Johnson 2012, Hessburg et al. 2013). The primary outputs of a departure assessment are the number of acres of different structure and vegetation type classes that are too high, too low, or within range relative to the reference condition range. Departure of species composition (cover type) and pattern are also assessed and added where they do not overlap with forest structure departures. A map of departed structure classes was then created to identify where treatments should be focused to address departures.

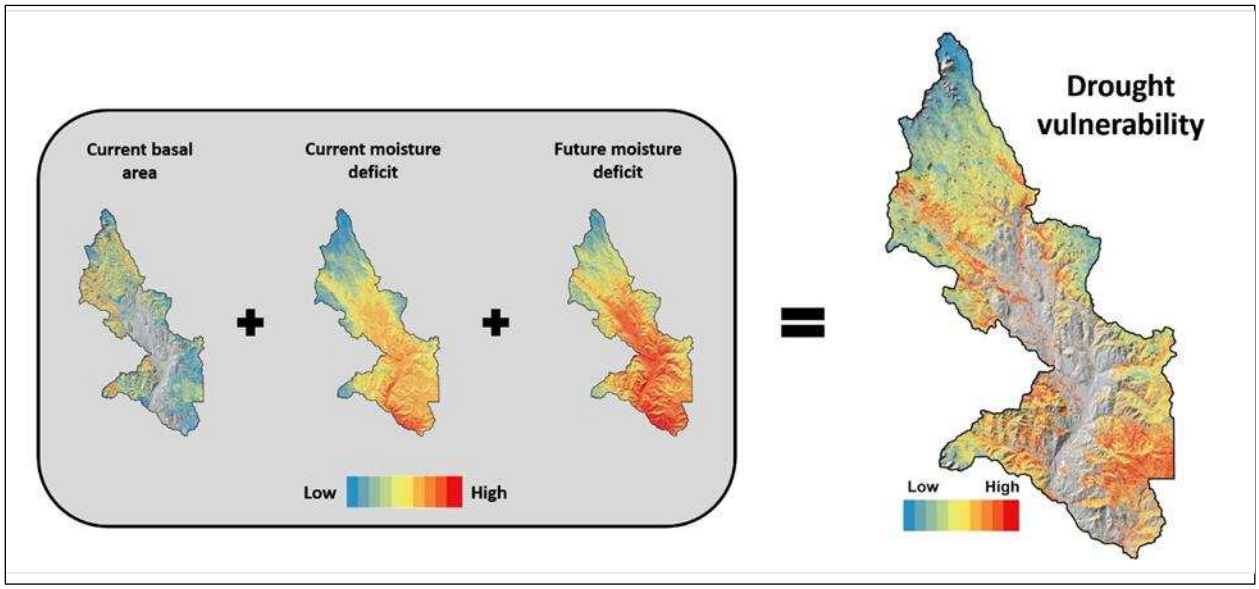
Similar to forest structure, two different methodologies were used. For planning areas with LiDAR current condition data, reference conditions were derived from state and transition models (STM) that were developed for the ILAP project and the Colville National Forest plan revision and upgraded by DNR scientists. For areas with PI current condition data, historical and future reference conditions from early to mid-20th century aerial photographs were used (USFS 2012).

5. **Assess wildfire risk:** Data products from the 2017 Pacific Northwest Quantitative Wildfire Risk Assessment (Gilbertson-Day et al. 2018) were used to quantify fire risk across each planning area. DNR staff calculated fire risk (expected net value change) by combining annual fire or burn probability, expected fire intensity as measured by flame length, and the response of different resources to flame length (Scott et al. 2013). Risk to homes, infrastructure, and forest (overstory tree mortality) was calculated and then combined. Risk levels were placed in six categories based on relative values across all planning areas: extreme, very high, high, moderate, low, and beneficial. Maps of conditional net value change – the risk of loss or benefit without fire probability factored in – were generated to examine expected loss or gain irrespective of fire probability in each planning area. Burn probability and intensity were derived from large-fire simulator FSim models that used patterns of fire weather, ignitions, and large fire spread from 1992-2015. This risk assessment did not directly include fire effects on wildlife habitat, watershed function, or other resources. Fire risk in non-forested shrub-steppe areas was only calculated for homes and infrastructure.

6. **Analyze drought vulnerability:** This analysis assessed vulnerability to current and predicted future moisture stress, and is the primary way that climate change adaptation strategies were incorporated. Moisture stress, as measured by climatic water deficit (deficit), is a good predictor of vegetation type in moisture-limited ecosystems and is a primary driver of large insect outbreaks (Kolb et al. 2016). Deficit was calculated at 90 meter pixel resolution for the 1981-2010 and 2041-2070 time periods. Deficit levels were placed into four deficit zones – low, moderate, high and extreme – that were then associated with vegetation groups for each planning area based on plot data and field verification. Maps of current and future predicted zones were generated for each planning area to assess magnitude of the predicted effects of climate change (Fig. 8). General areas within each planning area were identified where forest is unlikely to be supported in the future, where moist and cold vegetation types are likely to transition to dry vegetation types, and where moist and cold vegetation types are likely to be sustained in the future. Finally, a drought vulnerability index was generated using current and future deficit along with forest density from either basal area (modeled from LiDAR)

or canopy cover (Fig. 8). Note that there is considerable uncertainty in climate models regarding timing and mechanisms (e.g., fire, drought, regeneration failures) that will drive vegetation transitions, although the direction is clear. Thus, these maps should not be used as fine scale maps of predicted future vegetation.

Figure 8. Individual inputs to the drought vulnerability metric. The gray box shows individual metrics that constitute the drought vulnerability metric (right).



7. **Map habitat for focal wildlife species:** Focal wildlife species were identified for each planning area through a process that involved wildlife biologists from multiple agencies and tribes. Specific habitat requirements and the location of that habitat for each species was mapped across all planning areas based on current conditions data and habitat classifications. The sustainability of this habitat was then analyzed based on fire risk and drought vulnerability to highlight locations across each planning area where treatments may be needed to build or maintain open canopy structure (e.g., higher fire and drought risk), as well as closed canopy, large tree structure (e.g. lower fire and drought risk locations). This information is intended help managers identify key areas to protect as well as where treatments can provide necessary habitat features to sustain focal species and address vegetation pattern needs such as reducing fragmentation by building larger areas of contiguous habitat.

8. **Evaluate aquatic function:** These evaluations are conducted to better understand aquatic and riparian forest function in the planning area and determine restoration needs and priorities. This can include assessments of fish habitat, road impacts (e.g., the Geomorphic Road Analysis and Inventory Package, or GRAIP), water yield, or fire risk to

drinking water areas. DNR currently does not have the capacity to conduct these evaluations and relies on partners to conduct them. To date, aquatic assessments have been completed for the Manastash-Taneum, Upper Wenatchee, Twisp, and Stemilt priority planning areas. Aquatic assessments are in progress or being discussed for Tieton, Nason Creek, Teanaway, and several other planning areas.

9. **Estimate treatment targets:** Treatment needs for a priority planning area are first generated from the departure analysis. Dense structure-vegetation group classes (e.g., dry forest-large dense, moist forest-medium dense) that are higher than the reference range are selected. These are the classes where departure can be shifted through active versus passive management. For these departed, dense classes, the number of acres needed to shift the class to the upper range of the reference range was calculated. This is the low end of the treatment range. The high end of the treatment range is the number of acres needed to shift the class to the mid-point of the reference range. In cases where small-dense classes are not currently departed but will be soon due to growth, treatment acres for small-dense classes were added. Targets for maintenance treatments in existing open, large, and medium tree size classes on dry and moist forest sites were added. Maintenance treatment targets were based on the estimated need to treat over the next 10-15 years 50 to 75 percent of existing open canopy dry forest and 25 to 50 percent of open canopy moist forest.

   Targets for each class were rounded to the nearest 250- 500 acres and then summed together to get the range of total treatment need. Targets were adjusted for some planning areas based on a number of local site factors (see Appendix B for more details). The treatment need numbers were then compared with a fire severity departure analysis that compares predicted fire severity across the priority planning area with desired ranges for low, moderate, and high severity in dry, moist, and cold forests. This served as an independent method of assessing treatment need. Treatment needs were broken out by anticipated treatment type based on tree size class. As discussed in the Results section, individual landowners will determine actual treatment types based on many factors.

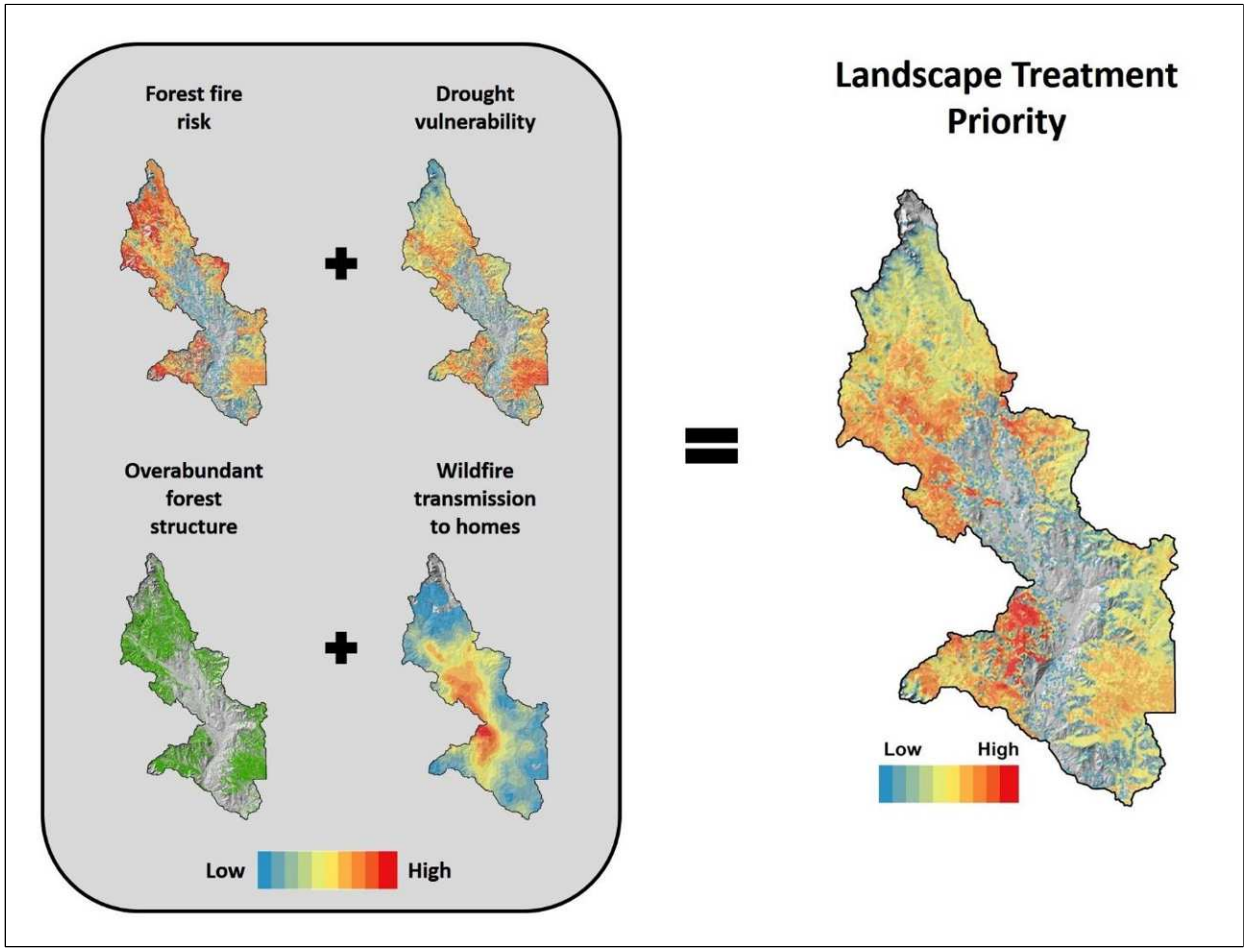
10. **Evaluate operational feasibility and economics:** This analysis evaluates logging system type and projected revenues for potential treatment locations. Slope, road system, overstory tree size, and volume layers were fed into a tool that produced a map of operational units. Logging system type (ground, cable, helicopter) and potential revenue were generated based on parameters for maximum slope for ground based yarding, maximum and average yarding distances, log prices, haul costs, etc. This information was

intended as a general assessment showing which parts of a priority planning area are accessible for mechanical treatments or need fire based treatments, as well as which areas are likely to generate revenue, be revenue neutral, or require investments. Managers can use this information for delineating operational units and to prioritize locations for field based operational assessments. The outputs of this tool will be further refined based on feedback from managers.

11. **Map dense forest, large tree sustainability:** While dense or closed canopy forests are over abundant in most of eastern Washington, they are still part of resilient landscapes in eastern Washington. They provide important ecosystem services such as wildlife habitat, wood production, carbon storage, biodiversity, and hydrological functions, especially when they contain large trees. To help managers determine where to retain and manage for dense forests, locations were identified where this forest structure type is most likely to persist through future fires and climate warming. First, areas were mapped based on current condition data with closed canopies and large tree structure (quadratic mean diameter (QMD) greater than 15 inches and canopy cover greater than 50 percent), as well as potential areas that can develop this stand structure quickly (QMD greater than12 inches diameter at breast height (DBH) and canopy cover less than 40 percent). Current and potential large-tree closed canopy areas were then scored with a sustainability index based on current and future moisture deficit and fire risk.

12. **Prioritize landscape treatments:** Locations with each priority planning area are prioritized for treatment based on three measures of forest health that are each described above and one measure of community wildfire risk that are given the same approximate weight (Fig. 9). These include fire risk to forest ecosystems (methodology item 5), current and future drought vulnerability due to climate change (methodology item 6), and forest structure types that are overabundant relative to desired reference conditions (methodology item 4). Wildfire transmission to homes is then added to highlight locations where fire starts pose the highest risk to homes (Ager et al. 2019a). The goal of the landscape treatment prioritization is to identify where treatments will accomplish the greatest amount of fire risk reduction and climate adaptation work, while also reducing fire risk to communities. To ensure that habitat for wildlife dependent on large tree, closed canopy forest is incorporated into treatment planning, DNR recommends overlaying the large dense forest sustainability layer over the landscape treatment priority layer to help inform treatment locations. Note that this landscape-level treatment prioritization does not currently include other factors that influence whether a specific site should be treated or not, such as cultural resources, species composition, sensitive soils, operational considerations, or economic objectives.

Figure 9. Individual inputs to the landscape treatment prioritization. The gray box shows individual metrics that constitute the landscape treatment priority metric (right). Warm colors represent higher values and cold colors represent lower values except for the overabundant forest structure map for which green shows presence. Individual metrics mapped at a resolution of 18-acre polygons were normalized to a score of one to 100. The metrics in the gray box were added to obtain the landscape treatment prioritization map shown on the right.

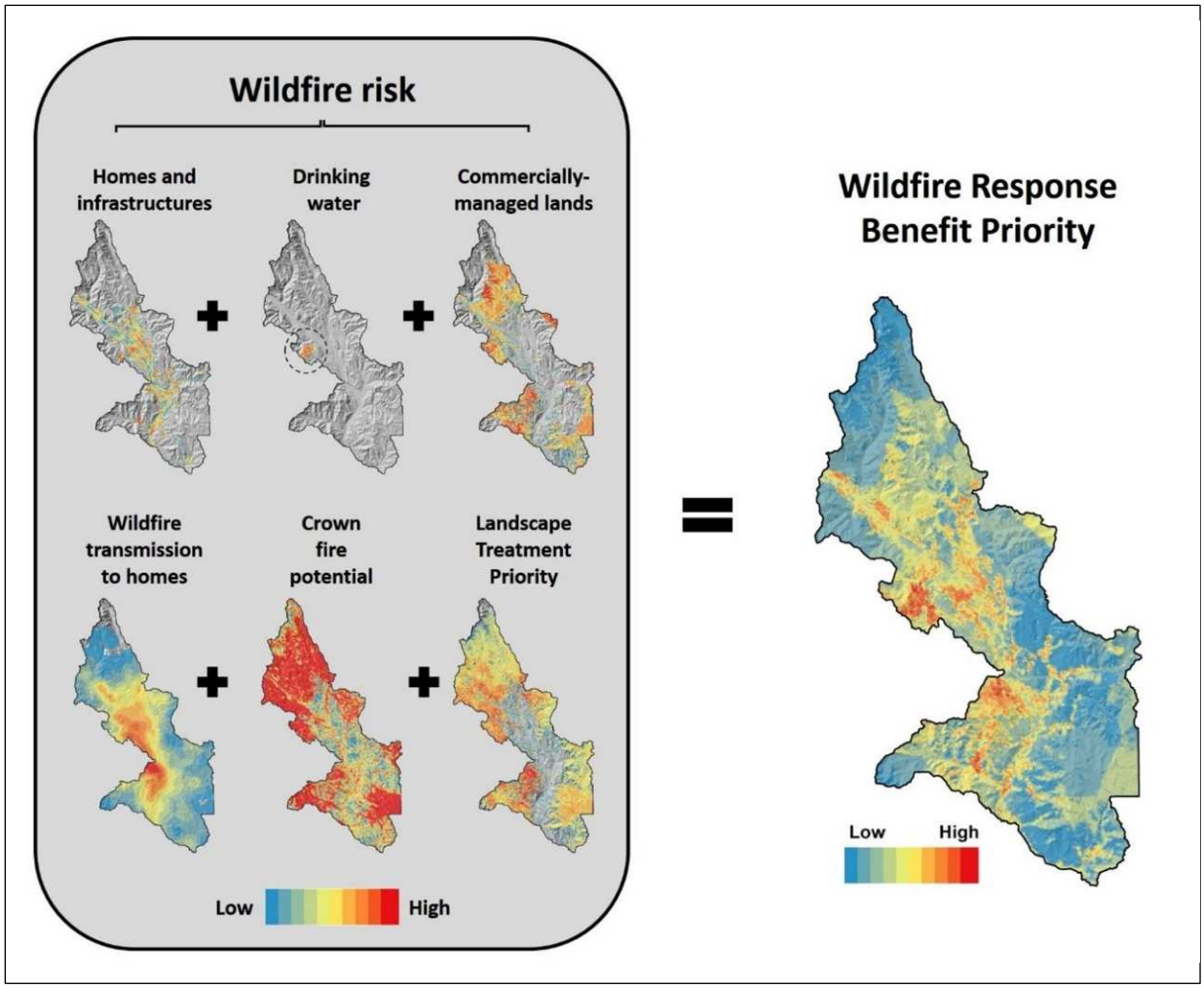


13. **Prioritize wildfire response benefit:** The wildfire response benefit metric identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes and infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior (Fig. 10). This metric also includes the landscape treatment prioritization map previously described in methodology item 12, again emphasizing the concept of dual benefit. Specifically, the metric uses three risk layers for which risk is calculated using methods described in methodology item 5. Risk layers reflect highly valued resources: homes and infrastructures, commercially managed lands and sources of surface drinking water. Commercially managed lands were defined as a subset of

forestland and included industrial, DNR trust lands, tribal land, Forest Service land where timber is a primary objective, and private non-industrial lands with more than five acres. Risk to homes were based on DNR's wildland urban interface map to identify where homes exist on the landscape. Infrastructures were mapped based on data products from the 2017 Pacific Northwest Quantitative Wildfire Risk Assessment (Gilbertson-Day et al. 2018) combined with local data where available. The location of surface sources of drinking water were based on publicly available atlas of sources of drinking water from the Washington State Department of Health.

The wildfire response benefit metric also includes a transmission map (described above) and a crown fire potential metric modeled with FlamMap, assuming the 97th percentile fire weather for each priority planning area. All variables described above were converted to a score between 1-100 where 100 represents the maximum value for each variable in each priority planning area. High benefit areas may constitute strategic opportunities for forest health and fuel treatments. Additional work at the local level will be required to identify appropriate actions and assess treatment feasibility. In other areas of high response benefit, treatments along escape routes, resident and community fire mitigation activities (e.g., defensible space, home hardening), and improving signage and road conditions may be required.

Figure 10. Individual inputs to the wildfire response benefit priority metric. The gray box shows individual metrics that constitute the wildfire response benefit priority metric (right). Individual metrics, mapped at resolution of 18-acre polygons, were normalized to a score of one to 100. The metrics in the gray box were added, using different weights, to obtain the wildfire response benefit map shown on the right. The landscape treatment priority metric weighted at 25 percent and the remaining metrics (three wildfire risk layers, wildfire transmission to homes, and crown fire potential) collectively accounted for the remaining 75 percent.



14. **Prioritize for dual benefit using wildland fire Potential Operational Delineations (PODs):** Wildland fire Potential Operational Delineations (PODs) is a framework to conduct cross-boundary pre-fire analysis and planning to increase wildfire response safety and efficiency (Thompson et al. 2016). In a PODs framework fire operations personnel define large landscape areas that are surrounded by potential control lines, i.e., natural and artificial areas that provide strategic opportunities for fire operations (Fig. 11). Potential control lines can be roads, ridgelines, old fires, and treated areas. There are

multiple uses for PODs landscape areas, including pre-fire response planning and development of fire response plans for each landscape based on quantitative assessments of value at risk.

The landscape evaluation process uses PODs to summarize, visualize and communicate dual benefit priorities qualitatively using a three priority ranking (Fig. 11). Dual benefit refers to potential treatment actions that benefit both forest health (by restoring a resilient forest condition) and fire operations (by creating strategic opportunities for safer and effective fire engagement). Specifically, DNR used the landscape treatment priority metric to prioritize PODs and used the wildfire response benefit priority metric to prioritize potential control lines (PLCs). Individual values of the landscape treatment (Fig. 9) were summed across each POD and divided by the forested area in each POD. Priority rankings of PODs were based on the landscape treatment prioritization value per acre of each POD. To prioritize PCLs (the boundaries of PODs) DNR used the wildfire response benefit priority metric (Fig. 10). DNR used the tool ForSysX (Ager et al. 2019b) to create PCL projects based on each project's total wildfire response benefit value and rank each PCL project based on its wildfire response benefit value per acre. See Appendix B for a detailed description of the prioritization process.

DNR used the PODs delineations for the Okanogan-Wenatchee National Forest as a starting point for a cross-boundary PODs delineation and, through the HB 1784 pilot, initiated a collaborative process of vetting and adjusting current delineations using input from local fire districts and DNR wildfire staff. The process of vetting and adjusting PODs is ongoing. Coordination between all agencies with wildfire responsibilities will require continued engagement and dialogue among all partners. Furthermore, as actions occur in these landscapes to change risk and forest health conditions, priorities, i.e., the colors shown in Fig. 11, will change. The HB 1784 pilot is one step toward a long-term, cross-boundary process to increase forest health and resilience and protect communities in priority planning areas.

The final two steps of this methodology were developed through a pilot effort to inform DNR's implementation of HB 1784 in coordination with partners in three geographies in eastern Washington: Methow Valley, Leavenworth, and Cle Elum (Fig. 12). These geographies include eight priority planning areas, so the landscape evaluations for these priority planning areas serve as an example of the completion of the treatment framework as amended by HB 1784. Moving forward, DNR will add these new landscape evaluation components to all priority planning areas. See Appendix C for a full summary of the HB 1784 pilot project process.

Figure 11. From Potential Operational Delineations to priority rankings of dual benefit. Potential wildland fire Operational Delineations (PODs) correspond to large landscape areas surrounded by potential control lines (PCLs, shown in red with white fill). PCLs can be ridgelines, roads, old fire scars or treatments and correspond to locations where firefighters have a strategic opportunity to engage and where there is potential for fire control. Having a PCL does not guarantee successful outcomes. PODs were ranked based on the landscape treatment priority metric (see Fig. 9), and PCLs were ranked based on the wildfire response benefit priority metric (see Fig. 10). The dual benefit priority map shows PCL priorities and POD priorities combined in the same map to highlight opportunities for treatments that provide a dual benefit of forest health and wildfire response benefit. Red areas show first priority, yellow areas show second priority, and blue areas show third priority.

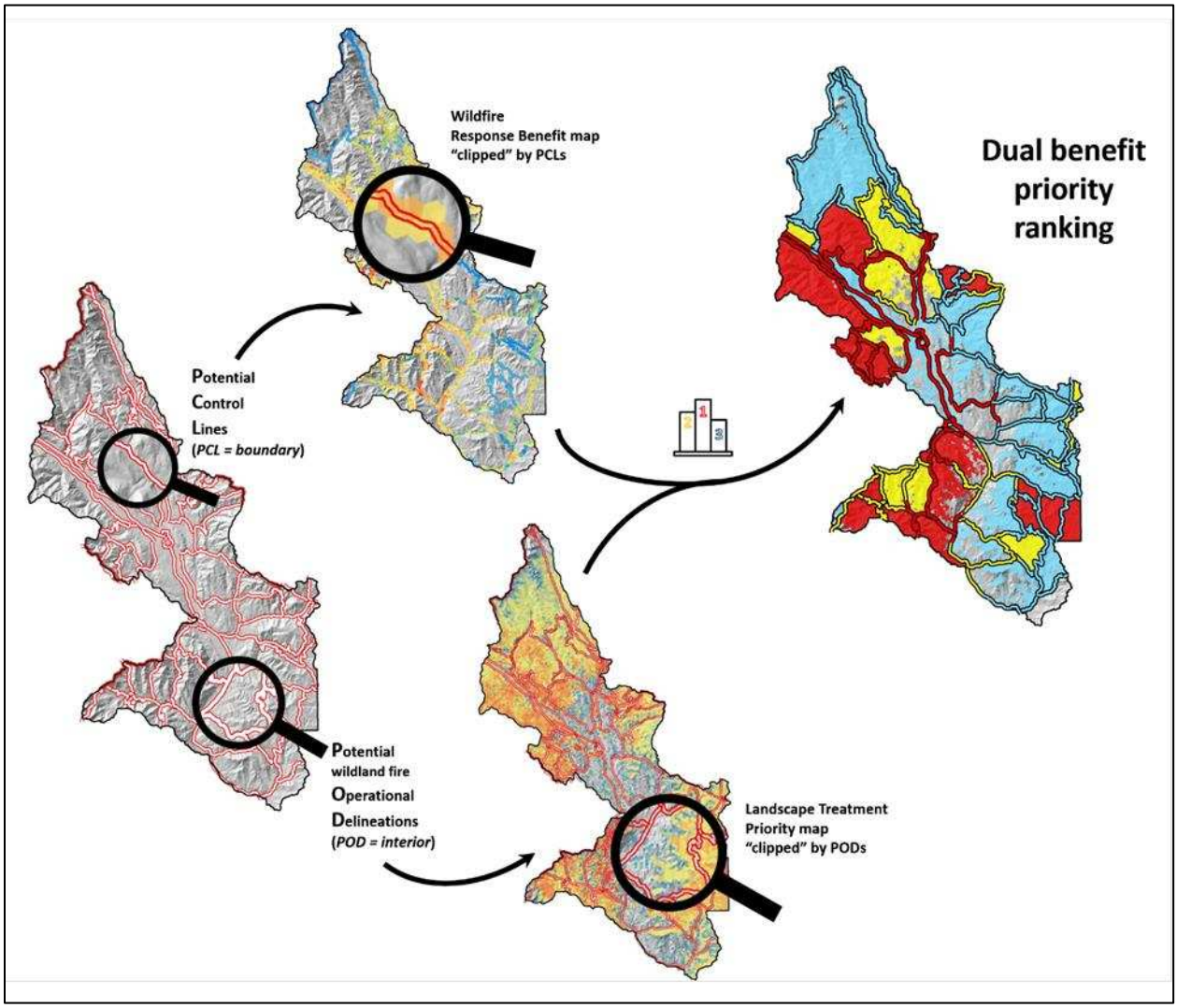
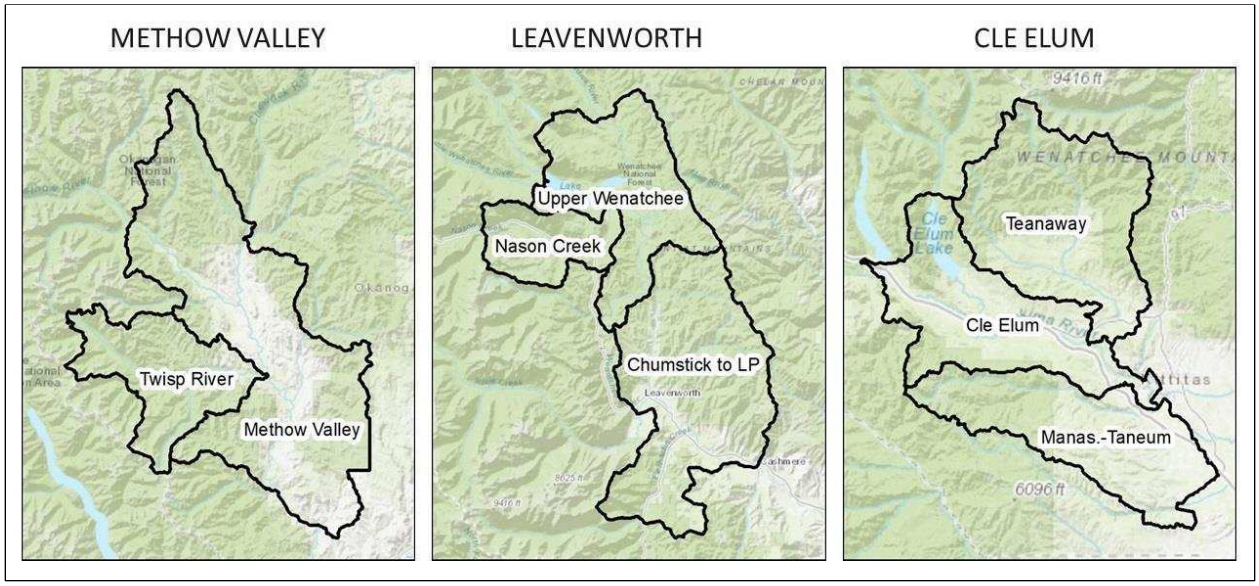


Figure 12. Pilot areas used to integrate the requirements of House Bill 1784 into the Forest Health Assessment Framework. The pilot areas are comprised of forest health priority planning areas as shown in the figure.



Forest Health Treatment Need Assessment Results

2018 and 2020 Priority Planning Areas Assessment Results

DNR completed landscape evaluations for 2018 and 2020 priority planning areas to assess the forest health treatment need within these landscapes (Tables 3 and 4). Thirty priority planning areas were evaluated comprising 3,372,745 acres. The purpose of landscape evaluations is to set high-level forest health treatment target recommendations for each planning area so that DNR, landowners and other stakeholders understand the level and types of treatments needed to create forest conditions that are resilient to large-scale disturbances. It also helps landowners work together to implement landscape-scale treatments and provide a benchmark to track progress on achieving resilient landscape conditions. It is important to note that estimated forest health treatment need derived from a landscape evaluation is a range, rather than a set number, as fire-dependent landscapes are dynamic. Representing treatment need as a range also accounts for potential tradeoffs in forest management goals among different landowners.

Based on landscape evaluations for 2018 (12 areas) and 2020 (18 areas) priority planning areas, DNR estimates that 807,720 to 1,162,620 acres of treatments are needed to move these landscapes into a resilient condition. Across all priority planning areas, this equates to approximately 32 to 47 percent of forested area.

Table 3. Forest Health Treatment Needs for the 2018 Forest Health Priority Planning Areas

Planning Area (2018)	Forest Structure Class (acres)		
	Small Dense[1]	**Medium-Large Dense[2]**	**Medium-Large Open[3]**
Chewelah[4]	500 - 1,000	50,000 - 65,000	8,500 - 14,000
Mill Creek	1,000 - 2,000	54,000 - 72,000	2,000 - 6,000
Mt Spokane	500 - 1,000	21,000 - 29,000	4,000 - 8,500
Upper Wenatchee	-	15,000 - 25,000	500 - 2,000
Stemilt	-	6,200 - 7,900	3,000 - 5,700
Manastash-Taneum	3,500 - 6,500	11,000 - 19,000	2,000 - 4,000
Cle Elum[4]	1,500 - 2,500	15,500 - 24,000	5,000 - 9,000
Ahtanum	2,000 - 2,500	13,000 - 18,500	4,000 - 8,000
Trout Lake	-	17,500 - 31,000	1,000 - 2,000
White Salmon	500 - 1,000	35,000 - 47,000	2,500 - 6,000
2018 Structure Class Total	**9,500 - 16,500**	**238,200 - 338,400**	**32,500 - 65,200**
2018 Subtotal	**280,200 - 420,100 acres**		
Tillicum[5]	7,614		
Mission Maintenance[5]	10,406		
2018 Total	**298,220 - 438,120 acres**		
Anticipated Treatment Type	[1] Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).		
	[2] Commercial thin plus fuels treatment if access exists. May be regeneration treatment or fire only (prescribed or managed wildfire).		
	[3] Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.		
Notes	[4] Chewelah and Cle Elum acre targets were updated in 2020. Cle Elum includes an additional sub-watershed.		
	[5] Full landscape evaluations were not conducted for Tillicum and Mission Maintenance. Acres for these two areas reflect planned USDA Forest Service treatments and were added to bottom and top of range in 2018 subtotal.		

Table 4. Forest Health Treatment Needs for 2020 Forest Health Priority Planning Areas

Planning Area (2020)	Forest Structure Class (acres)		
	Small Dense[1]	Medium-Large Dense[2]	Medium-Large Open[3]
Chumstick to LP	1,250 - 2,750	25,000 - 33,750	10,250 - 16,500
Glenwood	750 - 1,000	17,000 - 22,000	5,750 - 9,000
Ione	250 - 500	15,500 - 19,000	750 - 1,500
Klickitat	4,000 - 6,500	34,000 - 41,500	5,000 - 7,000
Little White	-	17,750 - 27,500	-
Long Lake	-	6,500 - 8,250	7,500 - 11,750
Mad Roaring Mills	7,500 - 11,250	1,000 - 1,750	5,000 - 7,000
Methow Valley	-	33,500 - 50,500	16,000 - 24,500
Mt Hull	250 - 900	6,750- 9,600	5,000 - 8,000
Nason Creek	750 - 2,000	5,000 - 8,000	1,000 - 1,500
Republic	-	33,000 - 43,500	13,500 - 20,500
Stranger	500 - 1,000	23,500 - 28,000	6,000 - 9,000
Teanaway	1,500 - 3,000	26,000 - 40,000	11,000 - 17,000
Tieton	-	31,250 - 49,500	6,750 - 11,000
Toroda-Tonata	-	43,500 - 54,000	7,500 - 12,000
Trail	750 - 1,500	26,250 - 33,000	5,500 - 9,500
Twisp River	250 - 500	22,000 - 29,500	3,750 - 6,500
Upper Swauk	-	11,000 - 16,750	3,000 - 5,250
Total	**17,750 - 30,900**	**378,500 - 516,100**	**113,250 - 177,500**
Grand Total	**509,500 - 724,500 acres**		
Anticipated Treatment Type	[1] Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).		
	[2] Commercial thin plus fuels treatment if access exists. May be regeneration treatment or fire only (prescribed or managed wildfire).		
	[3] Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.		

Table 5. Summary of Forest Health Treatment Needs for all 2018 and 2020 Forest Health Priority Planning Areas

Planning Area Totals (Year)	Forest Structure Class (acres)		
	Small Dense[1]	**Medium-Large Dense[2]**	**Medium-Large Open[3]**
2018 Structure Class Total	**9,500 - 16,500**	**238,200 - 338,400**	**32,500 - 65,200**
2018 Total	**298,220 - 438,120 acres**		
2020 Structure Class Total	**17,750 - 30,900**	**378,500 - 516,100**	**113,250 - 177,500**
2020 Total	**509,500 - 724,500 acres**		
Grand Total (2018 and 2020 areas)	**807,720 - 1,162,620 acres**		
Anticipated Treatment Type	[1] Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).		
	[2] Commercial thin plus fuels treatment if access exists. May be regeneration treatment or fire only (prescribed or managed wildfire).		
	[3] Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.		
Notes	2018 Total includes acres from planned USDA Forest Service treatments in the Tillicum and Mission Maintenance planning areas that are not in the Structure Class Total.		

Understanding forest health treatment need results

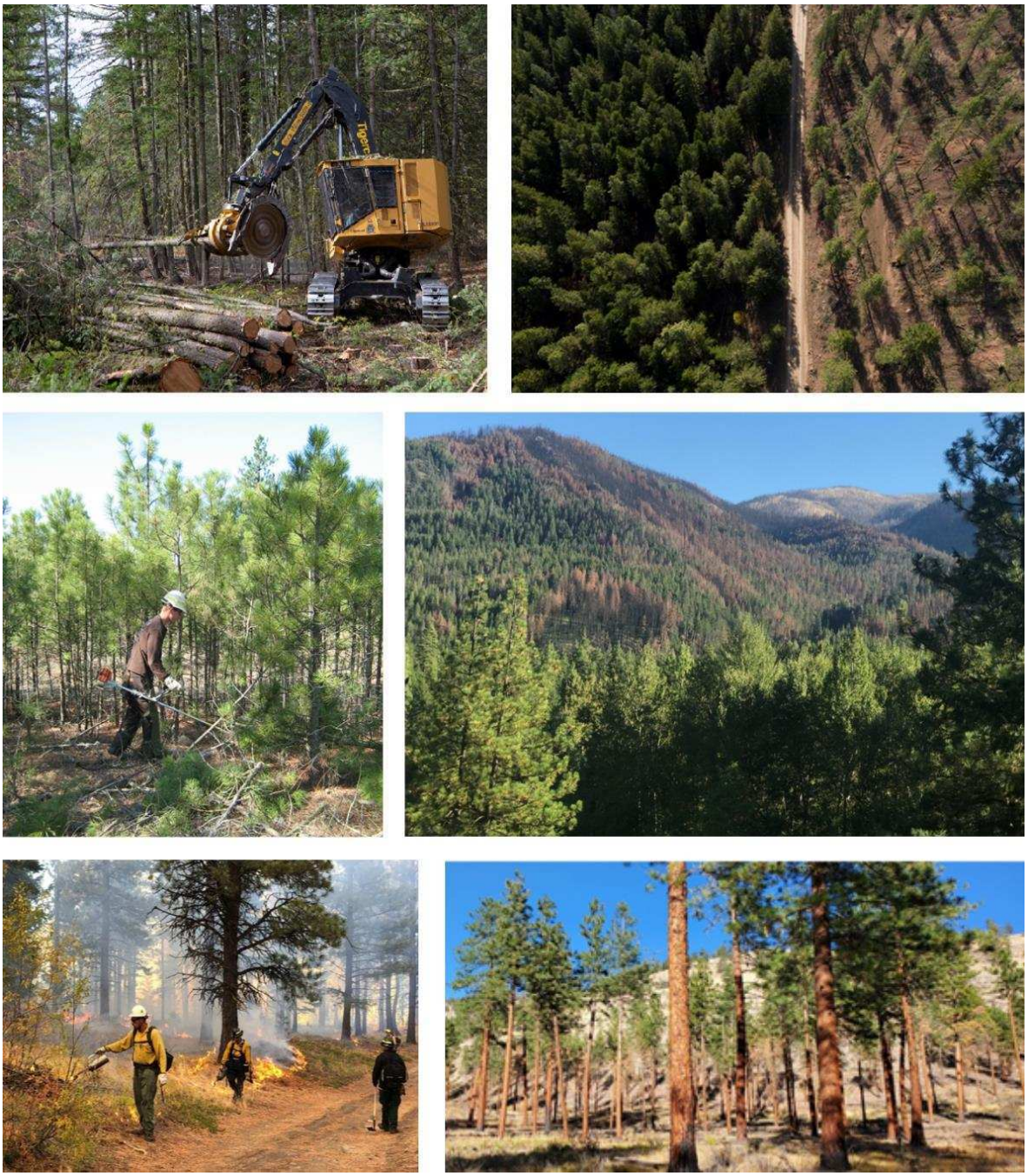
A landscape evaluation does not mandate management actions or treatment targets for specific land ownerships. It provides high-level recommendations for the priority planning area as a whole. Landowners conduct their own field assessments, planning, and decision-making processes to determine specific treatments they can carry out to achieve the collective goal of a resilient landscape, while also meeting their own management objectives and regulatory requirements.

Forest health treatment needs in landscape evaluations are expressed as ranges of acres - because there is no single condition that represents a resilient landscape - which are dynamic due to a combination of disturbances and shifts in climate over time. The range in treatment acres provides options for landowners to manage for and balance different objectives while still meeting the overall goal of a resilient landscape that can better adapt to a changing climate. For example, managing for the high end of treatment need will emphasize fire risk reduction, increased resistance to drought and related insect outbreaks, higher water yield potential, and more habitat for wildlife species that use open canopy forests. Conversely, managing for the lower end of the treatment need will emphasize habitat for closed canopy dependent species, timber production, carbon storage, and the reduction of road system effects on aquatic systems.

Based on tree size class, the majority of acres needing forest health treatment are commercially viable, although commercial viability ultimately depends on multiple factors. Individual landowners will determine which treatment types are most appropriate in specific locations given their objectives, regulatory requirements and operational and economic considerations.

To achieve forest resilience goals, a combination of treatment tools will be needed (Fig. 13). Commercial and non-commercial mechanical treatments are generally the most effective and predictable at reducing canopy density and fire risk provided that follow-up surface and ladder fuel reduction treatments are completed using prescribed fire or mechanical methods (Schwilk et al. 2009, Fulé et al. 2012). Yet, it will not be possible in most planning areas to achieve the targets with mechanical treatments alone due to access and other limitations. Significantly increasing the use of prescribed fire will be critical. Managed wildfire is another important tool that can be used to accomplish needed work when used in appropriate locations under the right circumstances. To help managers determine where different treatment types are most appropriate, a GIS tool was developed to map where mechanical treatments are likely possible or where prescribed fire or managed wildfire will needed.

Figure 13. Forest health treatment toolbox. Examples from eastern Washington (clockwise from top left): Two images of commercial thinning treatments on DNR state trust lands in the Methow Valley planning area; landscape view of the 2018 Crescent Fire in the Twisp planning area; Washington Department of Fish and Wildlife's wildlife area after thinning (2017) and prescribed fire (2019) treatments in the Methow Valley planning area; 2020 prescribed burn treatment in the Stemilt planning area; non-commercial thinning of young forest stand.



(Clockwise from top left, photos by John Marshall Photography, John Marshall Photography, Chuck Hersey/DNR, Chuck Hersey/DNR, Erin McKay/Chelan County, and DNR)

The landscape evaluation estimates clear targets for the needed shifts in vegetation conditions to create a resilient landscape. The scale of needed shifts is high and may seem difficult to achieve given current treatment rates and management approaches, as well as combined regulatory, social, and economic constraints. The goal of the forest health plan, however, is to achieve a resilient landscape by scaling up treatment capacity to meet these targets in any given planning area. If significant progress toward treatment targets cannot be made in a planning area, barriers can be identified and addressed through adaptive management. These may include changes to management practices, agency programs, incentives, funding levels, policies and regulations. To maintain social license for the forest health plan, agreement among major stakeholders will be needed for any major policy or regulatory changes to move forward.

Implementation of forest health treatment needs identified through the landscape evaluation process in a given priority planning area will likely take several biennia to accomplish (five to 10 years or more). The pace and scale of forest health treatment implementation will be driven by common and unique factors for each priority planning area, such as the capacity of land managers and contractors to plan and implement treatments; ratio of commercial versus non-commercial treatments, ability to conduct prescribed fire treatments, forest products markets, access, public support, ability to manage wildfires for resource benefits, funding levels for non-commercial treatments, and budget levels for public land management agencies. This highlights that a one-size fits all approach will be inadequate, and achieving goals in each priority planning area will require local solutions as well as systematic support.

In addition, once the first major tranche of forest health treatments are completed in a priority planning area and a more resilient mix of dense and open forest structures exists, there will be significant ongoing treatment needs to maintain a resilient landscape condition. Vegetation will continue to grow and conditions will change. Maintenance needs will vary by forest type, site productivity, landowner objectives, and other factors. However, maintenance need will be significant, underscoring the importance of increasing the ability to use prescribed fire and managed wildfire to meet a substantial portion of the maintenance need.

Finally, these landscapes are dynamic. Updates to landscape evaluations will occur over time as treatments, fires, other disturbances, and growth change forest conditions; input datasets for current conditions are improved; and methodologies are refined based on new science, monitoring results and adaptive management. As completing the recommended treatments in any one planning area will take time, stakeholders and landowners should expect several updates to landscape evaluations. These updates may include changes to treatment targets.

Understanding forest health spatial priorities and relationship to treatment need

The forest health treatment need identified in Table 5, sets the range of treatments needed in different forest types to shift the landscape to a more resilient condition. The forest health treatment need is based primarily on a departure analysis comparing current distribution and pattern of forest structures across the landscape to a desired range. Desired ranges come from historical forest conditions that were resilient to disturbances and climate fluctuations, and also incorporate predicted future climate. For every priority planning area in eastern Washington DNR has analyzed, the forest structure is denser than existed historically or denser than what is estimated to be sustainable under predicted future climates. The difference between current amount of dense forest structure and desired range of dense forest structure sets the forest health treatment need range.

The forest health treatment need and spatial priorities contained in this report are high-level recommendations resulting from an analytical process based on the best available science and data and applied across all forestland land irrespective of ownership considerations. Actual treatments will be planned and implemented by landowners in each planning area in alignment with landowner objectives and planning processes, local priorities, and regulations (Fig. 14).

To help land managers determine where treatments are most needed in each priority planning area, DNR mapped where forest health and wildfire response benefit priorities co-exist spatially in each planning area. The priority maps integrate a number of primary forest health and wildfire metrics to identify where there is the greatest overlap between forest health and wildfire response benefit. See the previous methodology section for details on how the landscape treatment and wildfire response benefit prioritization were derived.

Landscape treatment priority: The landscape treatment priority map (Fig. 9) illustrates where priorities for improving forest health exist. Not every high priority area identified on the landscape treatment priority map needs every acre treated; conversely not every low priority area should be left untreated. Landscape treatment prioritization scores are meant as a tool to help landowners focus forest health treatments. There are other reasons to treat or not treat specific sites that are not captured in the prioritization, are not detectable with remotely sensed data, or may become apparent during field-based evaluations. Reasons may include the presence of cultural sites, species composition that is not well suited to a particular site, root disease or other pathogen issues, wildlife habitat needs, sensitive soils, or operational constraints. Individual landowners will determine what treatment types are most appropriate in specific locations given their management objectives and operational and economic considerations.

Wildfire response benefit priority: It is necessary to conduct treatments to both improve forest health and reduce fire risk to communities as well as provide conditions where firefighters can safely and efficiently conduct fire operations (e.g., suppression, prescribed burning, and managed wildfire). The wildfire response benefit metric (Fig. 10) identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes, infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior. Because healthy forests will lead to safer fire operations, and effective fire operations contribute to the protection and maintenance of resilient forests, the wildfire response benefit metric also integrates the landscape treatment priority map.

Where wildfire response benefit is highest, actions may be needed to create and maintain conditions that provide a tactical advantage for fire operations. These actions will vary with local context and can include landscape-level forest health and fuel treatments, treatments along escape routes, resident and community fire mitigation activities (e.g., defensible space, home hardening), and improved signage and road conditions. The wildfire response benefit metric provides a high-level prioritization, and additional work at the local level will be required to identify appropriate actions and assess their feasibility. Wildfire response benefit is useful for prioritizing potential control lines (PCLs) for fire operations. PCLs are a part of PODs.

PODs as a spatial framework for prioritizing landscape treatments for dual benefits (forest health and wildfire response): PODs is a framework to conduct cross-boundary pre-fire analysis and planning to increase wildfire response safety and efficiency. PODs also provide a useful spatial framework to communicate and identify locations that will deliver dual benefits for forest health and wildfire response at the landscape scale. Summarizing landscape treatment priorities (Fig. 11) within PODs and wildfire response benefit priorities within PCLs enables planners and managers to identify, at a high level, locations where forest health or fuel treatments can be connected to a high-priority PCL that will support firefighter operations for suppression, prescribed fire or managed wildfire. The landscape evaluation process uses PODs to summarize, visualize and communicate dual benefit priorities qualitatively using a three-priority ranking (Fig. 11).

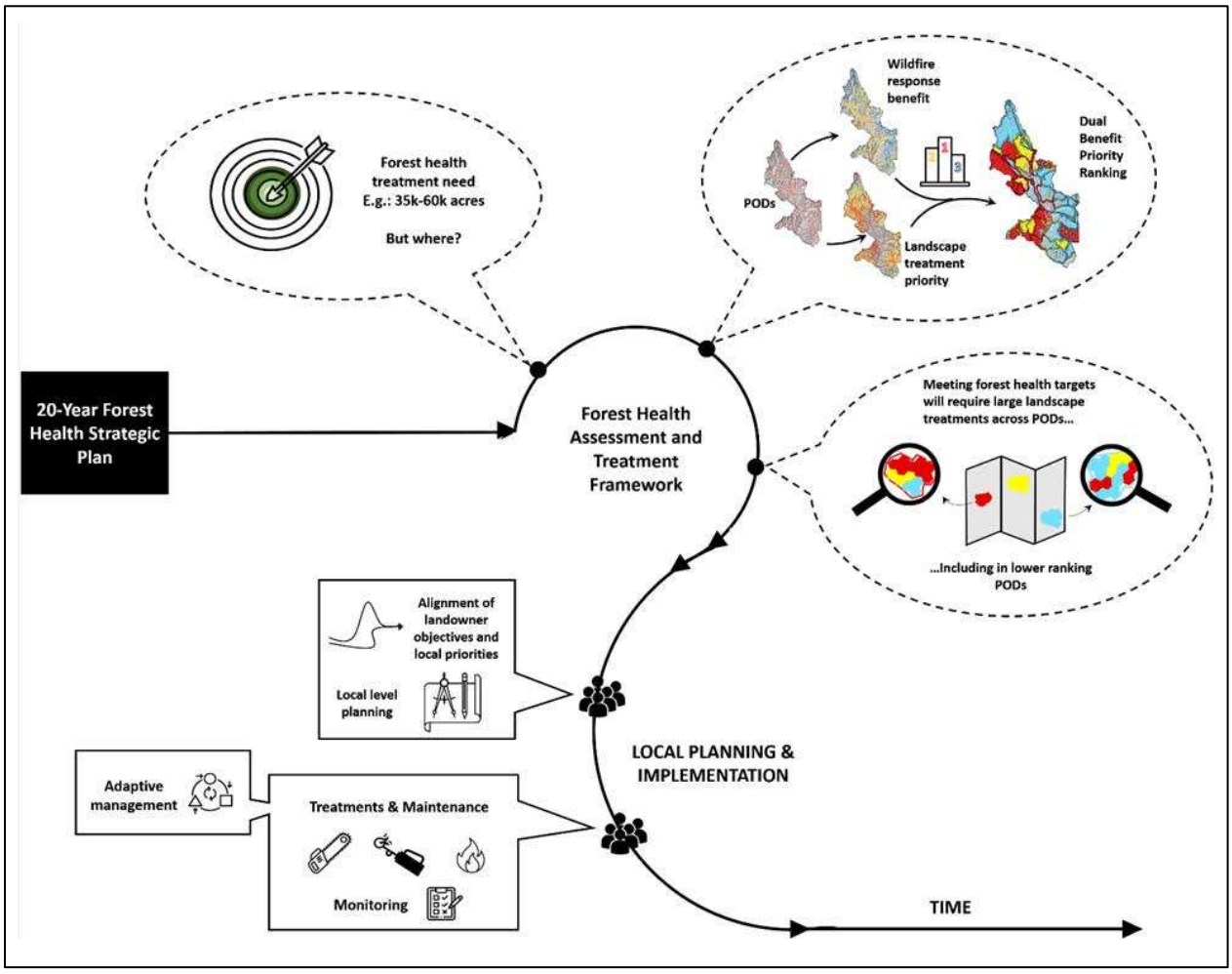
Achieving forest health and wildfire response dual benefits will require primarily large, landscape-level treatment units — in the hundreds to thousands of acres — across PODs and, to a lesser extent, targeted treatments such as fuel breaks along PCLs. These two approaches, when combined, will contribute to restoring and maintaining large portions of the landscape in a resilient condition while providing safe and effective areas for firefighter engagement during suppression, prescribed fire, or managed wildfire operations. Even in lower-ranking PODs, there

can be significant forest health treatment work required to achieve the treatment targets set in Table 5. Even if all the forest health treatment need is addressed in the higher-ranking PODs, there are usually more treatments required to address the overall forest health treatment need for the priority planning area in lower-ranking PODs.

Implementing landscape-level treatments in a priority planning area is the primary way the forest health treatment need in Table 5 should be addressed. In most cases, large, landscape-level treatments should intersect with potential control lines to reduce fuel loads and provide safe and effective areas for firefighters while also improving forest health. There may be areas (e.g., near communities and highly valued resources) where targeted fuel break treatments along potential control lines are justified in areas where large, landscape treatments are not feasible or appropriate.

Targeted fuel breaks along PCLs without integrated landscape treatments should be limited as they do not change fire risk or improve forest health on the landscape-scale that is required to achieve forest health goals. Fuel breaks alone will not stop wildfires, but fire suppression activities within fuel breaks may stop wildfires. Fuel breaks do not offer passive protection and are only effective when they are well maintained, there are adequate resources to engage, and fire weather conditions make it safer to do so. It is unrealistic to expect fuel breaks to passively stop fire spread, and communicating the real protective value of these treatments to the public, news media, and policymakers is critical. Failing to do so may create a false sense of security (Syphard et al. 2011b, Syphard et al. 2011a).

Figure 14. From high-level planning to local implementation of forest health treatments. This diagram illustrates the components of the Forest Health Assessment and Treatment Framework and their connection to treatment implementation. The treatment needs and spatial priorities for each planning area are high-level recommendations that serve as a guide on the magnitude of forest health treatments and potential treatment locations. It is important to implement treatments at a scale large enough to address the forest health treatment need and in strategic locations that are key to forest health and wildfire response. The forest health treatment need and spatial priorities contained in this report are high-level recommendations resulting from an analytical process based on the best available science and data and applied across all forestland land irrespective of ownership considerations. Actual treatments will be planned and implemented by landowners in each planning area in alignment with landowner objectives and planning processes, local priorities, and regulations.



Landscape evaluation data products

More information about the landscape evaluation results for 2020 priority planning areas are included in detailed landscape evaluation summaries in Appendix D. These summaries contain a variety of information such as forest types, treatment goals, drought vulnerability, fire risk, and landscape treatment priorities. The landscape evaluation summaries serve as an introduction and high-level reference describing forest health treatment needs and priorities in the area. DNR's forest health science team is available to help people access and use landscape evaluation data products. Detailed geospatial information for each priority planning area is available for major landscape evaluation data products such as fire risk, drought vulnerability, departed forest structures, land ownership, large dense forest sustainability, and landscape treatment priority. Landscape evaluation summaries for the eight priority planning areas in the HB 1784 pilot effort include a wildfire response benefit priority map and prioritization for dual benefit using PODs.

Landscape evaluation summaries for the 2018 and 2020 priority planning areas and a full list of data products are available at www.dnr.wa.gov/ForestHealthPlan#priority-planning-areas.

Tracking Forest Health Accomplishments

Forest health investments

The Washington State Legislature has made forest health investments through the capital budget for the last two biennia (fiscal years 2017-19 and 2019-21) to DNR and other state agencies, with programs that reach both eastern and western Washington (Table 8). With the adoption of the forest health plan and through implementation of the state's Shared Stewardship Investment Strategy, DNR and partners have a framework and scientific basis to guide strategic investments in forest health. This approach increases efficiency and effectiveness of achieving shared goals, and often results in leveraged funding and capacity by federal land managers and private landowners. Forest health investments focus on:

- Building capacity and coordinating project planning across large landscapes;
- Implementing forest health treatments in high priority, high need landscapes;
- Monitoring treatment progress over time and adapting the state's approach based on lessons learned.

State forest health investments

During the last two biennia, DNR received $27.2 million in capital (state) funds. These funds were provided to implement forest health restoration and hazard reduction across all-lands, increasing community resilience, and initiating a prescribed burn program. The results of these investments are reflected in acres of forest health treatments tracked across all-lands that DNR reports on in the next section, but also in programs and partnerships that leverage investments that are not easily translated in treatment tracking totals. Several of these investments include:

Federal Lands: DNR received $4.1 million in capital funds to establish and implement a Federal Lands Program ($500,000 in 2017-19, $3.1 million in 2019-21), including direct investments and use of Good Neighbor Authority (GNA) agreements. DNR signed a GNA master agreement with the US Forest Service in 2017 and established the DNR Federal Lands Program in 2018. The Federal Lands Program oversees the department's GNA agreements and does not technically manage any land for Forest Service or Bureau of Land Management (BLM). The program does conduct restoration projects on federal lands, as well as facilitates direct investments to support forest health projects on federal lands (Table 6). GNA enables more effective and coordinated cross-boundary and multi-agency partnerships focused on forest health and wildfire risk reduction. Since inception, the program has operated statewide and now has 36.5 million board feet (MMBF) under contract, which will generate up to $8.0 million dollars over the next three to four years to fund restoration projects on federal lands such as improving roads, removing fish passage barriers, restoring aquatic and upland habit and more. In total, the program has 46

projects underway in various stages with six complete, 20 in implementation, and 20 planned.

Table 6. DNR Federal Lands Program Good Neighbor Authority forest health accomplishments 2018-2020 (reported in the federal fiscal year)

Federal Project Area	2018 acres	2019 acres	2020 acres to date
Commercial restoration treatments, eastern Washington	604	1	1,541
Commercial restoration treatments, western Washington	352	456	1,370
Non-commercial fuels reduction eastern Washington	497	0	1,695
Total treatments, eastern Washington	1,101	1	3,236
Total treatments, western Washington	352	456	1,370
Statewide total acres	**1,453**	**457**	**4,606**

To complement GNA projects, the program made $1.6 million in direct investments to forest health projects on the Colville, Gifford Pinchot, Okanogan-Wenatchee, and Umatilla national forests. These investments are in the implementation phase on approximately 2,100 acres and include non-commercial vegetation treatments, drought mitigation in the Upper Columbia Basin, and integrated forest health planning on over 100,000 acres.

Federal Lands Direct Investment Highlight: Mount Hull Restoration Project

Located in the Mount Hull priority planning area, the Okanogan Wenatchee National Forest worked in coordination with the North Central Washington Forest Health Collaborative to develop a landscape scale project that includes a suite of treatments to improve resilience over approximately 20,000 acres of national forestland. Two timber sales were sold and are underway to implement commercial vegetation treatments and generate stewardship funds to put towards further restoration.

Another 700 acres of priority non commercial vegetation treatments were made possible through leveraged partner support in the spirit of shared stewardship. Forest Service staff identified units to both improve bighorn sheep habitat adjacent to cliffs and reduce fuel loading, which required non commercial thinning followed by prescribed burning. DNR provided $400,000, while the Washington State Wild Sheep Foundation, Forest Service, Colville Confederated Tribes, and Washington Department of Fish and Wildlife provided funding and other support for thinning on these acres, and set them up for pile and broadcast burning in the biennium ahead. These completed acres benefit people and wildlife, while showing the power of partnerships to expedite results on the ground. Photos by Matt Marsh/USDA Forest Service.

Before:

After:

Wildfire Preparedness: DNR works to reduce adverse effects of wildfires on human and natural communities through the delivery of focused, wildfire risk reduction activities such as education, technical assistance and outreach within the wildland-urban interface (Fig. 15). This work includes support for community-based action plans such as Community Wildfire Protection Plans or Hazard Mitigation Plans, providing technical and educational assistance to new and existing Firewise USA® sites and fire adapted communities, and planning prioritized treatments to reduce hazardous wildfire fuel conditions in and around communities. This biennium, 14 new

Firewise USA® sites have been recognized statewide and 119 sites have renewed their commitment to community driven wildfire risk reduction. This biennium, 669 private landowners have completed work to reduce the risk of wildfire to their structures or entered into a cost-share agreement with DNR for forest health work on their property. Sixty personnel from conservation districts, fire districts, fire marshal offices, Forest Service, Bureau of Land Management, and other partner organizations attended the Northwest Fire Adapted Communities Workshop to increase coordination and planning for community wildfire resilience and preparedness. Additionally, a revised statewide wildland urban interface has been mapped and reviewed.

Figure 15. DNR Defend Your Home from Wildfire flyer available in English and Spanish

Forest Collaborative Grant Programs: The Legislature provided $3.4 million for two new forest health grant programs to help forest collaboratives support landscape-scale forest restoration and management activities (Table 7). Forest collaboratives are a mix of conservation groups, government agencies, businesses, and individuals who have joined forces across property lines to improve forest health in their communities while also supporting the rural timber economy. DNR selected nine forest collaboratives across the state to be recipients of the grant money (Fig. 16).

Figure 16. Forest collaboratives in Washington that received forest health grant dollars in state fiscal years 2017-21

(Map by Erica Simek Sloniker/The Nature Conservancy)

Through the new All Lands Forest Restoration Grant Program, DNR awarded $2.86 million to help forest collaboratives support land managers, such as National Forests, counties and small-private landowners, to analyze and treat the forests through methods such as thinning overly dense forests, mechanical reduction of fuels, and prescribed fire.

DNR awarded $555,000 to help forest collaboratives engage their communities and grow partnerships. Funding has help ensure that Washington's forest collaboratives have access to professional facilitation and meeting coordination, enabling forward momentum in collaborative efforts and projects. Grants have also supported public outreach, communication, and forest health planning activities in priority planning areas.

Investments through the Forest Collaborative Grant Programs have enabled forest collaboratives and their members to plan, engage and implement a wide array of forest health related activities. The dollars have facilitated positive strides toward community engagement with local stakeholders related to forest health issues, supported planning and implementation of critical survey work needed to conduct forest health related management activities, as well as empowered members to lead and engage shared stewardship strategy conversations to get important treatments done. These grants have supported 2,019 acres of forest health implementation work that is underway, as well as an additional 1,750 acres of pre-sale layout and more than 200,000 acres of planning in priority landscapes.

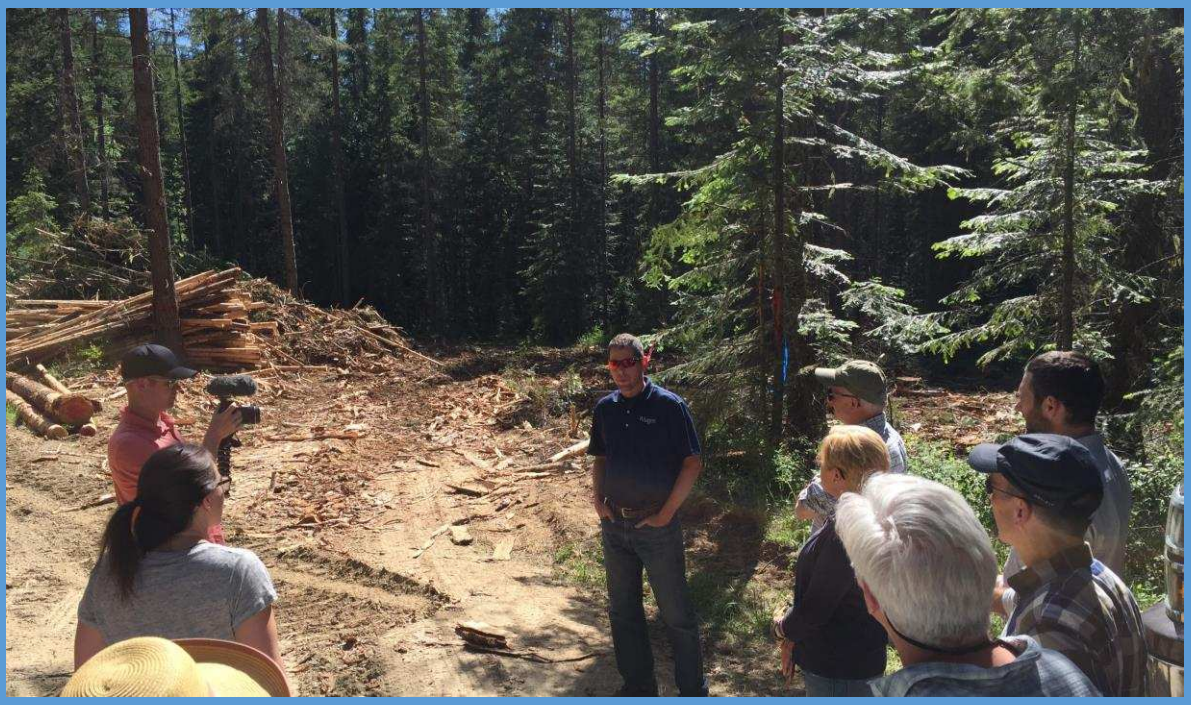
Table 7: Forest collaboratives grant program investments for state fiscal years 2017-21.
Total investments for this program are $3.4 million.

Grant recipient	Forest partnerships	Forest restoration	Forest partnerships	Forest restoration	Activities funded
	2017-19 biennium		2019-21 biennium		
Chumstick Wildfire Stewardship Coalition	$25,000	$100,000	$40,000	$196,000	Outreach Planning Thinning Monitoring
Darrington Collaborative	$25,000	$99,000	$40,000	$212,000	Outreach Planning Thinning Monitoring
North Central Washington Forest Health Collaborative	$25,000	$124,000	$40,000	$195,000	Outreach Planning Thinning Prescribed fire
Northeast Washington Forestry Coalition	$25,000	$400,000	$40,000	$0	Outreach Planning Thinning Monitoring
Olympic Forest Collaborative	$25,000	$71,000	$40,000	$125,000	Outreach Planning Thinning Monitoring
Pinchot Partners	$25,000	$181,000	$40,000	$0	Outreach Planning Thinning
South Gifford Pinchot Collaborative	$25,000	$375,000	$40,000	$353,000	Outreach Planning Thinning Prescribed fire Monitoring
Stemilt Partnership	$7,000	$107,000	$28,000	$172,000	Outreach Planning Thinning Prescribed fire Monitoring
Tapash Sustainable Forest Collaborative	$25,000	$150,000	$40,000	$0	Outreach Planning Thinning Prescribed fire
Total funding	**$1.8 million**		**$1.6 million**		

Forest Collaborative Highlight: Northeast Washington Forest Coalition

The Northeast Washington Forest Coalition (NEWFC) was formed in 2002 by volunteers from conservation organizations, professional foresters, timber mill owners and managers, and local businesses. By 2005, NEWFC was collaborating with the Colville National Forest on all forest restoration projects, moving the region past the timber wars of the 1990s. Now, instead of every timber sale blocked, the region has only seen one appeal and an unsuccessful lawsuit in the last 17 years. NEWFC has collaborated on over 40 successful restoration projects without appeal or litigation, and it is recognized as one of the oldest and most successful forest collaboratives in the nation.

Increasing the pace and scale of forest restoration has increased harvest volume in the Colville National Forest, from an average 35 million to 80 million board feet annually. Recently, the Colville National Forest outputs spiked to over 100 million board feet, one of the highest in the nation. Forest restoration projects have yielded over 427 million board feet of timber, critical for maintaining the local forest products infrastructure, and increased mechanical thinning threefold. An analysis by Headwaters Economic, found that nine to 13 jobs are created in Northeast Washington for every million board feet of timber harvested.



NEWFC field trip to a project area in the Colville National Forest. Photo by Andrew Spaeth/DNR.

Prescribed Fire Program: The Prescribed Fire Program is building momentum around key policy and operational areas, including standing up programs that focus on training, assisting partners, planning, collecting data, and implementing prescribed fire treatments across boundaries (Fig. 17). Agency prescribed fire policies have been drafted for review, while concurrent evaluation of existing wildfire policies occurred. DNR staff are continuing to build the Washington Certified Prescribed Burn Manager program that will launch in spring 2021. Fuels data collection has been integrated into the agency's multi-party forest health monitoring protocols. An agreement has been completed to support the Forest Service with additional resources for prescribed burning in Washington, and DNR staff participated in the implementation of burns on national forest land. Support has been provided to the Washington Prescribed Fire Council and Prescribed Fire Training Exchange (TREX) program with technical assistance and implementation, including a TREX program in October 2020 that included a successful prescribed burn on 20 acres of the Roslyn Urban Forest and adjacent private land.

Figure 17. A TREX crewmember lights a prescribed burn area near Roslyn in fall 2020

(Photo by Michael Norris/DNR)

This biennium, DNR also updated the state's Smoke Management Plan, which regulates the use of prescribed fire in forests to protect air quality. The revision is to better allow burning to reduce fuel loading, restore forest ecosystems, and reduce the risk of catastrophic wildfire. This update makes relatively modest changes to burn decision timing, allowable burning seasons, and permit denial thresholds. These changes are unlikely to cause emissions to exceed thresholds established under state and federal law pertaining to emissions limits. The plan discusses monitoring and mitigation procedures to prevent such effects. In complement to these updates, DNR launched an online burn portal in December 2019 to provide a one-stop shop to learn where silvicultural burns have been requested, apply and pay for permits, and search other links to learn more about prescribed burning. The site offers a map with various layers and calendar to easily view permits, burn requests, and burn bans. Although the permitting process is available online, paper copies of applications are still accepted.

Table 8. Legislature statewide forest health investments with capital funds during the last two biennia. Investments described in this table are in addition to the standard operating budgets for state and federal agencies.

Agency	2017-19	2019-21	Activities funded
Washington State Department of Natural Resources	$13 million	$14.2 million	Forest health treatments, planning and monitoring across multiple lands
Washington Department of Fish and Wildlife	$5 million	$2 million	Forest health treatments in state wildlife areas
Washington State Parks	$0	$1.3 million	Forest health treatments in state parks
Total	**$18 million**	**$17.5 million**	

Leveraged forest health investments

The investments from the Legislature complement federal resources to increase forest health and resilience across Washington. The Forest Service invests in forest health through various programs closely aligned with the state's Forest Action Plan. In total over the federal fiscal years 2017-21, the Forest Service invested more than $61.4 million in Washington through these programs. These include six State and Private Forestry Programs that support state forest health initiatives, including the Forest Legacy and Community Forest and Open Space Conservation Program, Forest Stewardship Program, Urban and Community Forestry Program, Forest Health Protection Program, Invasive Plant Program, and Wood Innovation Program. The Forest Service also invests in the following ways to increase the pace and scale of forest health treatments:

- Joint Chiefs funding was established in 2014 by the chiefs of Forest Service and the Natural Resources Conservation Service (NRCS) to leverage investments and facilitate efforts by state and local municipalities, tribes, and other partners to restore landscapes, reduce wildfire threats to communities and landowners, protect water resources and enhance wildlife habitat. This program provided more than $6.2 million in federal fiscal years 2017-21 for treatments to two eastern Washington projects: Northeast Washington Landscape Restoration Initiative and All Lands, All Hands East Cascades.

- The Collaborative Forest Landscape Restoration Program (CFLRP) was established by Congress in 2009 to encourage the collaborative, science-based ecosystem restoration of priority forest landscapes. This program provided $15.4 million during federal fiscal years 2017-21 to the Northeast Washington Vision project in the Colville National Forest and the Tapash Collaborative in the Okanogan-Wenatchee National Forest.

- Supplemental fuels projects focus investments in high priority locations to restore fire-adapted ecosystems and reduce uncharacteristic intensity, severity, and adverse effects of wildfire. They focus particularly in dry forests near communities, important water supplies, or other highly valued resources that could be harmed by wildfire, as well as places that provide opportunities to manage wildfire to achieve resource benefits. This program provided about $1.6 million to the Chelan County Pilot Project for forest health treatments and planning across multiple jurisdictions.

Additionally, during the federal fiscal years 2017-19 NRCS provided over $4.8 million to direct forest health projects on private and tribal land for fuel breaks, wood residue (slash) treatment, tree pruning, and thinning. State and federal investments also led to the contributions of private forest landowners, particularly through federal and state cost-share programs. In these programs, landowners receive funds to cover some of the costs associated with hiring a contractor to do the work or labor costs associated with completing the work themselves. For example, in the past two biennia, participating private forest landowners in cost-share agreements with DNR in eastern Washington have contributed over $15 million.

Conducting work at a landscape scale and across public and private ownerships requires innovative public-private partnerships and increased investments in forest health. State investments play a critical role in accelerating the planning and implementation of forest health and wildfire risk reduction projects, while leveraging additional resources. The state's leadership in addressing forest health leads to more coordinated and strategic alignment of projects across ownership boundaries, and it helps position the state and partners to be more competitive for regional and national grant programs that fund forest health activities.

Shared Stewardship Highlight: Stemilt Priority Planning Area

The Stemilt Squilchuck watersheds, just south of Wenatchee, encompass a priority planning area in the forest health plan. The priority planning area covers approximately 39,000 acres. Sixty percent of this land is privately owned, while the remainder is a checkerboard of federal, state, and county property. DNR's landscape evaluation found that a minimum of 9,200 acres of forest needed treatments to shift the landscape to a resilient condition, and those treatments would require cross boundary coordination.

The Stemilt Partnership, a diverse stakeholder group led by Chelan County, facilitates forest health activities in the watershed. In October 2020, they piloted a coordinated effort between DNR firefighters and Chelan County Fire District 1 to implement prescribed burning on 45 acres, with another 128 acres permitted for prescribed burning. The partnership has 1,651 acres of forest health treatments planned to implement over the next two years. Funding for forest health treatments has come from a variety of sources, including the Forest Service, DNR, Washington Department of Fish and Wildlife, Federal Emergency Management Agency, Washington State Parks, Chelan County, and private investments. In total, about $1.3 million has been dedicated to plan and implement forest health work in this area to meet the overall treatment need.

A prescribed burn in the Stemilt priority planning area in October 2020. Photo by Erin McKay/Chelan County.

Forest health monitoring

A primary goal of the forest health plan is to "develop and implement a forest health resilience monitoring program that establishes criteria, tools, and processes to monitor forest and watershed conditions, assess progress, and reassess strategies over time." Anticipating rapid and unprecedented changes across forest landscapes, DNR developed a framework to track progress toward forest health goals, including landscape restoration and climate change adaptation. DNR's Forest Health and Resiliency Division worked with partners to develop a monitoring framework as outlined in the forest health plan. This framework provides key components of adaptive management, which is the process of planning, implementing, monitoring, and integrating new information into management practices over time. Monitoring is essential for reporting and accountability, building shared understanding and trust, and increasing the effectiveness of forest health treatments over time. The framework has two overarching questions that will be addressed at three spatial scales. More specific monitoring questions are shown in Table 9.

1. How are forest conditions and associated forest health indicators changing over time?

This question is the foundation of forest health monitoring. DNR will comprehensively map and quantify changes in forest structure, composition, and patterns from treatments as well as regeneration, growth, mortality and natural disturbances over time. This baseline information will be used by DNR scientists, as well as other partners, to assess changes and trends in key indicators of forest health and wildfire risk. Indicators include predicted fire intensity and severity, vulnerability to drought and insect mortality, wildlife habitat, and departure from resilient landscape conditions (e.g., ranges and patch sizes of dense vs. open forest structure, species composition). In addition, treatment need in priority planning areas and across eastern Washington will be updated periodically.

2. What are the outcomes of forest health treatments?

Understanding how forest health treatments (mechanical, prescribed fire, and managed wildfire) affect landscape and community resilience is critical to the forest health plan. This will be achieved in three ways. First, treatment effects on forest structure will be quantified through remotely sensed data and in the field by partners, and economic outputs will be tracked. Second, models and indices will quantify how treatments change forest health indicators, particularly predicted wildfire behavior, burn severity, and risks to homes and infrastructure. Third, the effects of treatments on subsequent wildfires, insect outbreaks, and droughts will be evaluated as staff capacity permits. This will include opportunistically assessing the extent to which selected treatments reduced uncharacteristic wildfire severity and provided more options for wildfire management. In addition, DNR will maintain an up-to-date database showing where treatments have occurred to address this question and track treatment implementation.

Monitoring and reporting of trends will be conducted at three distinct levels that reflect the spatial scales at which different forest health indicators are best measured. These include the regional level (all of eastern Washington), priority planning area level, and treatment unit level.

The success of this ambitious monitoring framework will require DNR and its partners to work together to implement, analyze, report, and fund it over time. While DNR has the capacity to lead forest change monitoring and maintain key datasets, leadership and engagement by partners will be needed to implement and sustain the full framework. To formalize the critical role for partners in this effort, DNR will create a standing monitoring working group that will help with the technical and organizational challenges of implementing this framework, as well as developing compelling materials to communicate key lessons for adaptive management and highlight success stories.

Table 9. Primary monitoring questions and levels at which each question will be evaluated

Monitoring Questions	**Level of Monitoring**		
	Region	Priority Planning Area	Treatment Unit
Is treatment need in planning areas and across eastern Washington declining?	x	x	
Is fire risk to forests, communities, infrastructure, and forests declining?	x	x	
How is potential fire severity changing?		x	x
What is the annual trend in total burned acres and the proportion of low, moderate, and high severity by forest type?	x	x	
Are wildfire response benefits materializing?	x	x	
Is vulnerability to drought and insect outbreaks increasing or decreasing?	x	x	
How is the amount and pattern of focal wildlife species habitat changing?		x	x
Did treatments reduce fire severity when a wildfire occurred?		x	x
Did treatments reduce mortality from drought and related insect outbreaks?		x	x
What were the outputs of treatments in terms of wood volume and employment?	x	x	
Did treatments meet prescription targets for structure, pattern, composition, and fuels?			x
What is the response of trees, other vegetation, and woody fuels after treatments? Are trees regenerating and if so, what species? When will a maintenance treatment be needed?			x

Over the last two years, DNR staff have been working with scientists at partner agencies and

research institutions to develop methods and datasets for this effort. DNR State Uplands staff have developed innovative methods to obtain LiDAR-like forest structure data from aerial imagery that is flown every two years across all of Washington. Combining this data with LiDAR data and publically available satellite imagery will provide the consistent, wall-to-wall datasets needed to reliably detect changes in forest conditions at regular time intervals. To measure changes in fire risk, DNR will utilize and update the data and methods from the Pacific Northwest Quantitative Wildfire Risk Assessment. A common protocol for field monitoring plots has been developed to help partners collect this important data and combine it with remotely sensed data. See Appendix E for a full description of datasets and methods.

Baseline monitoring results and treatment tracking data will be compiled by planning area and summarized across eastern Washington every biennium as part of DNR's progress report to the Legislature. Results will be used to update landscape evaluations, including treatment need estimates, for planning areas that have experienced a major change. All results and data will be public and available for additional monitoring efforts by partners, except for specific information that individual landowners do not want public.

In addition to the indicators addressed in this framework, DNR recognizes the importance of monitoring the social and economic aspects of this work, including smoke effects to human health, economic inputs to rural communities, equity issues, and many others. There are also key questions regarding the economic and ecosystem benefits of achieving the goals of the forest health plan. As staff capacity and funding permit, DNR will work with partners to expand monitoring of the social and economic benefits, as well as treatment effects on aquatic function, carbon, snowpack, and streamflow.

Finally, monitoring is a dynamic process that will continue to evolve over time as forests, communities, objectives, and datasets change. The information and partnerships created through implementing this monitoring framework over time will be essential in collectively learning how to most effectively increase the resilience and adaptive capacity of forests and communities. These questions, along with a methodology and datasets for multi-party monitoring, are outlined in the 20-Year Forest Health Strategic Plan Monitoring Framework, see Appendix E.

Treatment tracking

One component of DNR's monitoring framework is tracking forest health treatments. DNR has developed a forest health treatment database for eastern Washington that includes not only treatment information for all DNR owned lands and forest health programs, but also information from other public, private, and tribal landowners willing to share data. RCW 79.10.520 defines a

forest health treatment as actions taken by DNR to restore forest health including, but not limited to, sub-landscape assessment and project planning, site preparation, reforestation, mechanical treatments including timber harvests, road realignment for fire protection and aquatic improvements, and prescribed burning. A treatment can be a standalone, one-time project or a component of a longer-term landscape scale forest health project. In simple terms, a forest health treatment is an action taken in a forest ecosystem aimed to improve forest health and resilience. The current scope of DNR's all-lands, forest health treatment tracking does not include road management and aquatic improvements in eastern Washington, but DNR intends to incorporate this data over time. With the current scope in mind, treatments are placed in three categories:

- **Non-commercial treatment:** An action to manage vegetation to improve forest health and resilience that do not produce a commercial product but are done at a cost. These actions may include non-commercial thinning, pre-commercial thinning, surface fuels treatment (pruning, piling, and removing vegetation that could carry fire from the ground up into trees), planting native vegetation, reforestation, or invasive removing invasive plant species.

- **Commercial treatment:** A manipulation of vegetation in a forested ecosystem with an objective to improve forest health and resilience, as well provide a primary or by-product of economically valued material. These actions may include a commercial thinning, uneven-age harvest, or regeneration harvest.

- **Prescribed fire treatment:** Also sometimes called a prescribed burn or controlled burn, this involves trained practitioners applying fire to vegetation to improve forest ecosystem health and resilience. This includes two primary types of prescribed fire: broadcast burning (burning widely across the forest floor) and pile burning.[1]

The responsible person, agency, or organization leading a forest health treatment submits their information to the database. The party submitting forest health treatment information is responsible for reviewing the DNR definition of forest health and determining whether the treatment was motivated and implemented with the intent to improve forest health and resilience. Therefore, DNR is not the arbiter of what treatments are reflected in this data. Because reporting is voluntary and there are many landowners in eastern Washington, the data set is incomplete and will continue to expand with new partner inputs over time. For example, DNR's data set currently does not include any commercial forest health treatments conducted

[1] In this report, some data sets include pile burning within non-commercial treatment types where the action included hand or machine piling in the same treatment.

by private forest landowners. DNR will address these gaps in data collection over time. To date, forest health treatment data has been provided by Chelan County, City of Roslyn, Colville Confederated Tribes, Kittitas County Conservation District, Natural Resource Conservation Service, The Nature Conservancy, U.S. Fish and Wildlife Service, Forest Service, WDFW, DNR, and Washington State Parks.

The database consistently tracks completed forest heath treatments from January 1, 2017 through present across forested lands in eastern Washington, with an ability to sort treatments by priority planning areas under the forest health plan. Forest health treatment acres are tracked and reported in both total treatment acres, as well as footprint acres. Total treatment acres track every forest health treatment conducted, including those that occurred in sequence on the same acre over time. For example, a commercial thinning may have been conducted on an acre prior to a prescribed burn. Footprint acres are calculated through spatial analysis to ensure one acre that experienced one or more forest health treatments is only counted once. Both of these reporting outputs have value in tracking progress, but it is important to differentiate between them.

In addition to completed forest health treatments, DNR tracks forest health treatments, sometimes within larger projects, in several phases before completion: proposed, planned, and in-progress. Additionally, DNR records planned vegetation management activities that may not be reported to DNR as forest health treatments but provide context to the footprint of active forestry in eastern Washington. These projects speak to the treatments that will soon be seen on the landscape, contingent upon available resources. Treatment data for projects in these early phases varies by landowner and program, reflecting differences in project development.

Examples of proposed and planned treatments in eastern Washington since early 2017 include:

- Nineteen forest stewardship plans written to maintain and improve forest health on 3,827 acres of private lands.

- More than 76,000 footprint acres of forest health treatments planned by the Forest Service in priority planning areas that were analyzed through the National Environmental Policy Act (NEPA) and are recorded in final records of decision for each project. An additional 275,000 acres of national forest land in priority planning areas are under analysis through forest health project planning.

- DNR State Lands' 34,976 acres of non-commercial and 13,006 acres of commercial forest health treatments planned in eastern Washington for state fiscal years 2022 and 2023.

See the E2SHB 1711 legislative report for further details.

- DNR forest practices applications approved for forest management activities on 296,831 acres in eastern Washington. These applications do not indicate if the activities are motivated by improving forest health, but the extent of intended forest management activities is important context to monitoring.

Forest health treatment tracking increases DNR's situational awareness of forest health activities across land ownerships, and is a helpful indicator in measuring the pace and scale of treatments to meet Goal 1 of the forest health plan. Treatment tracking alone is not adequate to fully understand progress towards the treatment needs identified in DNR's landscape evaluations to move priority planning areas, and forests across eastern Washington, into a resilient state. The treatment needs established in the landscape evaluations (in footprint acres), reflect the need to change forest conditions. Therefore, forest health treatment tracking is most meaningful when it is interpreted within the context of DNR's comprehensive monitoring framework.

Table 10. Total forest health treatment acres (not footprint acres), by calendar year, from January 1, 2017 through October 30, 2020 across eastern Washington and priority planning areas of the 20-Year Forest Health Strategic Plan

	EASTERN WASHINGTON TREATMENT ACRES					PRIORITY PLANNING AREA TREATMENT ACRES				
	2017	2018	2019	2020	TOTAL ACRES	2017	2018	2019	2020	TOTAL ACRES
WA DNR State Trust Lands	**18,119.75**	**24,095.50**	**16,994.90**	**20,751.85**	**79,962.00**	**7,428.80**	**8,324.80**	**7,935.19**	**8,975.65**	**32,664.44**
Commercial Vegetation	7,950.78	5,832.30	7,444.13	5,197.42	26,424.63	3,320.37	1,656.64	3,583.69	2,240.81	10,801.51
Non-commercial Vegetation	10,168.97	18,263.20	9,550.77	15,554.43	53,537.37	4,108.43	6,668.16	4,351.50	6,734.84	21,862.92
WA DNR Landowner Assistance	**2,723.98**	**3,174.67**	**4,251.53**	**3,888.05**	**14,038.24**	**1,087.89**	**1,413.82**	**1,817.87**	**1,825.52**	**6,145.10**
Non-commercial Vegetation	2,723.98	3,174.67	4,251.53	3,888.05	14,038.24	1,087.89	1,413.82	1,817.87	1,825.52	6,145.10
WA State Parks	**66.10**	**247.55**	**1,461.45**	**348.49**	**2,123.59**	**66.10**	**247.55**	**1,447.25**	**344.29**	**2,105.19**
Commercial Vegetation	61.80	92.07			153.87	61.80	92.07			153.87
Non-commercial Vegetation	4.30	155.48	1,461.45	348.49	1,969.73	4.30	155.48	1,447.25	344.29	1,951.33
WA Dept. Fish & Wildlife	**5,169.60**	**4,331.42**	**4,749.66**	**782.39**	**15,033.07**	**3,429.55**	**2,247.25**	**2,326.75**	**535.23**	**8,538.77**
Commercial Vegetation	1,930.80	1,538.46	521.39		3,990.64	1,500.24	1,047.15	518.34		3,065.73
Non-commercial Vegetation	479.85	447.34	3,509.84	770.47	5,207.51	381.46	51.26	1,267.27	523.32	2,223.31
Prescribed Fire	2,758.96	2,345.62	718.43	11.91	5,834.93	1,547.86	1,148.83	541.14	11.91	3,249.74
US Forest Service	**34,445.42**	**39,047.17**	**44,148.75**	**19,080.14**	**136,721.48**	**17,211.93**	**16,274.69**	**20,382.50**	**10,996.29**	**64,865.41**
Prescribed Fire	11,389.51	10,459.63	16,900.11		38,749.25	2,785.93	6,354.64	5,891.53	3,047.22	18,079.32
Non-commercial Vegetation	12,036.50	17,620.18	15,926.20	13,994.36	59,577.24	8,684.12	6,248.52	7,182.28	7,949.06	30,063.98
Commercial Vegetation	11,019.41	10,967.35	11,322.44	5,085.78	38,394.98	5,741.88	3,671.54	7,308.70		16,722.11
US Fish & Wildlife Service	**549.45**	**779.50**	**1,041.48**	**1,151.03**	**3,521.45**	**549.45**	**779.50**	**1,041.48**	**1,151.03**	**3,521.45**
Commercial Vegetation			492.55	572.42	1,064.97			492.55	572.42	1,064.97
Non-commercial Vegetation		26.41	105.20	240.48	372.09		26.41	105.20	240.48	372.09
Prescribed Fire	549.45	753.08	443.74	338.13	2,084.39	549.45	753.08	443.74	338.13	2,084.39
Natural Resource Conservation Service	**1,244.20**	**924.40**	**911.00**	**896.40**	**3,976.00**	**1,244.20**	**924.40**	**911.00**	**896.40**	**3,976.00**
Non-commercial Vegetation	1,244.20	924.40	911.00	896.40	3,976.00	1,244.20	924.40	911.00	896.40	3,976.00
The Nature Conservancy	**206.59**	**108.67**		**123.35**	**438.61**	**206.64**	**108.70**		**123.38**	**438.72**
Commercial Vegetation	206.59	108.67			315.26	206.64	108.70			315.34
Non-commercial Vegetation				123.35	123.35				123.38	123.38
Kalispel Tribe of Indians	**81.58**	**96.62**	**103.30**	**115.79**	**397.30**	**81.58**	**96.62**	**103.30**	**115.79**	**397.30**
Commercial Vegetation	81.58	96.62	103.30	115.79	397.30	81.58	96.62	103.30	115.79	397.30
Colville Confederated Tribes	**175.60**				**175.60**	**175.60**				**175.60**
Commercial Vegetation	175.60				175.60	175.60				175.60
TOTAL TREATMENT ACRES	**62,782.26**	**72,805.50**	**73,662.08**	**47,137.49**	**256,387.33**	**31,481.74**	**30,417.33**	**35,965.34**	**24,963.58**	**122,827.98**

NOTE: This data set represents forest health treatment data as reported to DNR. Due to the extreme wildfire season throughout Region 6 of the Forest Service, their federal fiscal year reporting deadline for 2020 was extended until January 1, 2021. Therefore, DNR will update this table to address any discrepancies in Forest Service data in early 2021. DNR State trust lands completed forest health treatment data includes timber sales sold that are currently being implemented.

Table 11. Forest health treatment need, completed total treatments acres, and completed footprint acres by priority planning areas of the 20-Year Forest Health Strategic Plan.
Results reported from January 1, 2017 through October 30, 2020.

Priority Planning Area	Total Acres	Total Forested Acres	Assessed Treatment Need	Completed Treatments	
				Completed Total Treatment Acres	Completed Footprint Treatment Acres
Ahtanum	120,477	89,217	19,000 – 29,000	2,086	1,887
Asotin	149,152	93,329	Analysis in 2022	6,199	3,646
Chelan	98,051	31,342	Analysis in 2022	381	149
Chewelah	195,408	158,352	59,000 – 80,000	7,362	4,476
Chewuch	94,250	83,846	Analysis in 2022	322	204
Chumstick to LP	115,333	84,216	36,500 – 53,000	5,981	2,562
Cle Elum	109,396	80,300	22,000 – 35,500	3,620	2,110
Deer Park	181,171	90,497	Analysis in 2022	3,317	2,435
Dollar	61,238	50,767	Analysis in 2022	164	154
Glenwood	104,501	83,758	23,500 – 32,000	3,235	2,886
Hwy 97	60,398	37,415	Analysis in 2022	78	77
Ione	44,248	41,784	16,500 – 21,000	527	487
Klickitat	149,649	103,274	43,000 – 55,000	824	622
Little Naches	95,433	92,914	Analysis in 2022	816	816
Little Pend Oreille	117,820	105,372	Analysis in 2022	7,343	5,920
Little White	95,750	84,705	17,750 – 27,500	143	144
Long Lake	103,291	41,253	14,000 – 20,000	2,276	2,598
Mad Roaring Mills	65,008	33,325	13,500 – 20,000	2,114	1,678
Manastash Taneum	104,072	65,833	16,500 – 29,500	7,482	4,277
Methow Valley	338,246	182,937	49,500 – 75,000	9,251	7,511
Mill Creek	186,306	162,060	57,000 – 80,000	14,866	7,615
Mission	49,121	32,743	10,406	3,562	1,307
Mt Hull	105,431	34,809	12,000 – 18,500	1,096	809
Mt Spokane	121,767	95,814	25,500 – 38,500	4,649	3,782
Nason Creek	31,679	29,243	6,750 – 11,500	725	314
Republic	180,553	144,350	46,500 – 64,000	7,935	5,968
Stemilt	38,961	22,613	9,200 – 13,600	1,546	1,071
Stranger	89,904	72,061	30,000 – 38,000	2,507	1,156
Teanaway	132,120	111,696	38,500 – 60,000	2,185	1,855
Tieton	148,634	117,781	38,000 – 60,500	963	929
Tillicum	14,326	11,241	7,614	4,826	1,486
Toroda-Tonata	153,611	117,345	51,000 – 66,000	2,860	1,954
Touchet-Mill	203,750	110,794	Analysis in 2022	1,259	366
Trail	105,242	94,948	32,500 – 44,000	3,138	2,363
Trout Lake	117,153	105,015	18,500 – 33,000	2,819	2,785
Twisp River	111,918	82,349	26,000 – 36,500	59	57
Upper Swauk	39,175	35,450	14,000 – 22,000	712	695
Upper Wenatchee	74,777	66,277	15,500 – 27,000	1,811	1,158
White Salmon	126,688	104,022	38,000 – 54,000	1,580	1,529

With funding from the Legislature, DNR is leading the development of a Forest Health Tracker website to compile forest health project information across all-lands in Washington to increase awareness of which forest health activities are planned on the landscape and track the progress of those treatments. Information submitted by partners and displayed online for forest health projects will include spatial location, treatment type, project phase, lead implementer, and partner organizations. The primary focus of the websites development is forest health project information about managing the structure, pattern, and processes of forested vegetation in eastern Washington. Over time, it is intended that the Forest Health Tracker will include comprehensive forest health and resilience treatment data for all of Washington. This website will be available to the public by summer 2021.

Forest treatment tracking occurs across all phases of a treatment life cycle — proposed, planned, in progress, and completed. To provide a better sense of what this work and these partnerships look like on the ground, data from three priority planning areas are detailed below: the Manastash-Taneum area in central Washington, the Mill Creek area in northeast Washington, and the Asotin area in southeast Washington.

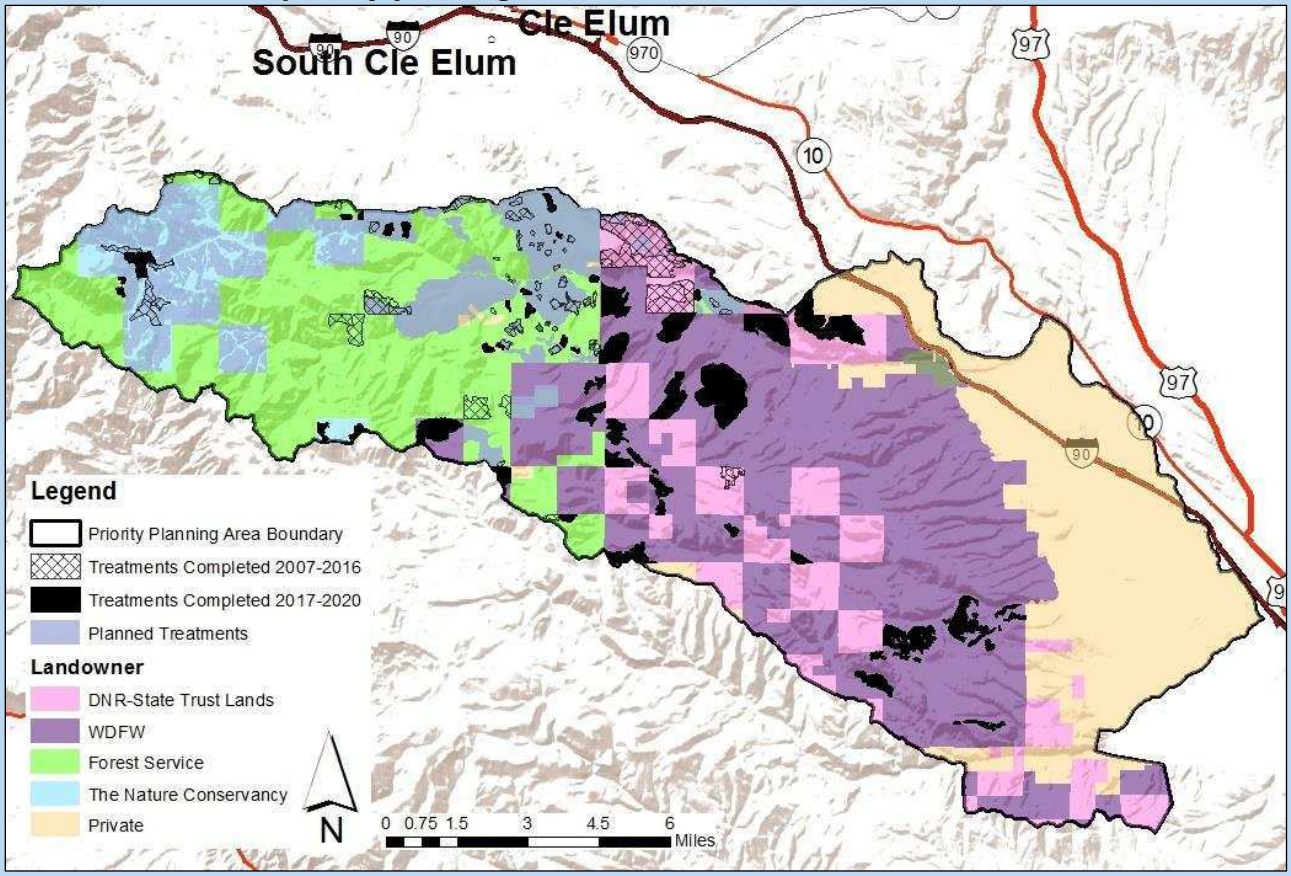
Priority Planning Area Highlight: Manastash-Taneum

The Manastash-Taneum priority planning area in central Washington was identified as high priority in the 2018 planning cycle and includes over 70,000 forested acres (Fig. 18). This area highlights the importance of collaborative efforts when working on cross-ownership, landscape-scale forest restoration. Landowners have collectively completed approximately 7,500 acres of forest health treatments since 2017, building on forest health investments made the previous decade. The treatment goal range for this area is 16,500 to 29,500 acres.

"Fire, insects and disease, water, fish and wildlife do not recognize property boundaries. Furthermore, the flow of sustainable products and economic well-being is supported across ownerships. The Conservancy is honored to manage Central Cascades Forest and to partner and coordinate forest and aquatic restoration actions with other land managers in the Manastash-Taneum. Together, we are truly working at a scale that is addressing real threats and creating a resilient future for people and nature."

— Reese Lolley, Director of Forest Restoration and Fire, The Nature Conservancy

Figure 18. Location of completed (2007-2020) and planned forest health treatments in the Manastash-Taneum priority planning area.



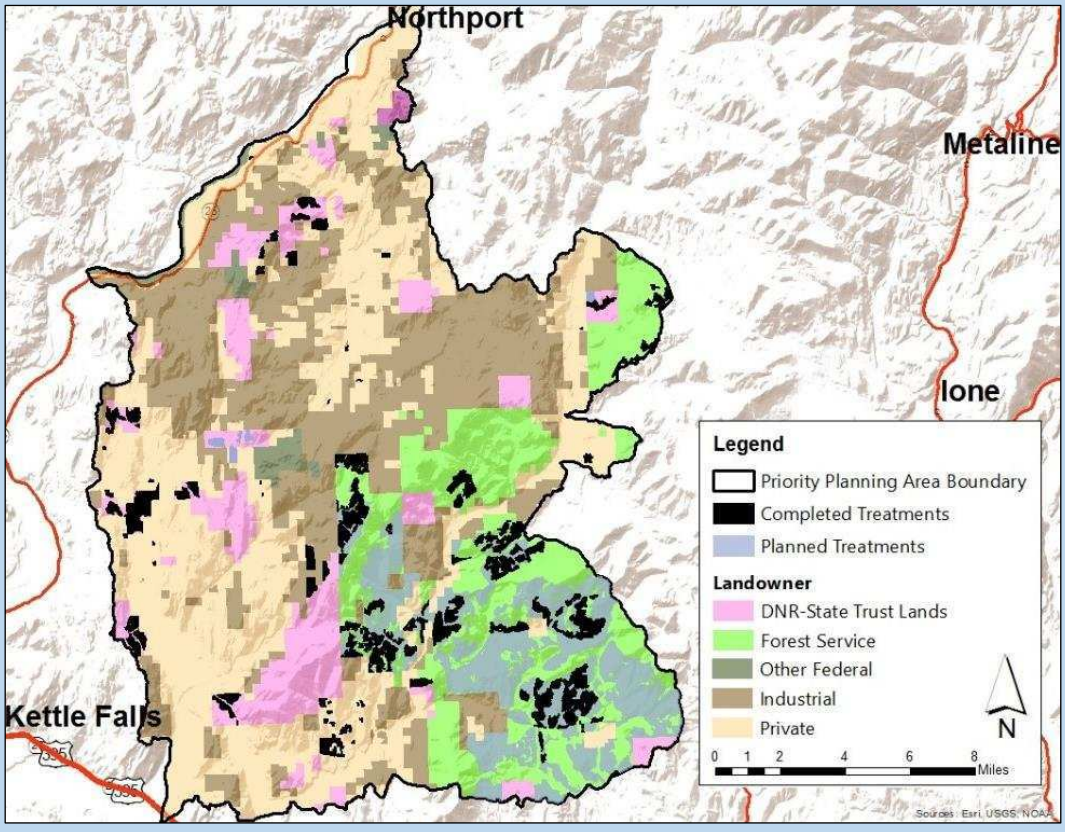
Priority Planning Area Highlight: Mill Creek A-Z

The Mill Creek A-Z priority planning area, in the northeast corner of the state, was identified as high priority in the 2018 planning cycle and includes more than 158,000 forested acres (Fig. 19). This area highlights the importance of innovative private-public partnerships in implementing projects that can sustain healthy forests over time. Partners have collectively completed about 15,000 acres of forest health treatments since 2017. Treatment goals for this area: 57,000-80,000 acres. Treatments to date have been completed on national forest land, DNR state trust lands, and private land with the DNR Landowner Assistance Program.

"The Mill Creek A-Z project was a first of its kind partnership. Formed to address the forest health issues on National Forest managed lands within the Mill Creek watershed, and in a truly collaborative way, this project's success relied upon engagement and hard work by a diverse set of interests. These interests, like the Northeast Washington Forest Coalition — the contractor and all their sub-contractors — and local, state, and federally elected officials, were instrumental in the outcome of this project. Without the focus on the issues, and the shared stewardship approach, these much needed restoration activities would not have produced the desired results or the success we've seen to date."

— Josh White, District Ranger, Colville National Forest

Figure 19. Location of completed (2007-2020) and planned forest health treatments in Mill Creek A-Z area.



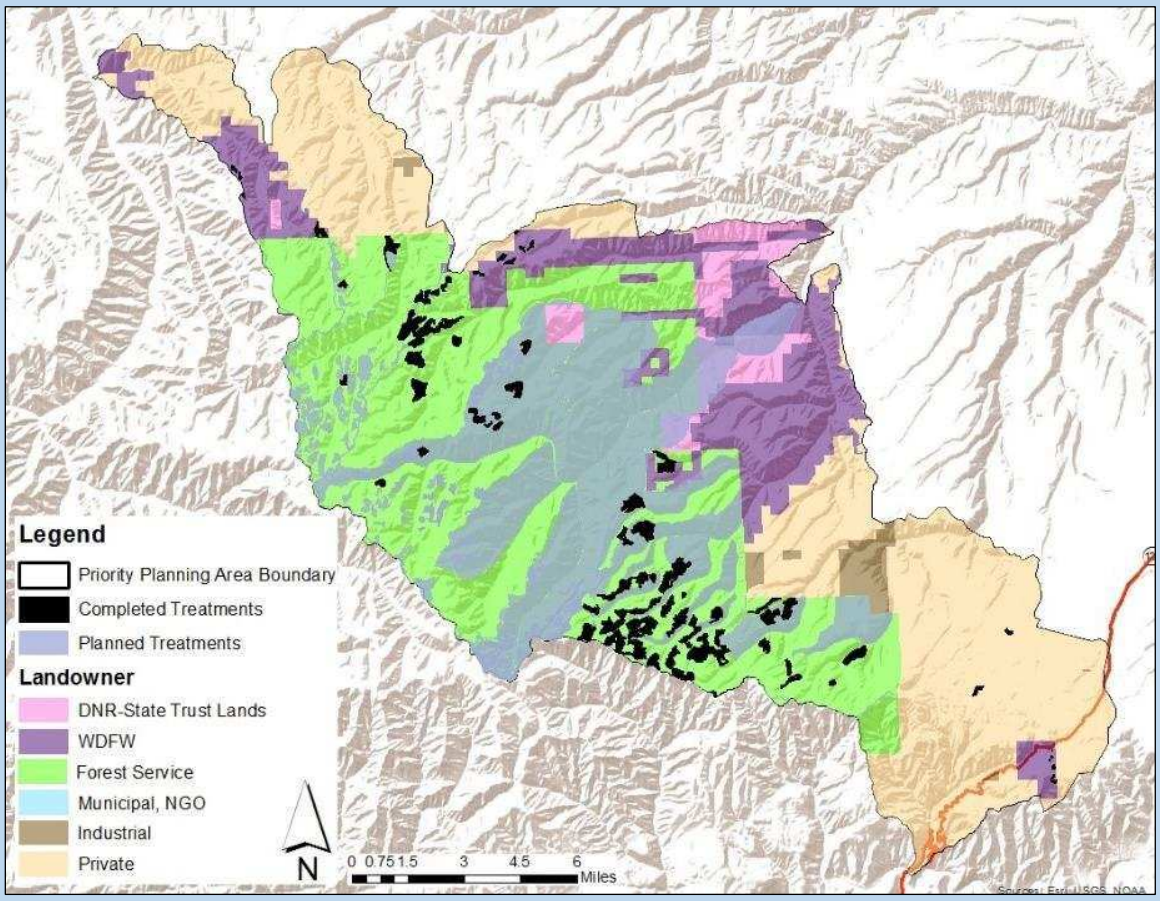
Priority Planning Area Highlight: Asotin

The Asotin priority planning area, in the southeast corner of the state, was identified as high priority in the 2020 planning cycle and includes more than 82,000 forested acres (Fig. 20). This area highlights the importance of working with federal and state partners, who together completed over 6,000 acres of treatments since 2017. Treatment goals for this area will be set in 2022. Treatments have been completed on National Forest land, Washington State Parks, WDFW Wildlife Areas, and on private land with DNR's Landowner Assistance Program and NRCS.

"WDFW is proud to do our part across eastern Washington to restore forest health on our lands and contribute to healthy and resilient fish and wildlife populations, quality recreational opportunities and safe, thriving communities. In the Asotin priority landscape, our treatments over the past two years cover 40-50 percent of our treatment goals, and we plan to complete the initial treatments and move into maintaining healthy forest conditions in the next few years."

— Cynthia Wilkerson, Lands Division Manager, Washington Department of Fish and Wildlife

Figure 20. Location of completed (2017-2020) and planned forest health treatments in the Asotin area.



2021-23 Appropriations Request

In the face of COVID-19 and wildfire destruction, DNR's 2021-23 biennium agency requests address the extraordinary need for job creation as well as landscape and community resilience. Specific to forest health, the DNR will request $25 million in the 2021-23 biennium to invest in cross-boundary forest health projects as guided by the 20-Year Forest Health Strategic Plan and the Forest Health Advisory Committee, including in thinning, prescribed burning, and GNA projects.

This is a scalable capital budget ask that crosses state, small-private landowner, and federal land for rapid job development in multiple sectors statewide, linking the Forest Action Plan, Forest Health Strategic Plan, and Wildfire Strategic Plan.

This proposal seeks to develop a robust economic response to the COVID-19 pandemic through rapid job development using traditional forest hazard reduction activities and incorporating forest resilience projects at a statewide level to enhance habitat and watershed health through the newly developed Forest Action Plan. In addition, this proposal would increase treatment efficiency and reporting capabilities of DNR, finalizing systems piloted under previous biennia. In total, this request would lead to the treatment of up to 46,000 acres across state, federal, and private land, produce up to 51,000 million board feet of federal and state timber volume, generate $9.7 million in revenue, and create an estimated 927 jobs across multiple sectors to protect communities and resources across Washington. A breakdown by program is as follows:

State Trust Land Forest Health Treatments ($4,300,000): This would build upon existing programs of work within the state trust lands portfolio to conduct non-commercial treatments on approximately 13,200 acres and support 1,100 acres of otherwise non-viable commercial projects. These treatments would improve the health and resilience of forested state trust lands while improving the future financial returns of state timber harvests. The commercial harvests would produce an estimated 5.5 million board feet of timber volume for local economies and generate an estimated $1.5 million dollars in revenue. This revenue would be deposited into DNR's Forest Health Revolving Account, enabling further investments in forest health treatments. Focus areas of these projects include central and northeastern Washington. In total, this investment would treat up to 14,300 acres and generate approximately 75 private forest industry and commercial contractor jobs in eastern Washington.

Federal Land Forest Restoration Treatments and Projects ($7,800,000): This would take a significant body of work that exists on federal land to support federal restoration targets and

connect existing or emerging projects on adjacent land when possible. In eastern Washington, DNR would conduct approximately 10,000 acres of hazardous fuels reduction treatments in priority watersheds identified in the forest health plan in the Okanagan-Wenatchee, Colville, Umatilla, and Gifford Pinchot national forests with 1,300 acres supporting commercial restoration projects through the GNA. Additionally, forest collaboratives through DNR's competitive grant program established in 2017 would yield increased efficiencies and leveraged resources to increase the footprint of implementation. In western Washington, priority watersheds identified in the 2020 Forest Action Plan would guide project selection and occur in the Olympic, Mount Baker-Snoqualmie, and Gifford Pinchot national forests. Commercial restoration projects on westside national forests would restore habitat on an estimated 2,200 acres. DNR would use this proposal in conjunction with existing federal funds to leverage state investments and generate an estimated 46,000 million board feet of timber volume to yield an estimated $8.2 million dollars in revenue to reinvest into national forests through the Natural Resources Federal Lands Revolving Account established in 2018. In addition to treatment acres, this project focuses efforts to repair 23 critical fish passage blockages, complete 75 miles of deferred maintenance, including removing of up to 10 miles of unneeded or unrepairable roads on federal land across Washington. In total, this request would lead to restoration on 14,100 acres of federal land statewide and would generate 439 jobs in the private contractor, non-profit, and forest industry sectors in urban and rural communities.

Private Land Forest Hazard Cost Share and Community Resilience Projects ($7,300,000): An expansive workload exists on private land in eastern Washington to protect homes and communities, as well as educate residents of the risks of living in fire-prone landscapes. The human component of resilience is demonstrated within the work accomplished by the department's effective Landowner Assistance Program. This proposal seeks to accomplish approximately 12,600 acres of private landowner cost-share through hazardous fuels reduction projects around homes and properties in eastern Washington that are combined with federal funding as available. State appropriated capital investments are key to reducing risks within the expanding wildland-urban interface. Focus areas for this work include communities in and around Spokane Valley, Chewelah, Newport, Colville, Metaline Falls, Northport, Republic, Tonasket, Oroville, Leavenworth and Chumstick, Liberty, Stemilt, Cle Elum, Roslyn, Goldendale, White Salmon, Trout Lake, Carson, and Walla Walla. Approximately 26 Firewise USA © communities and seven Fire Adapted Communities would be established or renewed. This funding also would support educational events to ensure maximum return on investments for private treatments and help develop, update, or implement 10 Community Wildfire Protection Plans. In total, this investment would generate up to 145 private contractor jobs.

All Lands Treatment and Planning Efforts ($5,600,000): This proposal bolsters state, federal, local, tribal, and private land projects through increasing cross-boundary and collective implementation, planning, and tracking power. It would build a short-term project level surge in critical staffing needed to layout and complete the large number of contracts associated with this funding proposals. DNR is tripling its current historic level of acreages, which current staffing will not be able to absorb. To achieve significant increases in treatment efficacy and accountability for DNR and its partners, investments in DNR's ability to transparently and accurately track progress across all-lands is necessary. Through this proposal, DNR would build on existing development of an online, comprehensive forest health treatment tracking system with enhancements to the existing system to increase functionality, integrate field data validating treatments, connect financial investments to treatment data, and expand the system statewide by 2022. DNR staff would analyze changed forest conditions, risk to values from wildfire and other disturbances, and the need for active treatments on approximately 12 million acres of forested landscapes and watersheds to inform strategic plan implementation. Boots on the ground data collection and verification would occur across 20,000 acres of state, private, and federal treatments. Additionally, 1,000 acres of state-led prescribed fire is anticipated in strategic locations to create an all-lands benefit and expand the DNR's progress of reinstating prescribed fire as a critical tool in its toolbox. To accomplish this broad array of work, the development of a Forest Resiliency Strike Team is included in this proposal. This team would work across all lands supporting data collection on 20,000 acres, federal timber sale presales work on 1,200 acres, layout of non-commercial fuel-reduction projects on 4,000 acres of federal and private land, and other needs. This work would generate up to 268 private contractor and forest industry jobs statewide and support up to 5,200 acres of treatments on private and federal land.

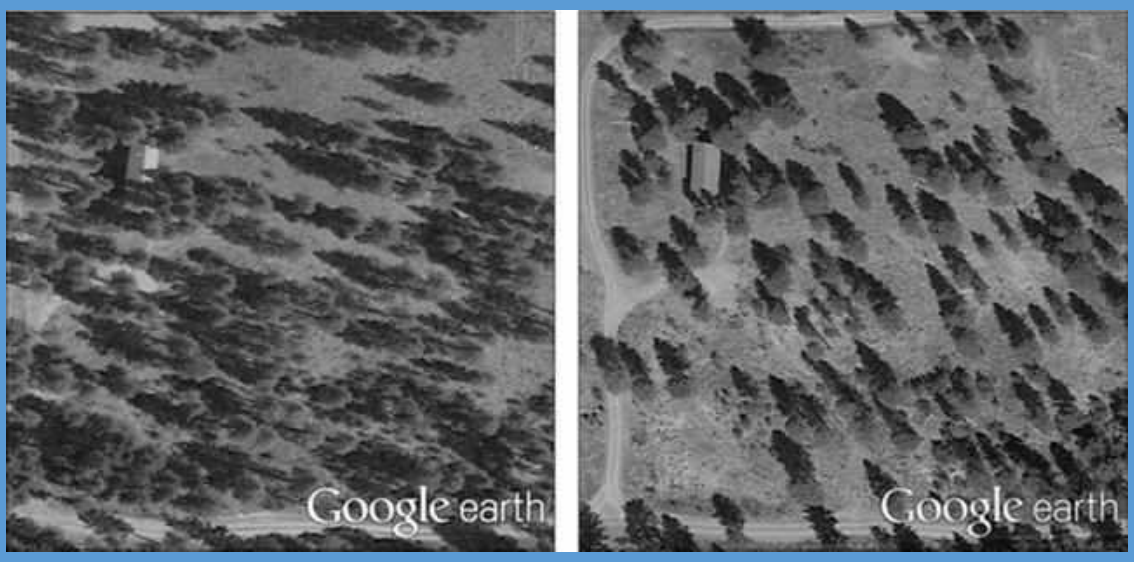
Forest Health Investment Highlights

Below are summaries of two projects that highlight several types of forest health projects the state has previously funded with capital budget appropriations, and that will benefit from additional resources. The Pine Forest summary highlights a residential community in Methow Valley taking proactive steps to improve the health of their forests with assistance from DNR and other agencies. The Sxwuytn-Kaniksu Connections 'Trail' Project summary highlights a first of its kind collaboration in the nation among the Kalispel Tribe, USDA Forest Service and DNR to plan and implement landscape-scale forest health treatments in Pend Oreille County. Appropriations for the 21-23 biennium forest health capital budget will fund projects similar to those described below as well as other projects.

Community Fuels Reduction Highlight: Pine Forest

Pine Forest is a 520 acre residential community near Winthrop with 134 lots and 200 acres of common space. This residential subdivision is nestled in the forested foothills of the Methow Valley in Okanogan County and has some of the highest wildfire risk in the state. The 2015 Twisp River Fire burned within a quarter mile of the Pine Forest community. Following the Twisp River Fire, the Pine Forest Owners Association updated their forest stewardship plan, received Firewise USA © recognition, and conducted their first round of cost share fuel reduction treatments through the DNR Landowner Assistance Program.

From 2015 to 2020, the Pine Forest community made significant progress implementing fuel reduction treatments. The community has implemented both commercial and non commercial fuel reduction treatments to reduce fire risk. Both individual lot owners and the Pine Forest Owners Association have actively implemented fuel reduction projects over the last several years. An impressive 75 percent of individual lot owners have completed fuel reduction treatments on their land and 70 percent of the common space has been treated. This work resulted in more than 400,000 board feet of merchantable timber, however, due to a variety of challenges, the sale of merchantable timber offset less than half the cost of the treatments. Individual lot owners and the Pine Forest Owners Association paid over $300,000 to complete the treatments. Pine Forest is an excellent example of small private landowners working together, with assistance from natural resource agencies, to significantly reduce wildfire risk in their community.



Pine Forest lots 153 and 154 before (left) and after (right) commercial thinning.

Project Highlight: Sxwuytn Kaniksu Connections 'Trail Project

This innovative forest health project in northeast Washington is advancing a new model of project planning and public engagement that seeks to address forest health issues in a checkerboard of mixed ownership in a priority planning area that will result in forest health treatments to implement in the 2021 23 biennium.

The project encompasses 90,700 acres in Pend Oreille County, including land owned and managed by the Colville National Forest, Kalispell Tribe of Indians (KTI), DNR, Washington Department of Fish and Wildlife, and private forestland owners. The project uses the Tribal Forest Protection Act and Good Neighbor Authority to formally engage KTI and DNR in the planning process. It focuses on reducing the threat of catastrophic wildfire by treating hazardous fuels, enhancing fish and wildlife habitat, removing invasive species, and supporting the economic vitality of the county.

In the 2017 19 biennium, KTI, in partnership with the Northeast Washington Forestry Coalition and Colville National Forest, received a $400,000 All Lands Forest Restoration Grant. The funding is accelerating the planning and implementation of the project by at least two years. KTI has matched the state investment by more than 1:1 with about $733,000 (Lithgow 2020). This investment of staff and financial resources speaks to the importance of the project to the tribe and the region. Through partnerships and shared investments, priority landscapes help focus multiple agencies and organizations, leading to accelerated planning and implementation of projects across large landscapes.

An aerial image of forests within the Trail project.

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Appendices

Appendix A – Forest Restoration Need in Eastern Washington

Appendix B – Forest Health Assessment and Treatment Framework Methodology

Appendix C – HB 1784 Pilot Project

Appendix D – Landscape Evaluation Summary Results for 2020 Priority Planning Areas

Appendix E – 20-Year Forest Health Strategic Plan Monitoring Framework

Appendix A: Forest Restoration Need in Eastern Washington

October 2020

Madison Laughlin, Brian Harvey and Jon Bakker, University of Washington (UW)

Derek Churchill and Chuck Hersey, Washington State Department of Natural Resources (DNR)

This analysis provided DNR and its partners with up-to-date high-level estimates of treatment need in eastern Washington for the 20-Year Forest Health Strategic Plan and other forest health efforts. Previous estimates of restoration need used vegetation data from 2006 (Haugo et al. 2015) and 2012 (DeMeo et al. 2018) and did not include the Washington Blue Mountains. Since those estimates were produced, eastern Washington has experienced multiple large fire years, tens of thousands of acres have been treated, and vegetation has continued to grow.

In addition, the US Forest Service and its partners have improved the analytical methods used to generate current conditions data (GNN) and generate treatment need estimates. Thus, DNR contracted with UW to use these latest methods to assess forest restoration need in a consistent manner across eastern Washington annually from 1986 to 2017. This analysis provides DNR with both the absolute amount of treatment need acres and trends over the last 30 years.

Current eastern Washington forest restoration need (2017)

The analysis found that the active forest restoration need (disturbance only and disturbance + growth) in eastern Washington for 2017 was 3.07 million acres (Table 1 and Figure 1). Over 75% of the total disturbance need (2.35 out of 3.07 million acres) is in dry mixed conifer and ponderosa pine forests, driven by an overabundance of mid-closed forest and a deficit of mid and late open-canopy forest.

Change in eastern Washington forest restoration need from 2006 to 2017

The original forest restoration need assessment (Haugo et al. 2015) reflected vegetation conditions in 2006. Since 2006, the total active forest restoration need (disturbance only and disturbance + growth) in eastern Washington has decreased by 5% from 3.23 million acres[1] (2006) to 3.07 million acres (2017) particularly in the WNE and WEC mapzones (-8.4% and -1.6%, respectively; Figure 2). Individual watersheds in Okanogan County saw up to a 16% decrease in disturbance need, driven primarily by the 2014 and 2015 wildfires. These fires are doing good work by reducing density, though they also are killing large trees and thereby increasing the need for growth based restoration.

[1] *In the Haugo et al. (2015) publication, the total disturbance restoration need reported for eastern Washington was 2.7 million acres. This number was calculated using the original methods and did not include any restoration need from the OBM mapzone (Blue Mountains) within the state. The 3.23 million acres of total disturbance need for 2006 calculated by the University of Washington reflects updated methods and includes the OBM mapzone (which accounts for an additional 147,000 acres of total disturbance need).*

Restoration need has decreased every year since 2012 (Figure 3), likely due to the increase in acres burned by wildfires (Figure 4) and treatments. However, the rate of decrease is only around 1% per year.

Overall, active restoration need is trending in the right direction but is not changing fast enough to meet the goals of the 20-Year Forest Health Strategic Plan or to keep pace with projected climate change. The need to increase the pace of active forest restoration in eastern Washington is clear.

Table 1. A high-level estimate of 2017 active restoration need (acres) by land ownership within eastern Washington. Disturbance may be mechanical treatments or fires that reduce tree density. Growth indicates that time is needed so that existing trees can grow larger and/or canopy cover can increase.

Landowner	Active Restoration Need (acres) (Disturbance Only and Disturbance + Growth)	Percentage of Active Restoration Need
Federal	1,330,000	43%
Private, Industrial	583,000	19%
Tribal	494,000	16%
Private Small, Non-Industrial	288,000	9%
DNR	285,000	9%
DFW & Other State	74,000	2%
Other	14,000	0.5%
Total	3.07 million acres	

Note: The restoration need numbers for land ownership are proportionally allocated based on how much area each land ownership occupies within strata (biophysical setting by landscape level), as was done previously (Haugo et al. 2015; DeMeo et al. 2018). For example, if a given stratum needs 100,000 acres of total disturbance restoration need and 60% of the forested area is DNR land and 40% is federal land, then 60,000 acres of total disturbance restoration need are distributed to DNR lands and 40,000 to federal lands. This is repeated for each stratum and then the areas are summed to produce the table above. This estimate results in the restoration need across eastern Washington being distributed largely based on the proportion of land ownership in eastern Washington. It is not possible to determine exact restoration need acres by landowner. Table 1 should not be interpreted as the exact restoration need for each landowner, rather it is a high-level estimate based on the proportion of land ownership in eastern Washington.

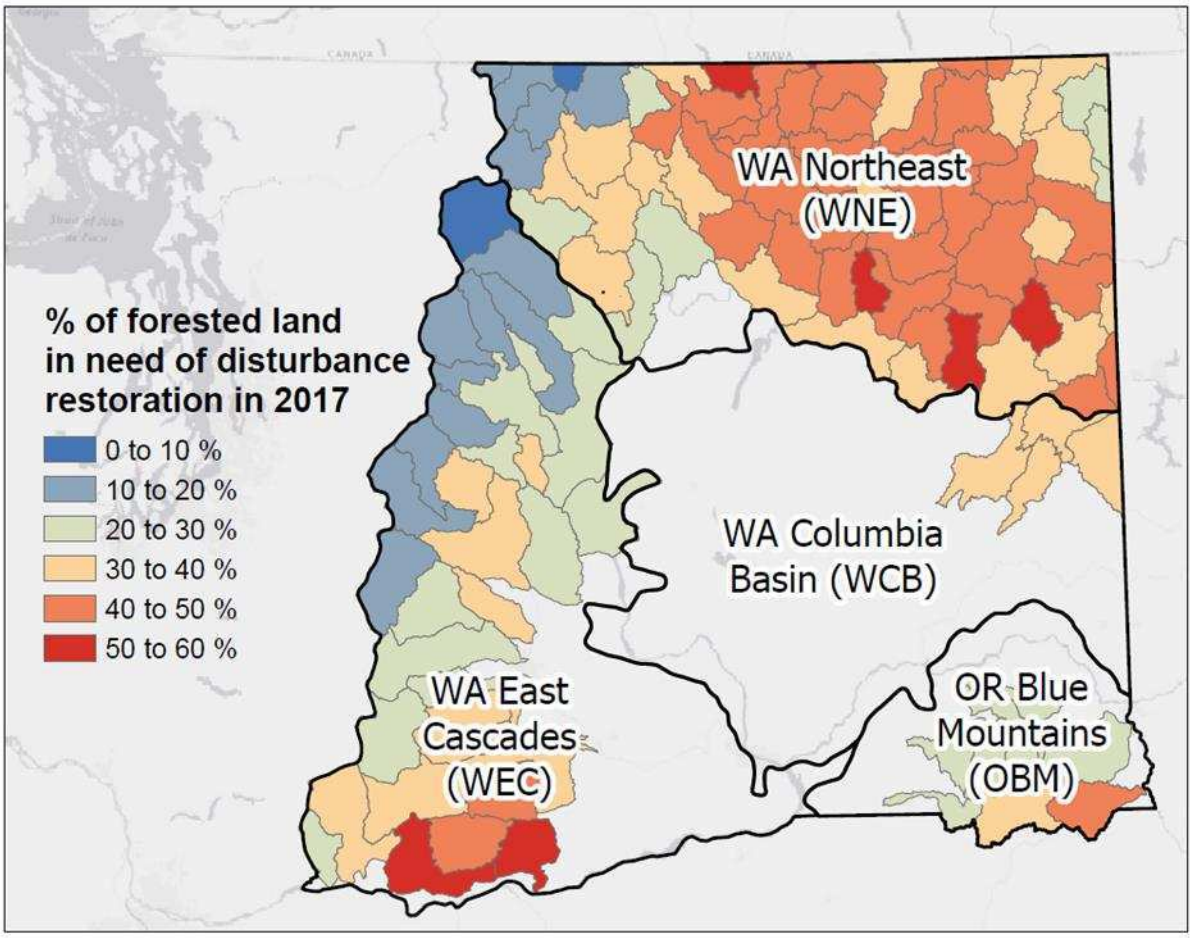

Figure 1. The percent of forested land in need of disturbance restoration within watersheds (USGS 10-digit/5th level hydrological unit; average ~113,000 acres) in 2017. Disturbance restoration need includes disturbance only treatments (mechanical thinning or fire) and disturbance + growth treatments (mechanical thinning or fire followed by a period of growth). The study area is divided into 4 mapzones--the Washington (WNE), Washington East Cascades (WEC), Washington Columbia Basin (WCB), and the Oregon Blue Mountains (OBM) which are delineated on the map. The mapzone boundaries are consistent with previous restoration need assessments (Haugo et al. 2015; Demeo et al. 2018), however the OBM mapzone was modified to only include forested land within watersheds located primarily in Washington state.

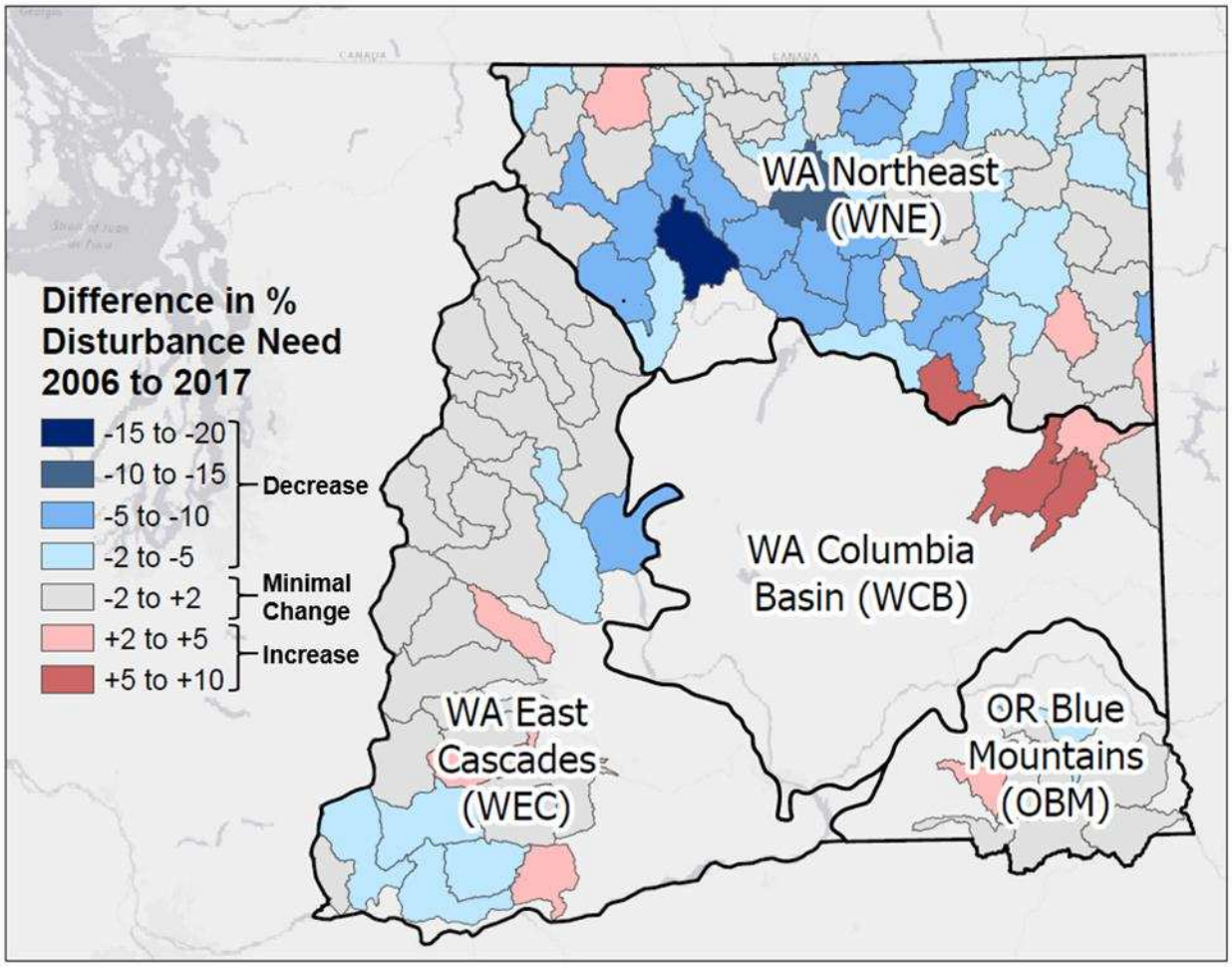

Figure 2. Change in disturbance need between 2006 and 2017. Blue colors indicate decreases in disturbance need and red colors indicate increases in disturbance need. The minimal change category (-2 to 2% change) shows watersheds where the direction of change is not clear given the year-to-year variation in estimates of current condition.

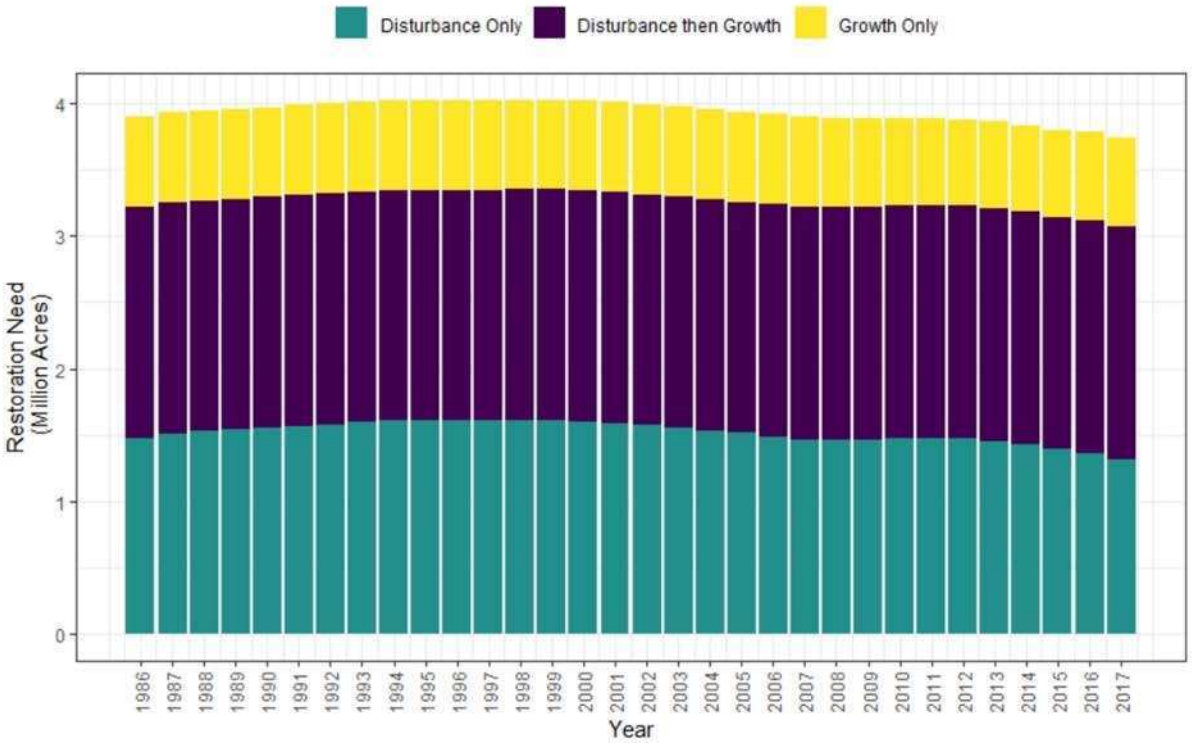

Figure 3. Long term trends in disturbance only, disturbance then growth, and growth only restoration need (acres) across forested areas of eastern Washington.

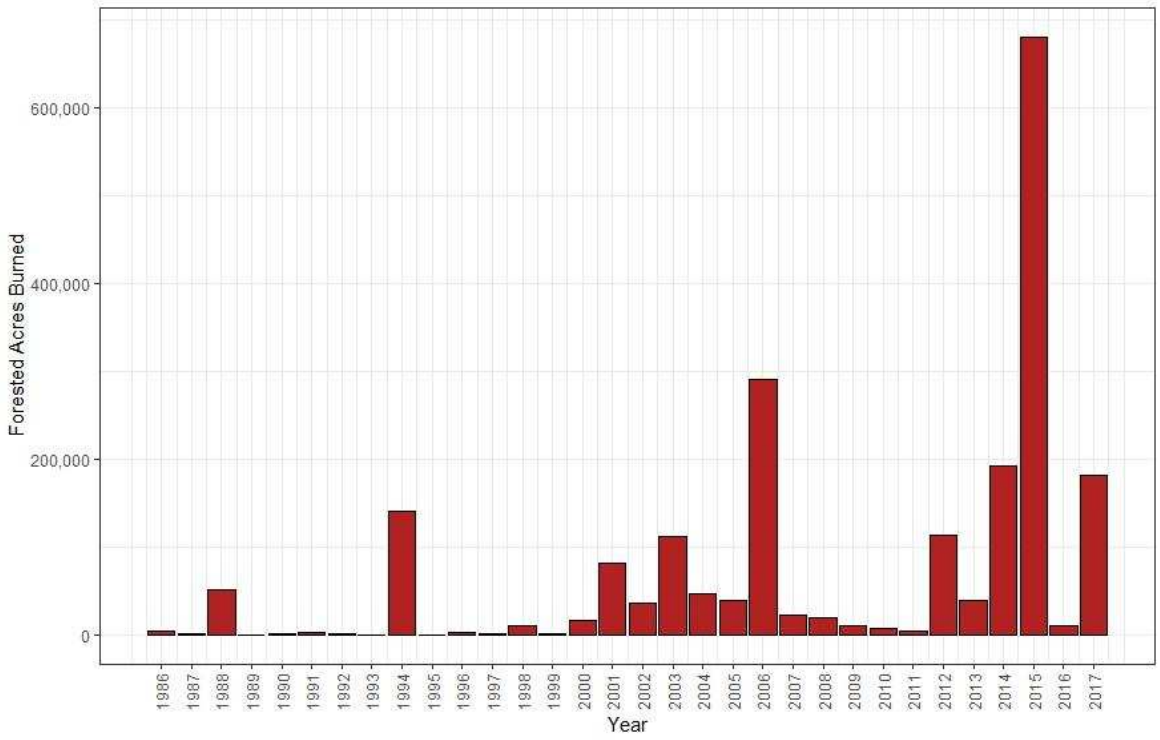

Figure 4. Total forested area burned (acres) across eastern Washington from 1986 – 2017.

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Appendix B: Forest Health Assessment and Treatment Framework Methodology

Introduction

DNR is employing the landscape evaluation and prescription process described below to assess and prioritize forest health treatment needs in the forest health priority planning areas as required by RCW 76.06.200. The landscape evaluation serves as the assessment component of the Forest Health Assessment and Treatment Framework.

The methodology developed to conduct landscape evaluations is based on the best available science on the ecology and management of fire-dependent landscapes (Stine et al. 2014, Spies et al. 2018, Hessburg et al. 2019), quantitative assessment of wildfire fire risk and transmission (Scott et al. 2013, Ager et al. 2019c), treatment prioritization (Ager et al. 2019b), and climate change impacts and adaptation strategies (Clark et al. 2016, Schoennagel et al. 2017).

The methodology is built upon the framework for landscape evaluations established in the Okanogan-Wenatchee National Forest (OWNF) Restoration Strategy (USFS 2012) and described in the 20-Year Forest Health Strategic Plan (see Appendix 2 of the Forest Health Plan). The methodology was formalized during the process of conducting landscape evaluations of the 2018 Planning Areas. Methods and data outputs were tailored to the management needs of major landowners. In addition, input from local land managers and stakeholders is incorporated at various stages of developing a landscape evaluation for a specific planning area.

Since the 2018 evaluations, DNR scientists have added important new components to landscape evaluations based on feedback from partners. On the forest health side, these include mapped prioritization of potential treatment locations, assessment of treatment type based on operational and economic feasibility, and identification of locations where managing for closed canopy and large-tree forest structure will be most sustainable over time. To integrate community wildfire protection and other goals of House Bill 1784 (HB 1784), a wildfire response benefit component was added to the landscape evaluations.

In addition to new components, many of the methods and datasets described in the 2018 report

have been upgraded or improved. These components and improvements are described below (methodology items 1-9), followed by new components (methodology items 10-14). All data used and generated for landscape evaluations are publically available and can be downloaded here[1]. Detailed documentation of all data layers is also provided. Note that the methodology used for landscape evaluations will continue to evolve as new science and methods emerge. This appendix document will be updated as needed to reflect changes in methods.

1. Identify ownership types and management objectives

Recognizing the diverse management objectives of different landowners is a critical first step in a landscape evaluation. Knowing the spatial distribution of different ownership classes provides an important context for the types of treatments and long-term forest structure that is likely in different parts of the planning area. Ownership information was derived from a DNR ownership layer developed by Atterbury Consultants from 2019 county tax parcel data. Updates were made based on U.S. Forest Service (USFS), DNR, and Washington Department of Fish & Wildlife (WDFW) corporate ownership layers to capture recent land transactions. These individual ownership layers were intersected hierarchically, and overlapping slivers were removed to create a seamless ownership map across eastern Washington.

2. Map vegetation and forest types

A consistent vegetation type layer was assembled by DNR scientists for all of eastern Washington using a combination of existing data sources. First, an improved forest mask to separate forested from non-forested areas was built from a combination of LANDFIRE, National Land Cover Dataset (NLCD), and Nature Serve ecological systems data. Next, vegetation-type geospatial layers were created for the eastern Cascade Mountains and northeast Washington from the Integrated Landscape Assessment Project (ILAP) data (Hemstrom et al. 2014) that were developed by the USFS Region 6 Ecology program. Improvements to ILAP data done by Jan Henderson (USFS) in 2012 – 2014 for much of northeast Washington and the eastern Cascades were included. For non-forest areas, LANDFIRE's existing vegetation type data were used.

To simplify reporting of results, vegetation types were grouped into three potential vegetation groups: cold forest, moist forest, and dry forest (Table 1). Dry forests are ponderosa pine, and Douglas-fir dominated forests that historically had low severity fires every 5 – 25 years. Moist forests historically had mixed-severity fires. They include sites in draws, north-facing aspects, and valley bottoms that had fire return intervals of 80 – 200+ years and were typically dominated by fire intolerant conifers such as grand fir or western red cedar. Moist forests also

[1] Data related to landscape evaluations can be downloaded here: https://bit.ly/ForestHealthData . For questions regarding data or methods, contact: Annie.Smith@dnr.wa.gov.

include sites that historically had more frequent fire (~30 – 100 years) and were typically dominated by Douglas-fir, western larch, and ponderosa pine. Cold forests are mid-to upper-elevation forests that historically had high severity fires every 80 – 200+ years and were dominated by subalpine fir, Engelmann spruce, lodgepole pine, as well as other conifers.

Table 1: Vegetation types and groups used in landscape evaluations

Vegetation Type	Region[1]	Potential Vegetation Group
Oak-pine	WEC	Dry Forest
Ponderosa pine	WEC	Dry Forest
Dry mixed-conifer	WEC	Dry Forest
Moist mixed-conifer	WEC	Moist Forest
Pacific silver fir	WEC	Cold Forest
Mountain hemlock	WEC	Cold Forest
Subalpine parklands	WEC	Cold Forest
Ponderosa pine dry	WNE	Dry Forest
Douglas-fir dry	WNE	Dry Forest
Northern Rocky Mountain Mixed Conifer (Grand fir - Cool/moist)*	WNE	Moist Forest
Western red cedar/ Western hemlock	WNE	Moist Forest
Subalpine fir-Lodgepole Pine (Subalpine fir-Cold Dry)*	WNE	Cold Forest
Spruce-Subalpine fir (Subalpine fir)*	WNE	Cold Forest
Subalpine fir	WNE	Cold Forest
Alpine	WNE	Cold Forest
Ponderosa pine – Xeric	WBM	Dry Forest
Ponderosa pine – Dry, with juniper	WBM	Dry Forest
Douglas-fir – Dry	WBM	Dry Forest
Grand fir – Warm/Dry	WBM	Dry Forest
Grand fir – Cool/Moist	WBM	Moist Forest
Subalpine fir – Cold/Dry	WBM	Cold Forest
Herbland	All	Non-Forest
Shrubland	All	Non-Forest
Agriculture	All	Non-Forest
Developed	All	Non-Forest
Unique – Other	All	Non-Forest
Not Vegetated - Barren	All	Non-Forest

[1]WEC: Washington East Cascades
WNE: Washington Northeast
WBM: Washington Blue Mountains

*ILAP names are in parentheses where they differ from names used in the Colville National Forest plan revision.

3. Map current forest structure and species composition

Current condition information for forest structure was obtained for each planning area in one of two ways based on the system used in the national forest in that area (Table 2). For the 16 planning areas in Northeast Washington and south and east of Mount Adams, recent LiDAR (2010 – 2019 acquisitions) or 2017 Digital Aerial Photogrammetry (DAP) data were used to create forest structure and geospatial inventory layers. The DAP process produces forest structure data from NAIP aerial imagery similar to those produced with LiDAR, and the methods used to analyze these data are identical. Data were produced by analysts at the University of Washington using direct LiDAR metrics (e.g., canopy cover and 95th percentile height) and modeled metrics (e.g., average diameter, basal area, volume). Modeled metrics were derived from DNR and USFS plot networks and LiDAR metrics (i.e., FUSION outputs) using standard LiDAR inventory modeling methods.

Eight basic structure classes were defined based on total canopy cover and the average diameter of the overstory (Table 3). These classes provided the basic framework for quantifying current conditions in the planning area. Classes were condensed into six classes for the landscape evaluation summaries to facilitate communication of results (Table 3). A 30m pixel structure class layer was developed for each planning area with LiDAR or DAP. For portions of planning areas that lacked LiDAR coverage, GNN data from 2017 was used to derive structure class (Table 2). Areas without LiDAR were generally dominated by agriculture or shrub-steppe vegetation. In addition, DNR inventory layers (RS-FRIS) were used in combination with LiDAR canopy cover to generate structure classes for the Little White planning area. DNR inventory layers are derived from DAP data. No species composition information is available from LiDAR or DAP data.

Data for the eight 2020 and four 2018 planning areas along the Eastern Cascades were obtained through photo-interpretation of digitized, stereo imagery using the approach from the OWNF Restoration Strategy (USFS 2012). The first step in the PI process is to delineate stands, or polygons, that have similar structure and composition across the whole planning area. Canopy cover, size class, canopy layering, and other attributes are then estimated for each polygon. Tree species composition is also included. Structure class, cover type (species groups), and other derived attributes such as habitat classifications are then generated for each polygon using classification criteria. To ensure consistency in the evaluation summaries, results for the seven PI structure classes were condensed into the same six simplified classes used in the LiDAR- or DAP-based approach. A crosswalk was developed for each planning area based on the dominant canopy cover, and size class ranges for each structure class (Table 3). The actual departure data was not converted to the six simple structure classes; just the treatment need ranges.

Table 2: Current condition data source for forest structure and departure assessment method

Planning Area	Source and Year of Current Condition Data (Percent of plan area for that data source)	Departure Assessment Method
2020		
Chumstick to LP	PI[1] - 2015 & 2017 DNR Imagery	Historical Imagery
Mad Roaring Mills	PI - 2014 Forest Service Imagery	Historical Imagery
Mt. Hull	PI - 2014 Forest Service Imagery	Historical Imagery
Nason Creek	PI - 2015 & 2017 DNR Imagery	Historical Imagery
Teanaway	PI - 2015 & 2017 DNR Imagery	Historical Imagery
Tieton	PI - 2015 & 2017 DNR Imagery	Historical Imagery
Twisp River	PI - 2015 & 2017 DNR Imagery	Historical Imagery
Upper Swauk	PI - 2012 Forest Service Imagery	Historical Imagery
Glenwood	2017 DAP	State and Transition Model
Ione	2015, 2016, & 2010 LiDAR	State and Transition Model
Klickitat	2017 DAP	State and Transition Model
Little White	2015 & 2016 LiDAR[2] canopy cover + 2017 DNR RS-FRIS[3] (90%), 2017 GNN_{dom}[4] (10%)	State and Transition Model
Long Lake	2016 & 2019 LiDAR[2]	State and Transition Model
Methow Valley	2018 LiDAR[2], 2017 GNN_{ht25}[4]	State and Transition Model
Republic	2012 & 2017 LiDAR[2] (80%), 2017 GNN_{ht25}[4] (10%), 2017 DAP (10%)	State and Transition Model
Stranger	2016 LiDAR	State and Transition Model
Toroda-Tonata	2017 & 2012 LiDAR[2] (95%), 2017 GNN_{ht25}[4] (5%)	State and Transition Model
Trail	2016, 2010, & 2019 LiDAR[2]	State and Transition Model
2018		
Cle Elum	PI - 2015 & 2017 DNR Imagery	Historical Imagery
Manastash.-Taneum	PI - 2012 Forest Service Imagery	Historical Imagery
Stemilt	PI - 2017 DNR Imagery	Historical Imagery
Upper Wenatchee	PI - 2014 Forest Service Imagery	Historical Imagery
Ahtanum	2015 DNR RS-FRIS[3] (90%), 2016 GNN_{ht25}[4] (10%)	State and Transition Model
Chewelah A-Z	2016 & 2015 LiDAR[2]	State and Transition Model
Mill Creek A-Z	2015 & 2016 LiDAR[2] (95%), 2016 GNN_{ht25}[4] (5%)	State and Transition Model
Mt. Spokane	2016 LiDAR (60%), 2016 GNN_{ht25}[4] (40%)	State and Transition Model
Trout Lake	2015 & 2016 LiDAR[2]	State and Transition Model
White Salmon	2015 LiDAR (75%), 2016 GNN_{ht25}[4] (25%)	State and Transition Model

[1] Photo interpretation of digitized, stereo imagery. DNR imagery is 2015 or 2017 NAIP imagery.

[2] LiDAR imagery years listed in order of coverage percentage, from highest to lowest.

[3] DNR RS FRIS canopy cover and tree diameter layers were used. This data is developed using DAP, which is a LiDAR-like product derived from 2017 NAIP stereo imagery.

[4] GNN_{dom} and GNN_{ht25} indicate GNN data, with the subscript indicating the type of QMD data. "dom" stands for QMD of the dominant trees, and "ht25" is for QMD of the top 25th percentile of trees.

Table 3: Structure classes used for planning areas

Class	Condensed Class	Definition	Corresponding Structure Classes from Photo-Interpretation System
Small Open	Small Open	canopy cover[1] < 10% OR dbh[2] < 10", canopy cover ≥ 10% dbh and < 40%	Stand Initiation
Small Closed	Small Dense	dbh < 10", canopy cover ≥ 40%	Stand Initiation; Stem exclusion closed canopy
Medium Open	Medium Open	dbh ≥ 10" and < 20", canopy cover ≥ 10% and < 40%	Stem exclusion open canopy
Medium Moderate	Medium Dense	dbh ≥ 10" and < 20", canopy cover ≥ 40% and < 60%	Young forest multistory; understory re-initiation; Stem exclusion closed canopy
Medium Closed	Medium Dense	dbh ≥ 10" and < 20", canopy cover ≥ 60%	
Large Open	Large Open	dbh ≥ 20", canopy cover ≥ 10% and < 40%	Old forest single story; Stem exclusion open canopy
Large Moderate	Large Dense	dbh ≥ 20", canopy cover ≥ 40% and < 60%	Old forest multistory; young forest multistory
Large Closed	Large Dense	dbh ≥ 20", canopy cover ≥ 60%	

[1] Canopy cover is derived from LiDAR or DAP using the percent of returns above 6.6 feet.
[2] Tree diameter at breast height (DBH) was derived from modeling relationships between LiDAR or DAP tree height layers and tree diameter from field plots. Tree diameter used to define structure class is based on the mean diameter of the dominant and co-dominant trees in a field plot. It is calculated by deriving the quadratic mean diameter of trees whose diameters are in the top 25% of trees that are greater than 5" in diameter.

4. Assess departure from reference conditions

The departure assessment quantifies how "out of whack" a planning area is by comparing it with landscape-level reference conditions that are thought to be resilient to large-scale disturbances and adaptable to changing climate. The primary outputs of a departure assessment are the number of acres of different structure classes that are too high, too low, or within range relative to the reference condition range. These outputs provide general targets for the classes of forest structure that are overabundant and need to be shifted to classes that are below reference conditions. Shifting classes can be accomplished through mechanical and fire-based treatments, as well as growth over time. A map of overabundant structure classes that can be shifted by treatments is created to identify where treatments should be focused to address departures. Desired ranges from reference conditions and departure are broken out by the three broad vegetation groups discussed above (dry, moist, and cold forests) in order to reflect different ecological conditions and disturbance regimes in each type. The pattern of forest structure is also evaluated. Patch sizes of dense and open forest, and the extent to which these are aggregated or fragmented, are assessed. The primary output of the pattern analysis is guidance regarding patch size targets for different structure classes and the extent to which large patches

of dense forest should be broken up. Finally, tree species composition is assessed relative to reference conditions when this information exists.

For fire-dependent forest ecosystems, reference conditions are common conditions that existed under an active fire regime and prior to widespread changes following Euro-American settlement and resulting fire exclusion and suppression, grazing, harvesting, and other changes (Hessburg and Agee 2003). These historical conditions serve as a baseline for a resilient landscape as they persisted through centuries of frequent fire, insect and other disturbances, as well as climatic fluctuations while sustaining biodiversity, aquatic, and other functions (Keane et al. 2009, Stephens et al. 2010, Hessburg et al. 2019). Frequent fire kept biomass levels well below carrying capacity in historical landscapes and maintained a patchwork of forest and non-forest conditions; both of which provided substantial resistance to large scale, high severity fires, and drought-related insect outbreaks (Fulé 2008, Hessburg et al. 2015). Utilizing historical reference conditions does not mean that we should attempt to restore these conditions fully. Instead, they provide a general baseline for conditions that we think will be resistant and resilient to large scale, high severity disturbances while providing a range of other ecosystem services that we want from our forests.

Current trends and projections of climate change indicate that historical conditions alone are not suitable reference conditions. The diversity of conditions across historical landscapes that were created and maintained by frequent fire enhanced the ability of these systems to adapt and change as the climate shifted from warmer to cooler periods over the last several millennia (Hessburg et al. 2019). Thus, historical reference conditions are a good starting place for climate adaption (Keane et al. 2009). Future climate and fire probability should be incorporated to ensure that reference conditions are a solid baseline for resilient conditions over time. Future reference conditions, however, are challenging to develop due to the uncertainties around the pace and magnitude of climate change and how individual species and ecosystems will respond. Another approach is to use "climate analog" reference conditions. This involves using historical conditions from warmer and drier locations as future reference conditions for a particular site (Gärtner et al. 2008). Climate change projections are used to select analog reference landscapes that have a similar historical climate to the projected future climate of the landscape under analysis. Climate analogs provide an empirical basis for integrating climate adaptation with ecosystem restoration and can provide ecologically based targets for resilience, response, or realignment of adaptation strategies (Stephens et al. 2010).

Two different methodologies were used for departure assessments in different parts of Central and Eastern Washington based on systems used by the National Forests in each area (Table 2). The first method is the approach used on the Okanogan-Wenatchee National Forest for their

Restoration Strategy (USFS 2012). Photo interpretation (PI) of aerial photography from the early-to-mid 20th century was used to derive a large dataset of historical reference conditions for forest structure, composition, and pattern attributes from a large sample of HUC 12 watersheds across Interior Columbia Basin (Hessburg et al. 1999). To assess departure of current conditions for HUC 12 watersheds within DNR planning areas, the same attributes are derived from current aerial photography. These current conditions are then compared with historical conditions from a subset of watersheds with similar environmental conditions to derive departure from the historic range of variation (HRV, Hessburg et al. 2013). In addition, a comparison with a climate analog subset of historical watersheds is conducted to derive departure from the "future range of variation" (FRV). The overlap between the HRV and FRV is used as the desired range of total area (percent land) and pattern (patch sizes) for different attributes. These attributes include forest structural stage by vegetation type (dry, moist, and cold forest), cover type (tree species composition), habitat for focal species, and other attributes. DNR scientists have partnered with OWNF staff to jointly collect and analyze the PI data for the 12 planning areas where this method was used (Table 2).

The second method follows the approach used on the Colville National Forest. Reference conditions are derived from state and transition models (STMs) that were developed for the Integrated Landscape Assessment Project (Hemstrom et al. 2014) and the Colville National Forest Plan Revision (USFS 2019), and then revised by DNR staff and Miles Hemstrom for the 20 Year Plan effort. STMs are based on the most current knowledge and data regarding forest development and historical disturbance regimes and have been developed for each forest vegetation type (Table 1). Ranges of percent land of eight forest structural stages (Table 3) for each vegetation type serve as the primary reference conditions. The departure of these eight structural classes is derived by comparing current structure class information from LiDAR, DAP, and GNN (see #3 above) for a planning area with the range from the STMs. The reference ranges are historical, and no future range of variability or climate analog reference conditions are generated. Also, no landscape pattern or species composition reference conditions are generated with this method. The current pattern and patch size information of forest structure is reported, but without the departure component. To address these deficiencies, DNR scientists are currently pursuing a hybrid approach where current conditions information from LiDAR or DAP can be used with the HRV and FRV from historical imagery.

5. Assess wildfire risk

Data products and methods from the 2017 Pacific Northwest Quantitative Wildfire Risk Assessment (PNRA) (Gilbertson-Day et al. 2018) were used to quantify fire risk across each planning area. This assessment was conducted for USFS Region 6 using the FSim fire model and quantitative risk assessment methods from Scott et al. (2013). DNR staff calculated fire risk

(expected net value change) by combining annual fire probability, expected fire intensity as measured by flame length, and the response of different resources to the expected flame length. The risk to three different resources was calculated and then combined into a single raster layer with higher priority resources overlaid on top. Risk levels were binned into six categories based on relative values across all planning areas: extreme, very high, high, moderate, low, and beneficial. Maps of conditional net value change, which is the risk of loss or benefit without fire probability factored in, were also generated to examine expected loss or gain irrespective of fire probability in each planning area.

The three resources in order of priority were: (1) wildland urban interface (WUI), intermix or interface areas, (2) infrastructure from GIS layers used in the PNRA report, and (3) general forest based on structure classes and vegetation types as described in the data dictionary. Response functions of how each resource responds to different flame length levels were taken from the PNRA report. General forest used the timber resource functions that quantify expected mortality of overstory trees. WUI structure densities were matched with property density values from the PNRA report to get resource functions. In this risk assessment approach, low-intensity fires (low flame lengths) have beneficial effects on medium and larger diameter forests in dry and moist forests as they consume ground fuels and smaller, understory trees (ladder fuels).

One of the goals identified in the 20-Year Forest Health Strategic Plan was to develop a consistent layer for the WUI. This was completed in 2020 by DNR staff and was used in all of the 2020 landscape evaluations. The WUI layer uses two primary data sources: structure information and a fuel model. The structure data is the result of a fusion of Microsoft structure points (https://github.com/microsoft/USBuildingFootprints) and the Washington Master Addressing Services (WAMAS) address points. The fuel model data come from the 2016 LANDFIRE Remap version of the Fire Behavior Fuel Model 40 (Scott and Burgan 2005; https://www.landfire.gov/fbfm40.php). The fused structure data are used to determine structure density, while the fuel model data are used to determine vegetative cover. Interface areas are zones with structures close to highly vegetated areas (≥ 75%), while intermix areas are zones with structures close to moderately vegetated areas (≥ 50%). The interface and intermix WUI categories are subset into density categories of structures per 40 acres (none, very low, medium, and high.

Fire probability and intensity are derived from the FSim (Finney et al. 2011) model using contemporary ignition and suppression probabilities and current climate (climate change is not incorporated). The primary risk assessment layers did not include fire effects on wildlife habitats, watershed function, drinking water, or other resources. Fire risk in non-forested shrub-steppe areas was only calculated for homes and infrastructure.

For the HB 1784 pilot areas, fire risk for drinking water protection areas and commercial lands were assessed in addition to WUI, infrastructure, and forest areas. The extra fire risk layers were created by limiting the general forest fire risk layer to drinking water protection and commercial land areas (see #13).

6. Analyze drought vulnerability

This analysis assessed vulnerability to current and projected future moisture stress, and it is the primary way that climate change predictions and corresponding adaptation strategies were incorporated into landscape evaluations. Moisture stress, as measured by climatic water deficit (Deficit), is a good predictor of vegetation type in moisture-limited ecosystems and is a primary driver of vulnerability to large insect outbreaks (Stephenson 1990, Dobrowski et al. 2011, Restaino et al. 2019).

Deficit was calculated for all forested watersheds in eastern Washington at a 90m pixel resolution. Deficit was calculated as the difference between potential evapotranspiration (PET) and actual evapotranspiration (AET). PET is closely related to the amount of photosynthesis that could occur in a given location if an infinite amount of water were available, while AET is related to the amount that can actually occur given water inputs and soil conditions. Deficit thus represents the amount of evaporative demand that cannot be met because soil water has been depleted during the summer dry period. A full description of the methods used to derive PET, AET, and Deficit is available in the DNR Forest Data Dictionary at: https://bit.ly/ForestHealthData

Monthly Deficit was calculated by subtracting AET from PET for each month. The final annual Deficit values were then calculated as the sum of monthly Deficit over the course of a year. Deficit layers were generated for the 1981-2010 time period and then for the 2041-2070 period based on projected future climate data from the average (ensemble) of 15 Global Circulation Models under the RCP 8.5 emissions scenario, which represents relatively high greenhouse gas emissions resulting from business-as-usual (Wang et al. 2016).

Four Deficit zones were then created and associated with vegetation types to facilitate ecological interpretation of current and projected future Deficit levels. A database of over 100,000 vegetation inventory plots from the US Forest Service, DNR, and other sources across eastern Washington was analyzed to associate Deficit into four classes corresponding to general vegetation types for each planning area. The plot data were summarized by calculating the percent basal area or canopy cover of each tree species for each plot and also identifying groups of tree species within plant association groups. The distribution of Deficit associated with each tree species or plant association group was analyzed using hierarchical agglomerative cluster analysis to identify thresholds where transitions in vegetation groups occurred within and

among planning areas. Species like subalpine fir, Engelmann spruce, noble fir, and western hemlock were indicators for a moist and cold vegetation group in the low deficit zone. Ponderosa pine and some Douglas-fir were the main indicators for a dry vegetation group in the high deficit zone. The moderate deficit zone corresponded to a transitional vegetation group between the dry and moist-cold types, indicated by a mix of Douglas-fir, western larch, lodgepole pine, or grand fir with small amounts of other species. A woodland/shrub-steppe group in the very high deficit zone was indicated by white oak, a low density of Ponderosa pine, or a lack of forest cover. This group identified the lower elevation transition between forest and non-forest vegetation, and the threshold for this very high deficit group was based on a composite forest/non-forest map combined with a systematic grid of sample points. Specific values for forest/non-forest thresholds vary across planning areas and are derived from 75th, 90th, or 95th of either all sample points or low elevation sample points below 3,000 feet (1,000 meters).

Maps of current and future projected zones were generated for each planning area in order to assess the magnitude of predicted effects of climate change. General areas within each planning area were identified where forest is unlikely to be supported in the future, where moist and cold vegetation types are likely to transition to dry vegetation types, and where moist and cold vegetation types are likely to be supported in the future. Note that there is considerable uncertainty in climate models regarding timing and mechanisms (e.g., fire, drought, regeneration failures) that will drive vegetation transitions, although the direction is clear. Thus, these maps should not be used as fine-scale maps of predicted future vegetation.

Finally, a drought vulnerability index was generated using (1) current and (2) future Deficit along with (3) forest density (Fig. 1). Each of the three metrics was first standardized to a 0-1 score and then weighted equally to calculate the drought vulnerability index from 0-1. These scores are consistent across all planning areas and thus can be used to assess the absolute drought vulnerability of a particulate site. Maps using a stretched color ramp show the relative drought vulnerability within a planning area. Density was calculated from either basal area (modeled from LiDAR or DAP) or canopy cover from aerial photo interpretation. Basal area was standardized by dividing by 275, which represents the upper end of carrying capacity in eastern Washington. Sites with basal area greater than 275 were given the maximum score of 1. Canopy cover was standardized by dividing by 90. Sites with canopy cover greater than 90 were given the maximum score of 1.

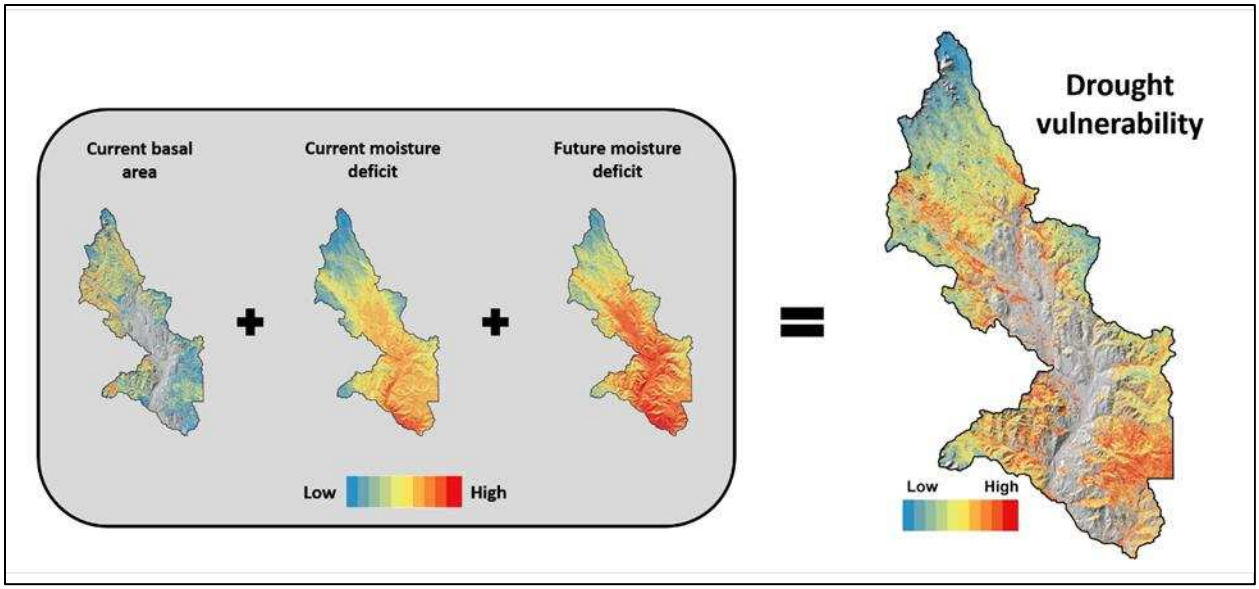

Figure 1: Schematic of metrics used to calculate the drought vulnerability index. Scores for all three metrics were standardized to 0-1 and then given equal weight to calculate the index.

Current and future Deficit were scored by using the thresholds for the different deficit zones to create deficit classes for a planning area that indicate different levels of site carrying capacity. First, a lower and upper bound of Deficit was identified. The upper bound was calculated by adding 30 to the threshold between the high and very high deficit zones (transition from dry forest to non-forest). The lower bound was calculated by subtracting 30 from the threshold between the low and moderate zones. Second, breaks for the deficit classes were generated by adding increments of 15 from the lower bound until the upper was reached. Third, the current and future deficit values for each 90m pixel in the planning area were then classified based on these breaks and divided by the total number of classes to derive a 0-1 score for both current and future time periods. Deficit values below the lower bound were put in the lowest class, while values greater than the upper bound were put in the highest class. For example, if the threshold between low and moderate was 180 and the threshold between dry forest and non-forest was 300, then the lower bound would be 180 and the upper bound 330. Twelve deficit classes would exist based on increments of 15 from 180 to 330, with a class for values below 180 and a class for values above 330. For example, a pixel with a deficit value of 170 would be in class 1, a value of 250 would be in class 6, a value of 290 in class 9, and a value of 350 in class 12.

7. Map habitat for focal wildlife species

A key component of a resilient landscape is the provision of sufficient habitat to sustain native wildlife species. Wildlife habitat is assessed in landscape evaluations through the application of focal species (see Suring et al. 2011, and synonymous with Surrogate Species in Gaines et al. 2017). This step is conducted to inform landowners of the condition of wildlife habitats and is

not connected to any regulatory aspects of threatened, endangered, or sensitive species. A rigorous, peer-reviewed process was used to identify focal species for eastern Washington (Suring et al. 2011, Gaines et al. 2017). Focal species serve as an umbrella function in terms of encompassing the habitat needs of a group of species, being sensitive to ecological changes likely to occur in the area, or otherwise serve as an indicator of ecological sustainability (Noss et al. 1997, Wenger 2008). In addition, it is assumed that a focal species has more demanding requirements for factors putting other group members at greater risk of extinction than the rest of the species in the group (Andelman et al. 2004). A key characteristic of a focal species is that status and trend of habitat conditions provide insights into the integrity of the larger ecological system to which it belongs (Noss et al. 1997, Andelman et al. 2004).

Focal wildlife species were identified for each planning area through a process that involved wildlife biologists from the USFS, WDFW, DNR, and the Yakama, Colville, and Kalispel tribes (Table 4). This process was led by Bill Gaines from the Washington Conservation Science Institute. Existing and recently completed regional assessments that addressed the viability of a wide array of focal wildlife species throughout much of eastern Washington were used to guide the selection of a meaningful set of focal species for landscape evaluations (Suring et al. 2011, Gaines et al. 2017). Habitat definitions and classifications were defined in a way they could be integrated with spatial data used in Landscape Evaluations (e.g., high-resolution photo-interpretation, LiDAR). Detailed information on the selection of focal species for each planning area and habitat classifications is provided in the DNR Forest Data Dictionary at: https://bit.ly/ForestHealthData.

Habitat for each focal species was mapped across all planning areas based on habitat classifications and current conditions data (photo interpreted attributes or LiDAR/DAP/GNN). Pixel-based habitat maps (LiDAR & DAP) were smoothed into habitat patches using the PatchMorph tool (Girvetz and Greco 2007) to match the polygon-based habitat maps where photo-interpretation was used. The amount of habitat for the focal species in each planning area was quantified, as well as pattern metrics (patch size, edge density, etc.). These metrics were compared with reference conditions for habitat in planning areas where historical imagery was used as the reference condition.

The resilience (or sustainability) of habitat for each focal species was then analyzed based on fire risk and drought vulnerability in order to highlight locations across each planning area where treatments may be needed to build or maintain open canopy forest structure (e.g., higher fire and drought risk), as well as closed canopy, large tree structure (e.g., lower fire and drought risk locations). This information is intended to help managers identify critical areas to protect and where treatments can provide necessary habitat features for foraging, breeding, shelter, and

movement to sustain focal species and address vegetation pattern needs such as reducing fragmentation by building larger patches. The process of integrating the needs of focal species with treatment prioritization to reduce fire risk and address forest health needs is ongoing. Additional meetings with habitat biologists from different agencies will be conducted to refine focal species habitat maps and needs for different planning areas.

Table 4: Focal species selected for 20 Year Plan planning areas. Note that a subset is used for an individual planning area.

Common Name	Group	Family
American (Pacific) marten	Medium/large trees	Cool/moist forest
Black-backed woodpecker	Postfire habitat	Open forest
Canada lynx	Boreal forest	Alpine/boreal
Fox sparrow	Early successional	Open forest
Northern goshawk	All forest communities	Forest mosaic
Northern spotted owl	Medium/large trees	Cool/moist forest
Pileated woodpecker	Medium/large trees	Cool/moist forest
White-headed woodpecker	Medium/large trees	Dry forest
Woodland caribou	Medium/large trees	Cool/moist forest
Western Gray Squirrel	Medium/large trees	Dry forest

8. Evaluate aquatic function

These evaluations are conducted to better understand aquatic and riparian forest functions in the planning area and determine restoration needs and priorities. This can include assessments of fish habitat, road impacts (e.g., the Geomorphic Road Analysis and Inventory Package, or GRAIP), water yield, or fire risk to drinking water areas. DNR currently does not have the capacity to conduct these evaluations and relies on partners to conduct them. To date, aquatic assessments have been completed for the Manastash-Taneum, Upper Wenatchee, Twisp, and Stemilt priority planning areas. Aquatic assessments are in progress or being discussed for Tieton, Nason Creek, Teanaway, and others.

9. Estimate treatment targets

Treatment needs for each planning area were first generated from the departure analysis. Combinations of potential vegetation and structure class (e.g., dry forest, large dense, moist forest, medium dense) that are overabundant relative to reference conditions were identified, with the initial focus on dense structure classes. These are the classes where departure can be shifted through treatments vs. departures that require time and growth (e.g., a shortage of large tree structures or too much open, small tree forest). For these departed, dense classes, the number of acres needed to shift the class to the upper end of the reference range was calculated. This is the low end of the treatment range. The high end of the treatment range is

the number of acres needed to shift the class to the mid-point of the reference range. In cases where small-dense classes are not currently departed but will be soon due to growth, treatment acres for small-dense classes were added. These treatment need numbers were then compared with a fire severity departure analysis that compares predicted fire severity across the planning area with desired ranges for low, moderate, and high severity in dry, moist, and cold forests. Desired ranges are based on LANDFIRE severity proportions for different vegetation types. This serves as an independent method of validating treatment needs.

In most planning areas, medium-sized closed (10-20" average overstory diameter; >60% canopy cover) and medium-sized moderate cover (40-60% canopy cover) classes (Table 3) make up the bulk of departure in dry, moist, and cold forests. In moist and cold forests, large tree closed and moderate classes are generally under-represented. Thus a portion of the overabundant medium classes need growth to reach these large tree classes and do not necessarily need to be treated. To account for this, the treatment need for cold and moist forests was adjusted downward based on the relative departures in the different classes. In dry forests, large open and large moderate classes are almost always underrepresented. Some of the medium tree, moderate cover structure class will grow into the large tree moderate class without necessarily needing treatment. The treatment need for dry forest was also adjusted downward to account for this based on the relative departures in that planning area. Finally, departure information for landscape pattern and species composition was evaluated to determine if the structure-based treatment need is sufficient to address pattern or species composition departures and to make any necessary adjustments. This last step was only done for planning areas that used the historical imagery and photo-interpretation methodology for the departure assessment (Table 2).

Targets for maintenance treatments in existing open, large, and medium tree size classes on dry forest sites were added based on assumptions regarding projected re-growth of small trees, grasses, shrubs, and woody ground fuels. Specifically, maintenance targets were based on the estimated need to treat over the next 15 years 50-75% of existing open canopy, dry forest, and 25-50% of open, canopy moist forest. Targets for each class are rounded to the nearest 250 acres and then summed to get the range of total treatment needs.

Treatment needs were broken out by the anticipated treatment type based on tree size class. The small size class (0-10" average overstory diameter) are non-commercial treatments, while the medium (10-20" average overstory diameter) and large (20" +) classes are anticipated to be commercially viable. However, many factors go into determining what kind of treatment is best for a given site, such as road access, soil impacts, forest conditions, presence of cultural sites, habitat or aquatic impacts, markets, logging system, etc. Prescribed fire or managed wildfire

may be the most appropriate treatment where road access is limited, commercial treatments are likely to cause significant negative impacts, or in forest areas where consuming surface and ladder fuels and lighter reduction of overstory density are the main treatment goals. Ultimately, individual landowners will determine the actual treatment type based on their objectives, planning processing, and regulatory requirements.

10. Evaluate operational feasibility and economics

A central focus of the 20-Year Forest Health Strategic Plan landscape evaluations is assessing forest restoration need from the perspective of landscape ecosystem functions and services. Planning and implementation of different kinds of treatments must also incorporate operational and economic considerations. To address the need to incorporate these two factors, DNR contracted with Sean Jeronimo (Jeronimo Precision Forestry) to work with logging system experts, operators, and log purchasers to develop a tool to evaluate logging system type and projected revenues for potential treatment locations for planning areas.

This information is intended as a general assessment of what parts of planning areas are accessible for mechanical treatments vs. where fire-based treatment will be needed, as well as identifying which areas are likely to generate revenue, be revenue neutral, or require investments. Slope, road system, overstory tree size, and volume layers are fed into a tool that produces a map of potential operational units. Logging system is determined for each unit and potential revenue or cost is calculated. Managers can use this information as a starting place for delineating operational units and prioritization locations for their field-based operational assessments.

The operational tool identifies logging system type (ground, cable, helicopter) and potential revenue based on user-defined parameters for maximum percent slope (vertical and cross slope) for ground and cable-based yarding, maximum yarding distances for favorable and adverse terrain, minimum unit size, logging costs for different systems, average haul costs, delivered log prices, and percent volume removal for different structural classes. DNR worked with logging system experts and operators to determine and tailor these parameters for different parts of eastern Washington.

The core input layers for the tool are a digital elevation model and a roads layer. A LiDAR ground model, resampled to 15' pixel size, is utilized to derive highly accurately slope information for planning areas that have LiDAR coverage. Otherwise, 10m USGS digital elevation models are used. Existing roads are based on a DNR roads layer that combines USFS, county, and DNR road information. In addition, volume and overstory tree size information comes from DNR RS-FRIS inventory layers where they exist and then filled in with GNN data.

The tool first determines the logging system (ground, cable, helicopter, or no system) for each pixel in a landscape by extending a line from the focal pixel to each road segment within the maximum yarding distance for any system. Based on slope, distance, and deflection thresholds, the elevation profile along that line is then analyzed to determine if it is ground or cable operable. Each pixel is then assigned an operating method based first on the most desirable logging system and second on the shortest yarding distance. The available systems were "Ground," "Cable," and "Cable downhill," in decreasing order of preference. Pixels are then grouped into units based on which road segment a particular pixel's product would be yarded up to under the assigned system and the specified minimum unit size. Up to 25% of cable based terrain is allowed in ground based units. Lastly, the raster-based unit map is converted into polygons. Units that were not accessible by ground nor cable are assigned to "Helicopter/Other" if they were within a user defined maximum distance from a road (e.g. 1 mile) and otherwise are “no system”.

A number of volume and cost/revenue variables are calculated for each unit. Volume removal per acre is based on a user-defined percent removal of standing volume that varies by structure class. Gross revenues are then calculated based on an average price per thousand board feet (mbf) for the whole planning area. Haul costs are also fixed for the planning area. Cost per mbf for felling, yarding, and loading are based on the logging system and the mbf per acre removed. Low volume operations (1-2 mbf/ac) and adequate-volume operations (8-10 mbf/ac) have different costs per mbf, with a linear ramp function in between. The costs and revenues are then summed to generate total and per acre net cost/revenue for each unit.

The final output is a polygon shapefile of the units with operational and economic information in the attribute table. This tool was run for all planning areas. It can be rerun with different input parameters or a roads layer that includes potential temporary roads. DNR will be working with managers to refine the tool over the next biennium. Once LiDAR ground models and accurate volume information is available for the majority of eastern Washington, the tool will be used to better estimate the proportion of the total restoration need that can be accomplished with mechanical treatments, potential wood product outputs, and the economic investments required to meet restoration targets.

11. Map dense forest and large tree sustainability

While dense or closed-canopy forests are currently overabundant in most of eastern Washington, they are part of resilient landscapes in eastern Washington. They provide important ecosystem services such as the provision of wildlife habitat, wood production, carbon storage, biodiversity, and hydrological functions, especially when they contain large trees. In order to help managers determine where to retain and manage dense forests, locations are

identified (high scores) where this forest structure type is most likely to persist through future fires and climate warming. Depending on landowner objectives, these areas often do not need or warrant treatment. In other cases, a light to moderate variable-density thinning treatment and/or prescribed fire may help to lower fire risk, accelerate the growth of large trees, or address a pathogen or insect issue that threatens the longevity of the patch. Others may be harvested to meet landowner economic objectives.

Conversely, low sustainability scores indicate locations were sustaining this structure type over time is likely to be challenging. The risk of losing the large trees within these areas to high severity fire or drought-related insect mortality is higher. Shifting these sites to large tree, open canopy structural classes with fire and drought-resistant species will increase the amount and patch sizes of this structure type, which is underrepresented in many planning areas. Treatments that incorporate variable patterns of individual trees, tree clumps and dense patches of different sizes, and openings, along with pockets of downed wood and snags and shrubs, will restore habitat conditions consistent with contemporary and historical frequent-fire forests while also reducing fire risk (Churchill et al. 2018, Stephens et al. In press). By lowering the likelihood of a large high severity fire across the landscape, such treatments will also reduce the risk for the remaining large tree, dense forest structure.

Light or moderate variable density thinning, ladder fuels treatments, and/or prescribed fire can be used in dense forest sites to lower fire risk and drought vulnerability while still maintaining sufficient canopy cover for species needs (e.g., 40-60% cover with some denser patches and some openings). It is also important to note that treatments around a particular patch of large tree dense forest will likely reduce fire risk, even if the patch is not treated. If such treatments are being planned across a landscape, managers may want to focus more on the current and future deficit component of this score when selecting locations to manage for large tree dense forest. Managers will also need to factor in vegetation type as high sustainability areas can be located in cold forest types that are not suitable habitat for some species.

To generate the large tree, dense forest sustainability layer for each planning area, areas that currently have closed canopies and large tree structure (QMD>15" and canopy cover >50%) were identified based on current condition data. Potential areas that can develop this habitat within a few decades (QMD>12" dbh and canopy cover >40%) were also identified. Current and potential large tree, closed canopy areas were then scored with a sustainability index based on current and future moisture deficit and fire risk. First, site capacity to support dense forest was quantified based on current and future Deficit, using the same process as used for drought vulnerability (see #6 above), but forest density is not included. Current and future deficit were averaged into a single 0-1 score. Sites with current and future low Deficit received a high score,

while high deficit sites a low score. Fire risk to forests (expected net value change to forests) was then standardized into a 0-1 score using the six classes described in #5 above. Sites with low fire risk received a high score. The fire risk and deficit scores are provided individually for current large tree dense forest as well as potential areas. The two components are combined with equal weight and standardized into 0-1 final sustainability score. These scores are consistent across all planning areas and thus can be used to assess the absolute sustainability of a particulate site. Maps using a stretched color ramp show relative sustainability within a planning area.

12. Prioritize landscape treatments

Locations with each planning area are prioritized for treatment based on three measures of forest health and wildfire transmission to homes (Fig. 2). These include fire risk to forest ecosystems (#5), drought vulnerability (#6), and forest structure types that are overabundant relative to desired reference conditions (#4). Wildfire transmission to homes is then added to highlight areas where ignitions result in fires that are likely to spread to areas with high home density (see Table 6). The goal of the landscape treatment prioritization is to identify where treatments will accomplish the greatest amount of fire risk reduction and climate adaptation work while reducing fire risk to communities.

The landscape prioritization layer is not intended to mandate where individual landowners should conduct treatments. Instead, it is information that landowners can factor into planning processes for specific projects in order to inform tradeoffs between different objectives. The four input layers should be evaluated individually so that managers and stakeholders understand the relative contribution of each metric to the overall prioritization. Managers may choose to emphasize one or two metrics over the others, depending on their management objectives. It is also important to note that this landscape-level prioritization does not include other factors that influence whether a specific site should be treated or not, such as cultural sites, species composition, sensitive soils, operational considerations, economic objectives, etc. Some of these additional factors may be added over time.

Focal species habitat was not directly included in the landscape prioritization. However, we recommend utilizing the large dense forest sustainability layer as a two part overlay when selecting treatment locations. First, patches with high to medium sustainability scores can be overlaid on the treatment prioritization to help select locations to emphasize retention and creation of large tree, dense forest structure and associated habitat. Full dry forest restoration or fuel reduction treatments are generally not consistent with this objective, although lighter, variable density thinning treatments that retain moderate canopy cover and some dense areas can be. The total amount of this structure type to manage for will depend on reference

conditions, habitat needs, regulatory requirements, and landowner objectives. Second, patches with low to medium sustainability scores can be overlaid to highlight areas where dry forest restoration treatments will create and expand patches of habitat for focal species that depend on large tree, open canopy forest structure. Treatments that incorporate variable patterns of individual trees, tree clumps, and dense patches of different sizes, and openings, along with pockets of downed wood and snags and shrubs, will restore habitat while also achieving fire risk reduction goals (Stephens et al. 2020).

The operational feasibility layer can be combined with the landscape prioritization layer to identify where different treatment approaches can be used to meet treatment goals for the planning area. For example, high priority areas without road access can be prioritized for prescribed fire or managed wildfire, while moderate priority areas that will produce revenue may be emphasized to help pay for high priority non-commercial terrestrial and aquatic treatments. This information can be used as a starting place for designing projects that meet landscape resilience and risk reduction goals and are also economically and operationally feasible.

The landscape prioritization layer was derived by first standardizing the values of the input layers to a 0-1 score. The drought vulnerability index is already in this format (see #6 above). Fire risk to forests (expected net value change to forests) was then standardized into a 0-1 score using the six classes described in #5 above. High scores indicate high values for both drought vulnerability and fire risk to forests. Departed forest structure classes, plus structure classes where maintenance treatments are potentially needed, are given a fixed score of 0.5. Wildfire transmission to homes was first standardized to a 0-1 range across all of eastern Washington by dividing by the 95% percentile value. All pixels above this value received a score of 1. For most planning areas, wildfire transmission was then multiplied by 0.75 to ensure high values did not dominate the overall prioritization. For seven planning areas that have low transmission values, the full transmission score was used (Ione, Trail, Chewelah, Stranger, Little White, Klickitat, and Glenwood).

The final step was to add the scores of the four metrics together and then standardized into a 0-1 score dividing by the highest possible score (3.5). These scores are consistent across all planning areas and thus can be used to assess the absolute priority of a particular site. However, maps using a stretched color ramp show relative priority within a planning area.

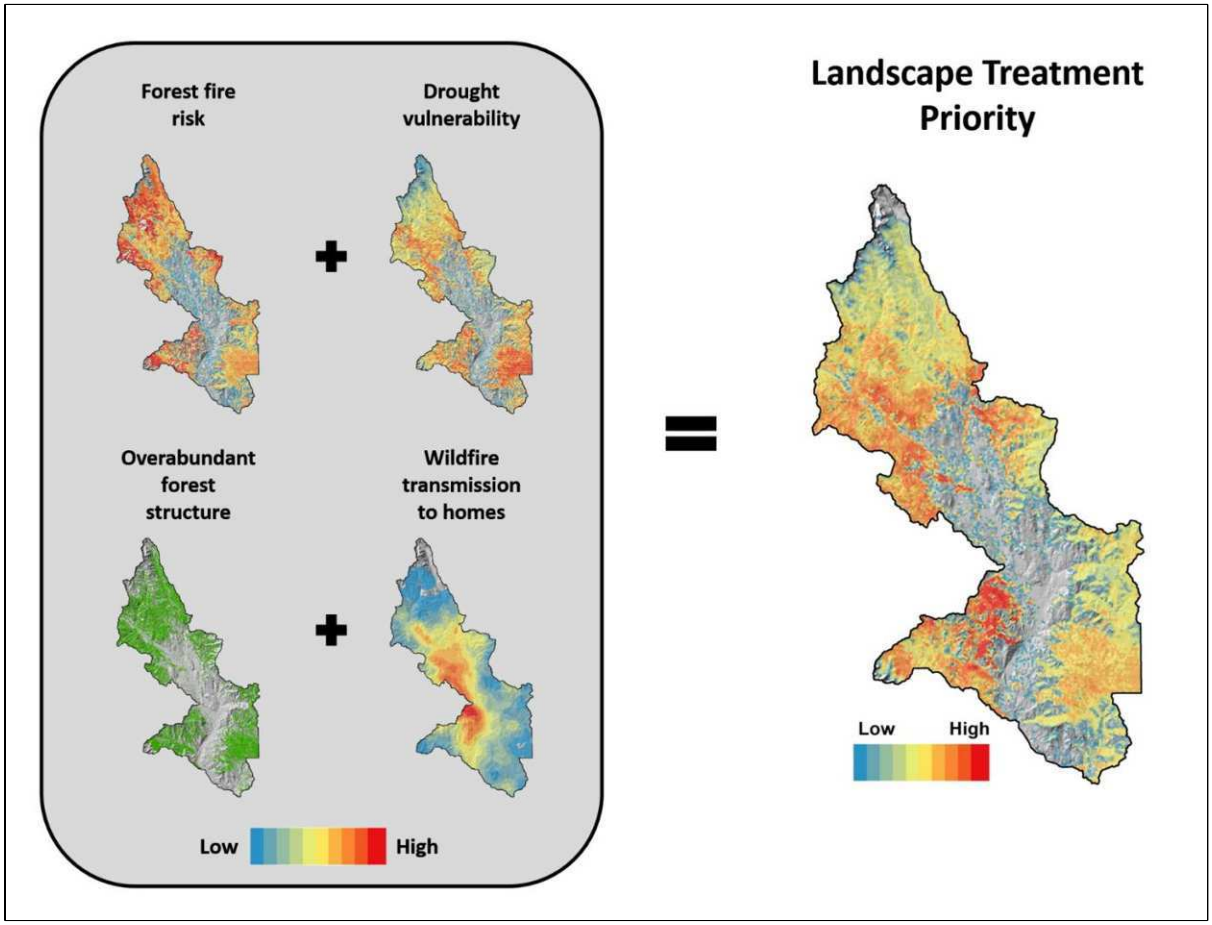

Figure 2: Individual metrics that are used in landscape treatment prioritization. The gray box shows individual metrics that constitute the landscape treatment prioritization metric (right side). Warm colors represent higher values, and cold colors represent lower values except for the overabundant forest structure map for which green shows presence.

13. Map wildfire response benefit

The first step to identify and prioritize treatment locations that provide a wildfire response benefit, in addition to the forest health benefits identified by the landscape treatment priority map, was to map wildfire response benefits across each planning area (Fig. 3). In the Forest Health Assessment and Treatment Framework, prioritizing treatment actions that benefit both forest health (by restoring a resilient forest condition) and fire operations (by creating strategic opportunities for safer wildfire engagement) is referred to as a *dual benefit* (see #14). The need to prioritize treatments for dual benefit was established in House Bill 1784 (HB 1784). The collaborative work process that ensued to integrate the requirements of HB1784 into the Forest Health Assessment and Treatment Framework is known as the HB 1784 process and described in Appendix C. A major new component of landscape evaluations was the development of a methodology to quantify and map wildfire response benefits per the requirements of HB 1784. This was done for eight pilot planning areas (Table 5). DNR will add this component to the remainder of planning areas over the next biennium.

We defined wildfire response benefit "*as any tactical advantage gained for wildfire response activities from actions on the landscape, including, but not restricted to, identifying and consolidating existing anchor points and control lines and reducing potential fire behavior*".

Our definition of wildfire response benefits is not limited to any specific wildfire management strategy and is centered around conditions that improve fire operations safety and effectiveness. Wildfire response activities include not only suppression actions but also managed fire and prescribed fire. Wildfire management goals vary across ownerships. Thus, wildfire response benefit(s) can be interpreted differently depending on different agency policies. The definition reflects the various mandates and statuses of agencies and organizations with wildfire responsibilities. Specific to DNR's wildfire suppression policy, response benefits are the tactical advantages of wildfire suppression activities. For other agencies, such as the USFS, fire management goals can be multiple, i.e., not restricted to full suppression.

Wildfire response benefit was mapped based on the spatial overlap of four maps: 1) wildfire risk to homes, infrastructure, commercially managed lands and surface sources of drinking water, 2) wildfire transmission to homes, 3) crown fire potential, and 4) the forest health treatment priorities (Fig. 3). The risk layers were selected to highlights locations with high risk to the resources for which fire operations are more likely to focus on. Wildfire transmission to homes was added to complement the risk to homes given the emphasis of fire suppression on home protection. Risk to homes is a *in situ* characterization of probability and consequence. One can think of it as what is the expected outcome when a fire reaches a home. On the other hand, wildfire transmission to homes is *ex situ*; it maps locations where fire starts are expected to

grow, travel across the landscape, and threaten homes. This provides an important third dimension to traditional risk – the source of exposure – and provides a complete description of the scale and geography of risk to homes (Ager et al. 2019c). It is important to note that transmission does not model long-distance ember showers, which are a major factor driving WUI losses (Keeley and Syphard 2019) or specific point protection actions that are deployed in and around communities and structures (Ager et al. 2019c). Protecting homes is one of the primary goals of fire suppression and prioritizing treatments where transmission to homes is the highest provides benefits to fire operations by reducing exposure to homes. Crown fire potential was added to identify and prioritize locations likely to generate severe wildfire behavior. Finally, the landscape treatment priority map was added to explicitly tie in landscape-scale forest health priorities into the wildfire response benefit spatial prioritization.

The input metrics (Table 6) were mapped for each planning area in the HB 1784 pilot process. Because inputs had different spatial resolutions and ranges of variation, each planning area was divided into a grid of 18-acre hexagons, hereafter, called hexels (from "hexagon" and "cell"). Individual input metrics were summarized at hexel level and normalized by dividing each hexel value by the sum of all values across all hexels in each planning area. Normalized input variables (ranging from 1-100) were combined into the wildfire response benefit metric using different weights. Collectively, risk to homes, infrastructure, drinking water sources, commercially managed lands, crown fire potential, and transmission to homes weighted 75% of the wildfire response benefit metric. The remaining 25% were attributed to the landscape treatment priority. This process resulted in a map of wildfire response benefit for each of the 1784 pilot planning areas. In conjunction with the landscape treatment priority map, the wildfire response benefit map was used to summarize and visualize dual benefit opportunities across the landscape using the Potential wildland fire Operational Delineations (PODs) framework – see #14.

Table 5. HB 1784 pilot project priority planning areas where the 14-point landscape evaluation analysis was completed.

HB 1784 pilot areas	Priority Planning Areas
Methow Valley	Methow Valley Twisp River
Leavenworth	Chumstick to LP Nason Creek Upper Wenatchee
Greater Cle Elum	Cle Elum Manastash-Taneum Teanaway

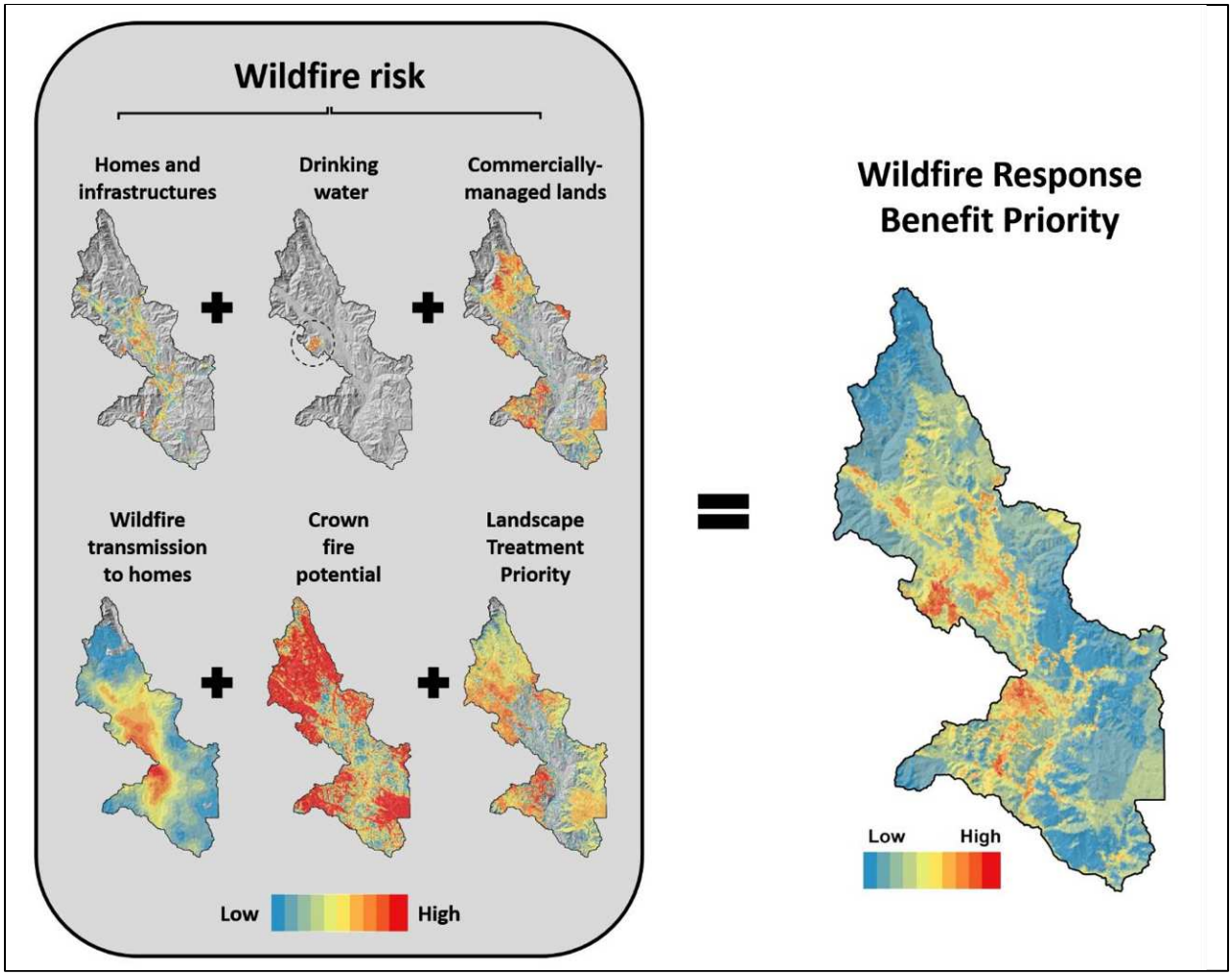

Figure 3. Individual inputs to the wildfire response benefit prioritization process. The box shows the individual maps that are combined to create the wildfire response benefit priority map (right side). Individual metrics, described in Table 6, were mapped at the scale of 18-acre hexel polygons and normalized to a score between 1 and 100. The input maps were combined, with different weights, to obtain the wildfire response benefit map shown on the right. The landscape treatment priority contributed to wildfire response benefit with a 25% weight. The remaining metrics (three wildfire risk layers, wildfire transmission to homes, and crown fire potential) collectively accounted for the remaining 75%.

Table 6. List of metrics leading to the input maps used to create the wildfire response benefit map.

Metric	Weight	Description	Mapping method
Wildfire risk to homes	75%	Expected net value change	Uses the PNRA (Gilbertson-Day et al. 2018) response functions and wildfire modeling outputs to estimate risk to homes using to DNR's wildland-urban interface map to identify home location. Uses the PNRA response functions for infrastructures and wildfire modeling outputs to estimate risk to infrastructures which include: electric transmission lines, railroads, interstates, state highways, communications sites/cell towers, seed orchards, sawmills, ski areas, recreation areas and historic structures. Spatial data on infrastructure location was based on the PNRA mapping for Washington and Oregon and complemented with local information when available.
Wildfire risk to surface sources of drinking war			Uses the PNRA (Gilbertson-Day et al. 2018) response functions to estimate risk to forest applied to locations that correspond to sources of surface drinking water. Spatial data on the location surface sources of drinking water was obtained from the Department of Health. Specifically, we used the Source Water Protection Areas spatial layer that identifies areas upland from surface water sources used for public drinking water supplies.
Wildfire risk to commercially managed lands			Uses the PNRA (Gilbertson-Day et al. 2018) response functions for forest. Spatial data on the location of commercially managed lands uses DNR's forested land ownership layer combined with DNR's forest mask and a set of query rules to create a map of commercially managed lands for the eastside of the state. For the purpose of this work commercially managed lands include: DNR Trustlands, tribal forests, industrial forests, non-industrial private forests, and US Forest Service forests where timber is a primary management objective.
Crown fire potential		Percentage of hexel with modeled crown fire activity	Uses wildfire fire simulation tool FlamMap (Finney 2006) to model crown fire activity under fixed fire weather conditions corresponding to the 97th percentile of fire weather and a fuelscape that approximates fuel load and structure as of 2018. Crown fire activity is calculated independently for each cell and does not account for "spotting". Area of crown fire potential per hexel was calculated based on grid cells with passive and active crown fire.
Wildfire transmission to homes		Number of houses per acre and per year (expected to be exposed by ignitions starting in that grid cell)	Uses simulated fire perimeters from FSim (Finney et al. 2011) to predict wildfire exposure in the wildland urban interface (WUI) as mapped by the SILVIS project (Radeloff et al. 2017). The SILVIS WUI defines areas where houses intermingle with wildland vegetation and is associated with different structure densities. Fire perimeters were simulated using daily wildfire scenarios for thousands of fire seasons using weather data from remoted automated weather stations and using relationships between fire ERC and historical fire occurrence. Surface and canopy fuels represented landscape conditions circa 2014 and updated for fire disturbances and based on LANDFIRE data. For detailed description of methods see Ager et al. (2014), Ager et al. (2019a), Ager et al. (2019b)
Landscape treatment priority	25%	Score representing treatment priority	See #12

14. Prioritize for dual benefit using Potential wildland fire Operational Delineations (PODs)

Potential wildland fire Operational Delineations (PODs) is a framework to conduct cross-boundary pre-fire analysis and planning to increase wildfire response safety and efficiency (Thompson et al. 2016). In a PODs framework, fire operations personnel define large landscape areas surrounded by potential control lines, i.e., natural and artificial areas that provide a strategic opportunity for fire operations (Fig. 4). Potential control lines often coincide with roads, ridgelines, old fires and treated areas. Fire staff uses their expertise, knowledge of local past fires, and analytics to identify potential control lines that provide the best odds for fire containment. There are multiple uses for the PODs, including pre-fire response planning and the development of fire response plans for each POD based on quantitative assessments of value at risk. Similar to how watersheds are units where hydrologists manage water resources, PODs are units designed by firefighters to manage fire.

Another use of the PODs framework is to summarize and communicate dual benefit priorities across the landscape. Dual benefit refers to potential treatment actions that benefit both forest health (by restoring a resilient forest condition) and fire operations (by creating strategic opportunities for safer wildfire engagement). The Forest Health Assessment and Treatment Framework uses PODs to break-up the landscape into functional units for fire management. These functional units, combined with the assessment of landscape treatment priorities and wildfire response benefit, provide a logical spatial template to prioritize for dual benefits. PODs can foster alignment between two often siloed worlds – forest health and wildfire management – by providing a common landscape functional units, the POD. And by doing so, PODs partition a large landscape challenge into smaller, more tractable pieces, but still at a scale that is adequate for forest health work with the desired dual benefit.

Delineating all-lands PODs

We used the PODs delineations for the OWNF as a starting point for a cross-boundary PODs delineation. The vetting process's goal was to gather input from other agencies and create a set of all-lands PODs that reflect the expertise and fire management mandates of different agencies. The HB 1784 process collected feedback from local fire districts and DNR wildfire staff. Additional PODs were delineated to cover areas outside the National Forest land. This component of the HB 1784 process was concurrent with the development of the analytical framework and is ongoing in all planning areas of the HB 1784 pilot. As a result, current delineations are a draft product. Coordination and alignment between all agencies with wildfire responsibilities will require continued engagement and dialogue among all partners. Furthermore, as actions occur in these landscapes to change risk and forest health conditions, priorities, i.e., the colors shown in Fig. 5, will vary.

Dual benefit ranking

The landscape evaluation process uses PODs to summarize, visualize, and communicate dual benefit priorities qualitatively using a three-level priority ranking (Fig. 5). The process prioritizes PCLs (the lines) and PODs (areas defined by the lines) differently (Fig. 4). There were two main reasons to prioritize PODs and PCLs separately. The first reason was to strike a balance between prioritizing forest health within PODs, where large landscape treatments are needed to meet the 20- Forest Health Strategic Plan goals, and prioritizing PCLs for wildfire response benefit, thereby creating opportunities for fire operations. Secondly, in cases in which a fuel reduction action is proposed for PCL, it will likely mean a linear shaded fuel break. Fuel breaks and landscape treatments have different buy-in from stakeholders. Stakeholders who are not supportive of fuel breaks, in general, might recognize the importance of a specific fuel break in a high-priority area, e.g., around a community. Providing separate rankings helps communicate their value and increase the credibility and transparency of the prioritization process. Working at the POD level, aligning landscape-level forest health treatments with treatments designed to harden targeted PCLs will increase the scale and pace of forest restoration and create conditions for safer fire suppression and more frequent fire use.

Defining prioritization metrics

The metrics and processes used to prioritize for dual benefit varied for PODs and PCLs. Individual hexels (see #13) were uniquely assigned to either a POD or a PCL based on a distance threshold between the hexel center and the PCL. Hexels within 600 feet or less from a PCL were considered PCL-hexels. All other hexels were considered POD-hexels and flagged with the corresponding POD identifier. As such, no hexel can simultaneously be a POD- and PCL-hexel.

PODs

The landscape treatment priority map (#12) was used to prioritize PODs for dual benefit. For each POD, the landscape priority score value for all the hexels that are part of the POD was summed and divided by the acres of forested area in the POD. PODs were ranked and compared based on area-corrected values to ensure that large PODs do not outrank smaller but high-priority PODs. This ranking process resulted in a quantitative ranking of individual PODs delineated for a given planning area. If the POD expands outside the planning area boundary, only hexels within the planning area were considered in the analysis and ranking.

PODs were classified into one of three qualitative classes of dual benefit priority – first, second and third priority. Classification of individual PODs into a qualitative ranking was based on the cumulative value per acre. PODs classified as first priority cumulatively account for 50% of total landscape treatment priority score per forested acre in that planning area. PODs classified as

second priority account for the following 25%, and third priority PODs account for the lower portion of the ranking - for 25% of the total planning area.

PCLs

The process of ranking PCLs for dual benefit was different from the process conducted for PODs in two ways. Firstly, because PCLs comprise a continuous network of lines without a discrete spatial unit like a POD, it was necessary to create discrete spatial units of analysis for PCLs. These discrete units that can be used to produce a ranking (hereafter referred to as projects) were created using the tool ForSysX 2 (formerly the Landscape Treatment Designer). Secondly, PCL projects were created and ranked based on the wildfire response benefit map, whereas PODs were ranked using the landscape treatment priority map.

The ForSysX tool was used to aggregate individual PCL-hexels into priority projects. ForSysX is a USFS tool and a core component of the USFS scenario planning effort that combines data-driven decision-making and a more inclusive, participatory approach to guide the development of better plans that are more likely to be implemented (Ager et al. 2016, Ager et al. 2017, Ager et al. 2019b). The tool was parameterized to create PCL projects with a maximum size of 2,500 acres (approximately 139 PCL-hexels). This value is user-defined, and a cut-and-try approach was used experimenting with different values until a reasonable number of priority projects per planning area was obtained.

ForSysX organizes hexels with high-values of wildfire response benefit and a shared boundary into projects and continuously grows projects based on value and adjacency until it reaches user-defined maximum project size. When a large proportion of the hexels on the landscape have already been prioritized (i.e., put into projects), the remaining available hexels can sometimes result in a smaller project. For simplicity, projects that were less than 250 acres were collapsed into the closest project. If a project smaller than 250 acres is in between two projects, it was collapsed into the lowest ranking of the two neighboring projects.

Once PCL hexels are organized into projects, a rank of PCL projects was created based on the project's value per acre. Value per acre was calculated for each project by dividing the sum of the wildfire response benefit metric score of all hexels in the project (project's value) by total project size. Similarly to the rank for PODs, but was meant so that smaller, but high-value projects, are not penalized due to size. In the case of PCLs, however, total project size was used instead of the forested area as done with PODs. This was because the PCL ranking is focused on wildfire response benefit irrespective of landcover, whereas the PODs ranking is focused on landscape treatment priorities for forest health. PCL-projects ranked based on area-corrected values were used to organize projects into a qualitative ranking of dual benefit with three priorities – first, second, and third. As described for PODs, the classification of individual projects

into a qualitative ranking was based on the cumulative project's value. Projects classified as high priority cumulatively account for 50% of total wildfire response benefit per acre in that planning area. Projects classified as moderate account for the following 25%, and the lower priority class includes projects that account for the lower portion of the ranking and account for 25% of total value per planning area.

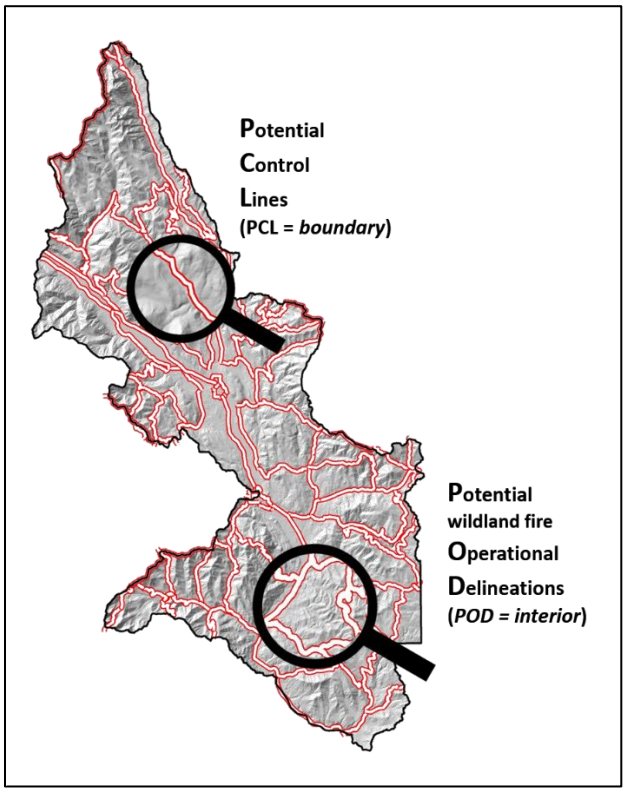

Figure 4. Potential wildland fire Operational Delineations (PODs) for the Methow Valley planning area (draft version). PODs are large landscape areas fully surrounded by potential control lines (PCLs). PODs and PCLs were prioritized for dual benefit, using two distinct metrics and processes (see text).

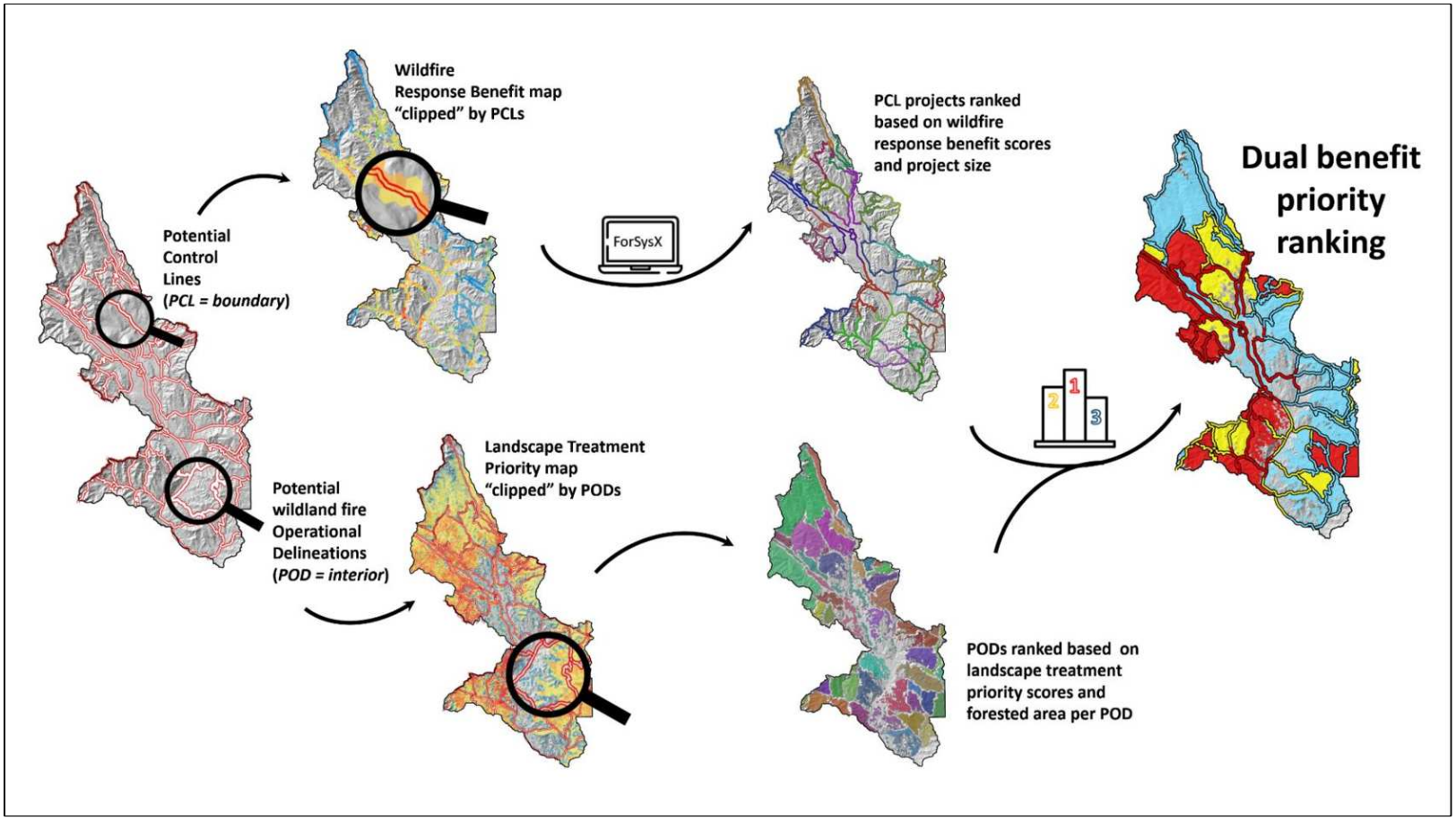

Figure 5. From POD delineations to priority rankings of dual benefit. Potential wildland fire Operational Delineations correspond to large landscape containers surrounded by potential control lines (PCLs, shown in red with a white fill). PODs were ranked based on the landscape treatment priority scores summarized at the POD level. PCL projects were ranked based on the wildfire response benefit using ForSysX. Colors in ranking figures show the rank position of individual PCL projects and PODs. The dual benefit priority ranking shows qualitative PCL priorities and POD priorities combined in the same map to highlight opportunities for treatments that provide a dual benefit of forest health and wildfire response benefit. Red areas show first priority, yellow areas show second priority, and blue areas show third priority.

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Appendix C: House Bill 1784 pilot project

House Bill 1784

In 2019 the State Legislature passed House Bill 1784 (hereafter HB 1784), amending RCW 76.06.200 - the statute directing DNR to complete an all-lands Forest Health Assessment and Treatment Framework designed to systematically and proactively address the forest health issues facing the state. Specifically, HB 1784 requires DNR to identify treatments that will benefit wildfire response and management operations as part of the Forest Health Assessment and Treatment Framework (Framework). Local implementation of treatments that come out of this planning effort are expected to provide dual benefits of improving forest while providing wildfire responders with strategically located areas with low fuel and safer operating conditions.

The HB 1784 pilot project (March to December 2020) developed analytical methods to integrate the requirements of HB 1784 into the existing Framework (RCW 76.06.200) through a collaborative pilot project in three pilot areas. The Forest Health Assessment and Treatment Framework, including the components developed during the HB 1784 pilot project, is described in Appendix B. This document describes the HB 1784 collaborative process – for a technical description of the analytical methods, see Appendix B (#13 and #14).

The HB 1784 pilot project was conducted in three pilot areas: Methow Valley, Leavenworth, and Greater Cle Elum (Fig. 1). These pilot areas were comprised of eight priority planning areas identified under the 20-Year Forest Health Strategic Plan. The choice of pilot areas was based on the need to involve both DNR Northeast and Southeast Regions and strong local partners that could participate in the pilot. The Leavenworth and Methow Valley pilot areas also overlap with DNR's social marketing wildfire campaign, thus providing synergies between the technical analysis/treatment prioritization with the education and outreach campaign.

The HB 1784 project was led by DNR's Olympia-based Forest Health Science Team, working in a collaborative Technical Team (TT) that includes a variety of regional staff and local partners to ensure that project outcomes would be actionable and meaningful to local landowners and managers. The TT initially included 52 members and has since grown to add partners and stakeholders who have expressed interest in learning about and contributing their knowledge and expertise to the project. The project also has a management team consisting of DNR leadership that provided general oversight and guidance on its development. The timeline for the HB 1784 project is described in Fig. 2 and described in detail in the sections below.

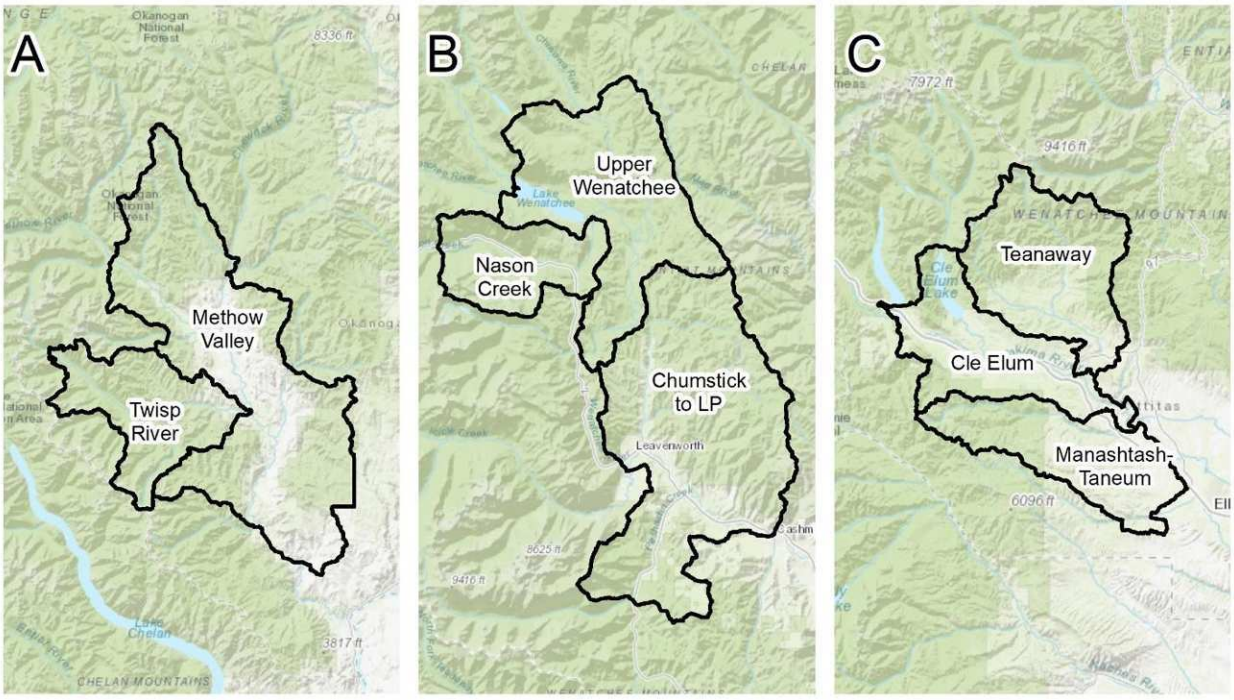


Figure 1. HB 1784 pilot areas: (A) Methow Valley, (B) Leavenworth and (C) Greater Cle Elum. Pilot areas were selected from existing DNR forest health planning areas. Service Credit Layer Sources: ESRI, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong) (c) OpenStreetMap contributors and the GIS User Community.

Kick-off meeting

The kick-off meeting (March 31st 2020) was an introduction to the project objectives, timeline, technical, and management teams. Part of the kick-off meeting included a presentation on Potential wildland fire Operational Delineations (PODs) by Dr. Chris Dunn (Oregon State University). The kick-off meeting introduced PODs because it provides a useful framework to address the wildfire response benefit requirements of HB 1784. In essence, PODs, which are delineated by firefighters, correspond to areas on the landscape surrounded by potential control lines where there is a reasonable chance of fire containment. Potential control lines are strategic opportunities provided by landscape features such as roads, rivers, ridgelines, old treatments, old fire scars, etc. Firefighters use their local knowledge of the landscape and past fire behavior combined with analytics to identify these potential control lines and delineate PODs. Similar to how watersheds are landscape units where hydrologists manage water resources, one can think of PODs as functional units for fire management.

After the kick-off meeting, invites to participate in the TT were sent to the partners and stakeholders.

The invite included four questions about HB 1784:

1. What are your thoughts on House Bill 1784's intent? Please highlight some of the wording that, in your opinion, speaks to the key requirements of the bill.
2. A wishlist: what products of HB1784 do you foresee as being useful in supporting the work you do?
3. Based on your experience, can you think of any concerns, cautions, and possible unintended consequences associated with HB1784 operationalization?
4. What information are you missing in order to answer 1-3?

First Technical Team meeting

A review of the feedback obtained for the four questions above was used to create a four-phase framework for the HB1784 process that was presented during the first TT meeting (May 1st 2020). During this meeting, the team reviewed the feedback obtained and presented a four-phase framework for the project, emphasizing phase 1 – defining what response benefit means for different partners and stakeholders and the key metrics that can be used to map wildfire response benefit.

DNR hosted standing "Office Hours" to answer questions, receive comments or feedback from technical team members. Collectively, input obtained during the meetings, from feedback requests and office hours, was used to develop the HB 1784 analytical methods. A Box site was created to share pertinent information about the project, including a frequently asked questions document, glossary, feedback summaries, presentations, reports, and other supporting materials. Access to the Box site is available upon request.

Second Technical Team meeting

The second TT meeting was held on June 30th 2020. Based on the TT feedback, a set of metrics was proposed to prioritize the landscape for wildfire response benefit, and the analytical methods to integrate wildfire response benefit considerations into the Forest Health Assessment and Treatment Framework was presented. A feedback request followed the second TT meeting and in preparation for the local meetings.

Overall, the first two project meetings focused on working towards a common understanding of what "wildfire response benefit" is and how it can be mapped and aligning the framework with local priorities and local data. The goal was to create a transparent, replicable framework that integrates and elevates local knowledge and past work.

A summary of the feedback obtained for all the requests can be found in the project's Box. Input received from the TT was once again used to refine the proposed analytical HB 1784 framework. The first two TT meetings and the feedback obtained throughout were the building blocks that led to the framework's first draft version. The draft version was used to deliver results specific to each pilot area during the local meetings.

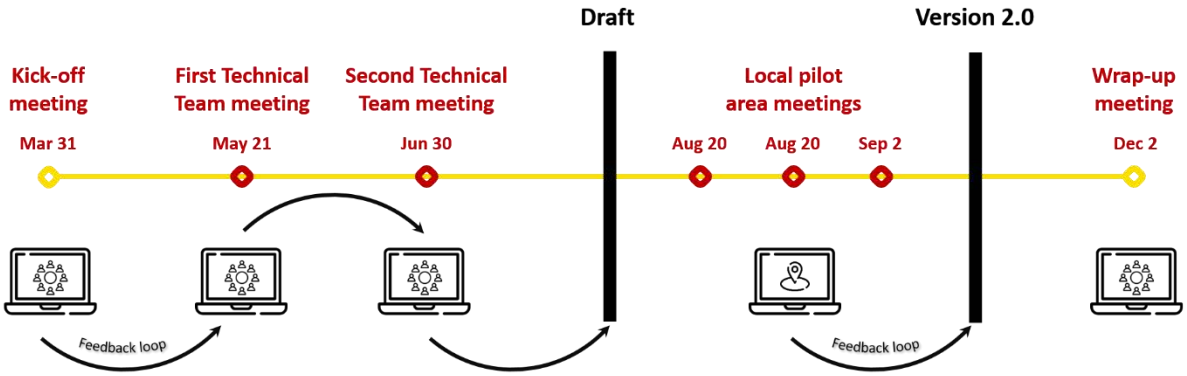


Figure 2. Timeline of the HB 1784 process showing the evolution of the Forest Health Assessment and Treatment framework versions. Version 1.0 was created in 2018, updated in 2020 to version 2.0 to reflect the requirements of HB 1784 and other changes. Feedback loops at the end of each meeting represent feedback requests sent out to the Technical Team, which helped develop the framework, track progress, and prepare subsequent meetings.

Local pilot area meetings: Methow Valley, Greater Cle Elum, and Leavenworth

Local meetings for the Methow Valley, Greater Cle Elum, and Leavenworth were held, one per week between August 20th and September 2^{nd,} 2020. The local meetings were specific to each pilot area and open to local partners and stakeholders outside the HB 1784 Technical Team. The meetings were designed to present each planning area's results and gather feedback specific to each pilot area. Specifically, goals were: (1) to give a summary of the results from applying the draft version of the HB 1784 analytical methods to planning areas in each pilot area and (2) to collect local stakeholder feedback so that project outcomes reflect local priorities and knowledge and will maximize local community support and participation in implementation.

Many of the expected attendees in the local meetings had not been involved in the Technical Team meetings. It was necessary to produce a data packet describing the project's background, the analytical methods, data, and draft results. It was sent out in advance of the meeting so that attendees could familiarize themselves with the past project and the current version of the framework. The local meeting presentations followed the contents in the packet closely.

Each local meeting provided an opportunity to have key stakeholders and partners to share some forest health and fire risk mitigation work locally. The goal was to help foster a common understanding of the ongoing work in the pilot areas and help identify avenues for alignment between on-the-ground treatment implementation and the planning tools, data, and assessments developed at the planning area level, i.e., the Forest Health Assessment and Treatment Framework (which includes the HB 1784 analysis).

At the end of each local meeting, meeting attendees participated in a group activity as "Pluses, Deltas, and Parking Lot." Each group, with 4-5 participants, had 10-minutes to discuss and identify:

1) Positive aspects of the framework, i.e., the pluses,
2) Components that need improvement or changes, i.e., the deltas
3) Thoughts or ideas that, albeit not directly related to the analytical framework, are of interest for future revisions (parking lot).

After the individual group discussion, each group shared their pluses, deltas, and parking lot points with the collective group. The pluses, deltas, and parking lot exercise was extremely helpful to collect feedback that led to the HB 1784 analytical methods presented in this report and integrated into the Forest Health Assessment and Treatment Framework. It also provided insights on what themes would be most important to address in a revised version as important considerations towards implementing the recommendations in this report.

Potential wildland fire Operational Delineation (PODs) vetting in pilot areas

The HB 1784 pilot project was the starting point of the vetting process of existing PODs delineation in pilot areas. Currently, US Forest Service fire staff have completed the only PODs delineations in Washington state. For the HB 1784 pilot project, we used existing PODs delineated by different US Forest Service Staff on the Okanogan-Wenatchee National Forest. The US Forest Service staff delineated the PODs with minimal feedback or engagement from other agencies with fire responsibilities. The vetting process's goal was to gather input from other agencies and create a set of all-lands PODs that reflect the expertise and fire management mandates of different agencies.

During the HB 1784 process, feedback on existing POD delineations was collected from local fire districts and DNR wildfire. Additional PODs were delineated to cover areas outside the National Forest land. The PODs vetting component of the HB1784 process co-occurred with the development of the analytical methods and is ongoing. In some pilot areas, the feedback obtained meant changing some of the initial POD lines proposed by the Forest Service. The process of collectively discussing these changes and deciding on a final set of lines has not happened yet. The pilot project ran through spring and summer combined with COVID19, which

created significant challenges to completing this work, and the delineations in the 2020 Legislative report should be seen as draft versions.

Within the HB 1784 pilot project, PODs were used to summarize and visualize treatment priorities that have dual benefits of forest health and wildfire response. Other uses for PODs include defining, based on values at risk, alternative suppression strategies. The HB 1784 process initiated the vetting of existing PODs and moving towards alignment and all-lands PODs delineations. However, thoroughly vetted PODs delineations will take time to develop based on a continuous dialogue between different agencies with fire responsibilities, combined with on-the-ground information on the lines.

Next steps towards implementation and future developments

Throughout the HB1784 process, input from meetings and feedback requests contributed to developing a transparent, science-based, and replicable analytical methods to implement the requirements of HB 1784 into the Forest Health Assessment and Treatment Framework. A few examples include feedback that highlighted the importance of protecting sources of drinking water and the need for a more robust integration to link the two components of dual benefit – forest health and wildfire response benefit - all of which were addressed in the current version of the framework.

A significant part of the feedback received throughout the HB 1784 process focused on 1) opportunities for future improvements to the current framework or 2) understanding how the results of the Forest Health Assessment and Treatment framework relate to the daily lives of those working and living in the priority planning areas. The latter often emphasized the need to understand connections to on-the-ground implementation of projects.

In terms of improving the framework, two main themes were 1) considerations of post-fire erosion potential in the prioritization, 2) identifying opportunities to integrate wildfire risk, and exposure from shrub-steppe currently not included in the forest health evaluation needs or treatment assessment.

Under the realm of implementation, participants in the HB 1784 meetings were mostly interested in understanding 1) how and when the data would be shared; and what are the plans for 2) for local outreach and implementation, and 3) collaborative delineation and vetting of current POD delineations.

Other questions pertinent to implementation included how the data from the Forest Health Assessment and Treatment framework can be used to implement projects, how the feasibility of treatments should be evaluated, and how we can accomplish more prescribed fire on the landscape.

The HB 1784 pilot project concluded December 2nd 2020, with the final meeting to present the Forest Health Assessment and Treatment Framework (with HB 1784 component) and discuss key

next steps. The Forest Health Science Team will continue to work on priority planning areas not included in the HB 1784 pilot project, which will be analyzed with the full Forest Health Assessment and Treatment Framework during the 2021-2022 biennium and beyond. Lessons learned from that work and the continued collaboration in the HB 1784 pilot areas will be integrated into future versions of the framework (2022) as needed. Recommendations for prioritized landscape-scale treatments in the HB 1784 pilot areas will be part of the Legislative Report in December 2020.

Acknowledgments

The HB 1784 pilot project benefited from the support and participation of numerous individuals in our Technical and Management teams that contributed their time, insight, and work to this pilot project during an incredibly challenging year. The COVID pandemic, combined with an unprecedented fire season in the western US, created additional challenges for participants to attend meetings, answer feedback requests, and delineate and vet PODs. A special thank you is owed to the fire staff that worked on outlining and vetting PODs, local project coordinators, local meeting facilitators, speakers, and collaborators that provided critical feedback and data:

Chief Cody Acord, Okanogan County Fire District 6
Alan Ager, USDA - Forest Service
Michael Barajas, USDA - Forest Service
Ashley Blazina, DNR
Chad Bowman Chelan Public Utility District
Assistant Chief Glenn Brautaset, Chelan County Fire District 3
Nolan Brewer, DNR
Scott Chambers, DNR
Derek Churchill, DNR
Trevor Contreras, DNR
Ben Curtis, USDA - Forest Service
Michelle Day, USDA - Forest Service
Chris Dunn, Oregon State University
Chief Rich Elliott, Kittitas Valley Fire and Rescue
Matt Ellis, USDA - Forest Service
Jason Emsley, DNR
Walter Escobar, DNR
Nancy Farr, Methow Valley Fire Adapted Communities
Chris Furr, USDA - Forest Service
Patrick Haggerty, Cascadia Conservation District
Jake Hardt, DNR
Corina Hayes, WA Department of Health
Kathryn Heim, Methow Valley Fire Adapted Communities
Paul Hessburg, USDA - Forest Service

Mike Kaputa, Chelan County
Allen Lebovitz, DNR
Mike Liu, Conservation Northwest
Reese Lolley, The Nature Conservancy
Brian Maier, USDA - Forest Service
Austin Marshall, DNR
Daniel Montano, DNR
Chief Phil Mosher, Chelan County Fire District 6
Chief Kelly O'Brien, Chelan County Fire District 3
Jim Passage, Lake Wenatchee Fire Adapted Community
Susan Prichard, University of Washington
Amy Ramsey, DNR
Chad Rissman, Chelan Public Utility District
Jeff Rivera, USDA - Forest Service
Rose Shriner, Washington Resource Conservation & Development Council
Liz Smith, DNR
Andrew Spaeth, DNR
Mike Starkovich, USDA - Forest Service
Cary Stock, USDA - Forest Service
Chief David Walker, Lake Wenatchee Fire and Rescue
Dave Werntz, Conservation Northwest

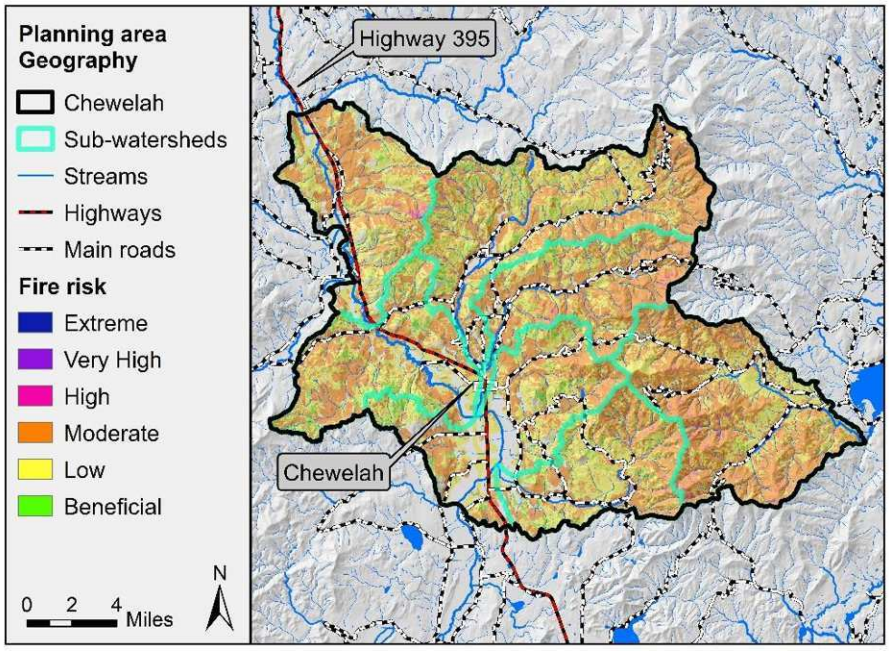
Appendix D: Landscape Evaluation Summary Results for 2020 Priority Planning Areas

Enclosed are landscape evaluation summaries for the following priority planning areas:

Chewelah
Chumstick to LP
Cle Elum
Glenwood
Ione
Klickitat
Little White
Long Lake
Mad Roaring Mills
Manastash-Taneum
Methow Valley
Mount Hull
Nason Creek
Republic
Stranger
Teanaway
Tieton
Toroda-Tonata
Trail
Twisp River
Upper Swauk
Upper Wenatchee

CHEWELAH PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
195,408	158,352	59,000 - 80,000



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- Ownership is split between the Colville National Forest (42%), private (36%), industrial forestland (16%), and other (6%).
- Fire probability and risk are highest in the eastern half of the planning area, as well as west of Highway 395. While fuel loads are high in these areas, fire probability is low, resulting in moderate risk.
- Treating 37-51% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- Treatment priority is highest in the southwestern block, west of the town of Chewelah, as well as on south-facing slopes in the southeastern portion.
- Vaagen Brothers Lumber Company, through an A-Z stewardship contract with Colville National Forest, is currently planning a large forest restoration project on USFS land within the planning area.
- Treatments completed on US Forest Service land after the 2015 LiDAR acquisition in the southeastern portion have already met some of the treatment need. These projects are part of the Power Lake Environmental Assessment.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Although fuel loads are moderate to high, fire risk to forests and homes is moderate to low across the planning area (Fig. 2) due to low burn probability, which is based on large fires from 1992-2015. If a fire does occur, however, predicted fire intensity is high in much of eastern 1/3rd and northwest. Without treatments, fire risk is predicted to increase as burn probability increases with projected climate warming. Landscape treatments will help reduce the risk of large, high-severity fire and restore conditions conducive to a more characteristic balance of low- and mixed-severity fire, with some high-severity patches. Over time, a restored landscape will provide managers more flexibility to utilize managed wildfire to maintain these fire-dependent ecosystems and thus harness the predicted increase in burn probability. In addition, implementing fuel reduction treatments around homes and establishing potential control line will increase firefighter safety and help protect communities.

Increase resilience and prepare for climate change

By mid-century, the majority of the planning area is projected to have moisture stress levels that are currently associated with dry forest (Fig. 3). South-facing slopes and areas with shallow soils west of Highway 395 are projected to transition to non-forest over time. Moderate and low moisture stress levels are projected to remain on north-facing slopes and valley bottoms at mid to upper elevations. Treatments, as well as managed wildfires in less accessible areas, that reduce density and favor drought-tolerant species will enhance resilience into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is abundant and well distributed, except in the southeastern portion. Patch sizes are adequate in the western half but on the small end in the eastern half. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Goshawk) is very abundant, with large and aggregated patch sizes. In high fire risk locations, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability while helping to maintain habitat in the most sustainable locations (Fig. 7). This would extend the spatial distribution and increase patch sizes of open canopy habitat on dry sites in the eastern half. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is also very abundant in the moist and cold forest portions, with moderate to large patch sizes.

Enhance rural economic development

Almost all of the planning area has road access, and most of the areas needing treatment will support commercial treatments. Meeting restoration treatment needs will produce a large amount of forest products and related economic activity. Although warming trends will necessitate managing for more drought-tolerant species and lower densities and fuel loads on current and future dry sites, long-term timber production should be possible. Reducing fire risk will help sustain recreation and tourism while reducing the potential of smoke affecting communities.

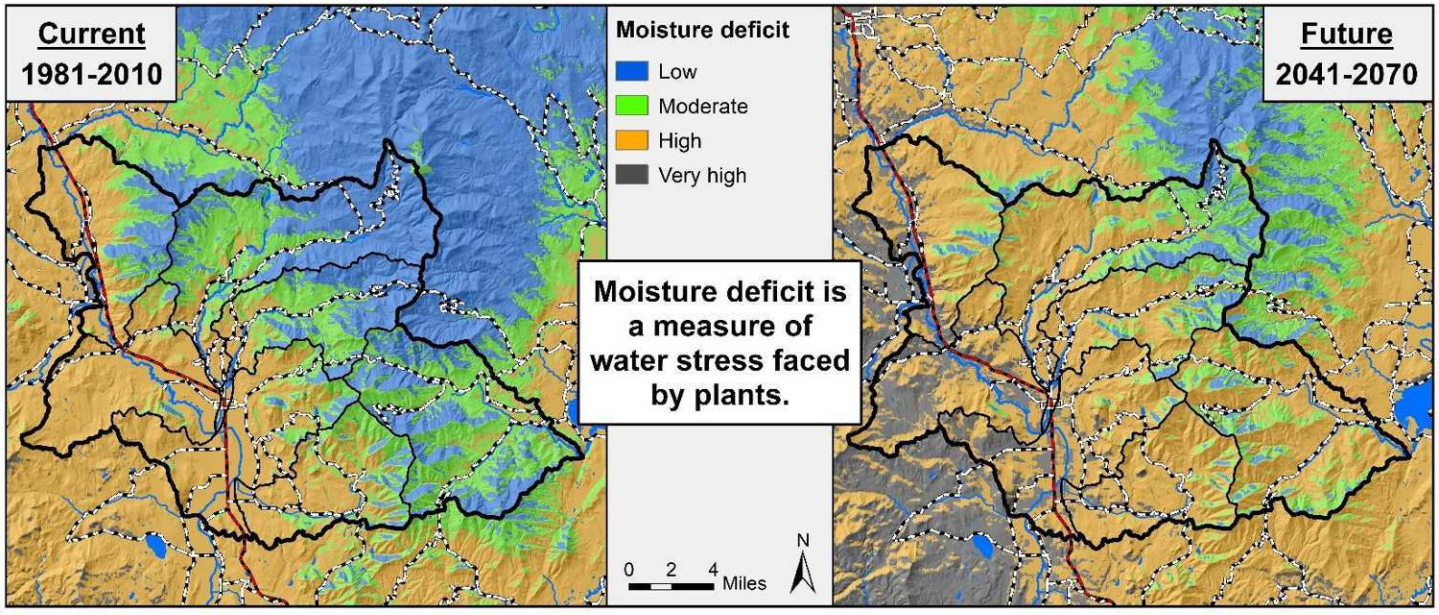


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

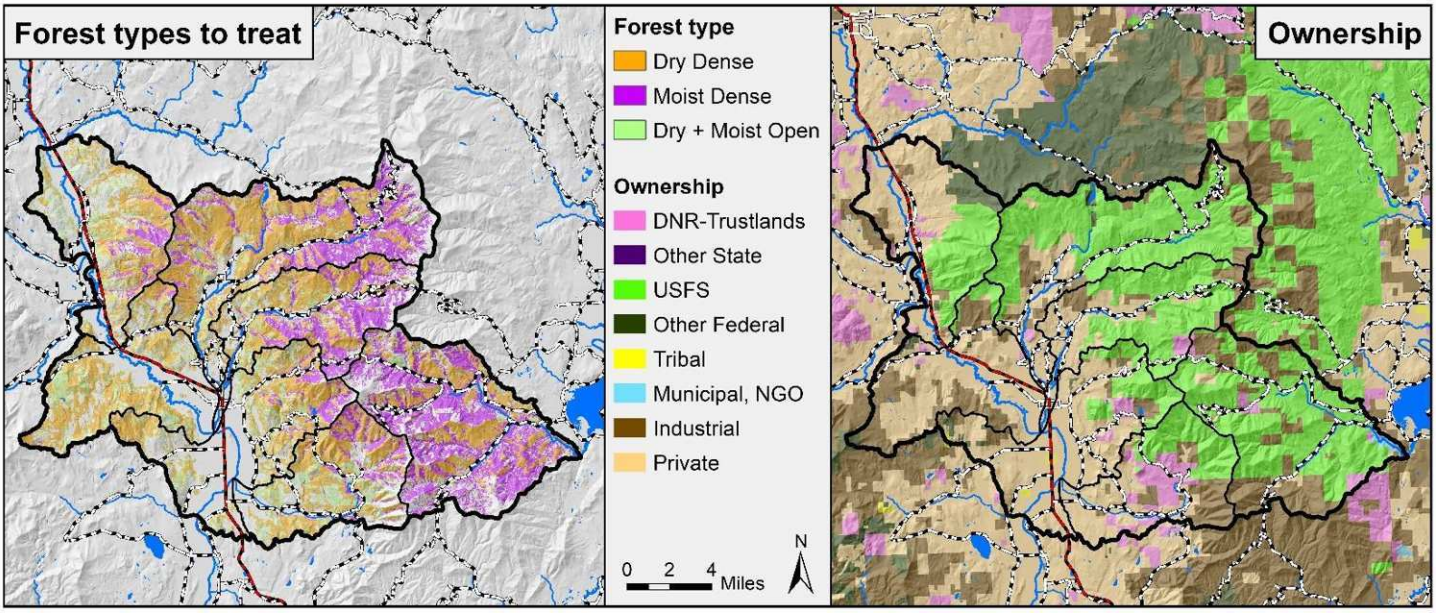
Forest Health Treatment Needs

Treating 59,000 to 80,000 acres is recommended to move the landscape into a resilient condition (37-51% of forested acres; Table 1). This total includes an estimated 50,500-66,000 acres to shift dense to open forest and 8,500-14,000 acres of maintenance treatments in existing open forest, based on current condition data from 2015 and 2016 LiDAR. Treatments completed after the 2015 LiDAR acquisition in the southeastern portion on USFS land have already met some of this treatment need. The majority of treatment need is located on USFS land, but substantial need exists on other ownerships as well.

Meeting this target range will require multiple treatment types (Table 1). Managed wildfire under safe conditions will be needed, especially in less accessible locations. Most treatments are commercially viable based on tree size. Treatment type will depend, however, on road access, logging systems, markets, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**USFS**	**Private**	**Industrial**	**DNR Trust**	**USFWS**
Dry Dense	Small	500 - 1,000	1,045	540	1,238	30	10
	Medium-Large	42,000 - 51,000	33,241	18,883	7,790	3,334	2,183
Moist Dense	Medium-Large	8,000 - 14,000	28,580	1,685	4,402	1,020	295
Dry + Moist Open	Medium-Large	8,500 - 14,000	3,568	8,380	5,191	1,556	295
Total		**59,000 - 80,000**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense forest structure of all size classes is over-represented on dry sites. Patch sizes are large and aggregated. Much of the dry forest is also dominated by Douglas-fir. These forests are vulnerable to uncharacteristic levels of high- and mixed-severity fire, as well as a combination of drought stress, root disease, and Douglas-fir beetle. Treating 42,500-52,000 acres of dry dense forest (Table 1) is recommended to create large patches (~100-1000 ac) of open forest and shift the majority of dry sites to open forest (Fig. 6). As the retained trees grow over time, much of the dry forest will shift to large tree, open forest, which is currently very low. Shifting composition toward ponderosa pine and western larch is also needed. In places where these species are poorly represented, planting may be needed after gap creation, variable retention harvests, or high-severity fire.

Moist and cold dense forest treatment need

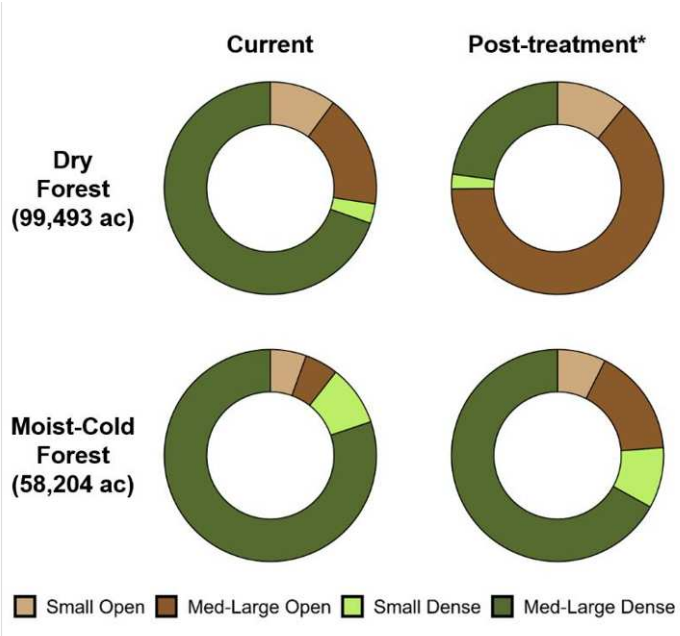
Dense, medium tree forest on moist sites exceeds desired ranges in the eastern half, while dense, large tree forest is at the upper end. Patch sizes are large and aggregated. Large tree, open structure is below desired ranges, as is small open forest. Treating 8,000-14,000 acres of this type (Table 1, Fig. 4) is recommended to create a mosaic of open, moderate, and dense patches that will reduce risks of large crown fire and insect outbreaks. A range of treatment types will be needed, including moderate to heavy thinning, regeneration treatments, and fire. Increasing the relative composition of western larch and ponderosa pine while decreasing grand fir and other fire-intolerant species is also needed, especially on sites projected to shift to dry forest (Fig. 3). Post treatment, over 70% of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

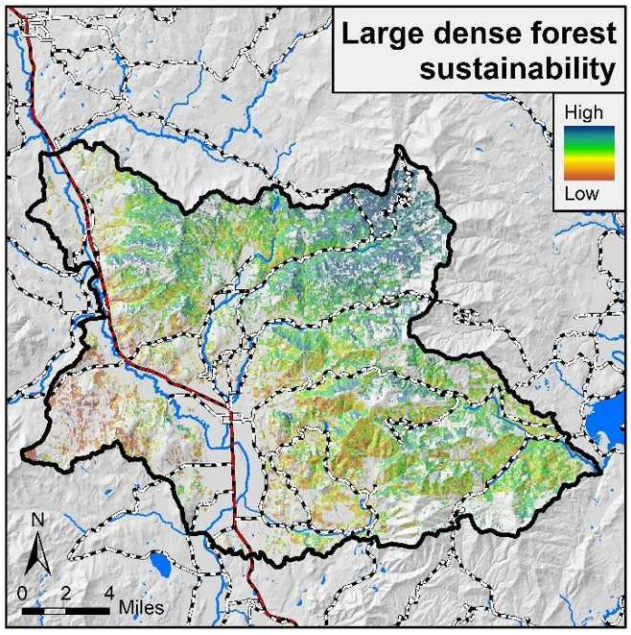
Open forest maintenance treatment need

Over the next 15 years, an estimated 8,500-14,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include more open south-facing slopes and recently treated areas where fire is currently predicted to have beneficial effects (Fig. 2). Specific maintenance strategies will depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this habitat type and associated ecosystem functions. Sustainable locations include the northeastern portion, as well as north-facing slopes in the remainder of the eastern half and in the northwest (Fig. 7). This sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to shift to open forest vs. where to maintain and increase large tree, closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). We also recommend incorporating the large dense forest sustainability layer (Fig. 7) as an overlay when selecting treatment locations. Wildfire transmission is moderate to high in western and northwestern portions, indicating that wildfires starting in these locations are expected to expose homes in and around the town of Chewelah (Fig. 2).

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Treatment priorities

Landscape treatment priority is highest in the southwestern block, west of the town of Chewelah, as well as on south-facing slopes in the southeastern portion. Medium priority areas are present throughout the planning area. Medium and high priority areas are spread across all major landowners: USFS, private, industrial forestland, and to a lesser extent DNR. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels with homes or other structures throughout the planning area.

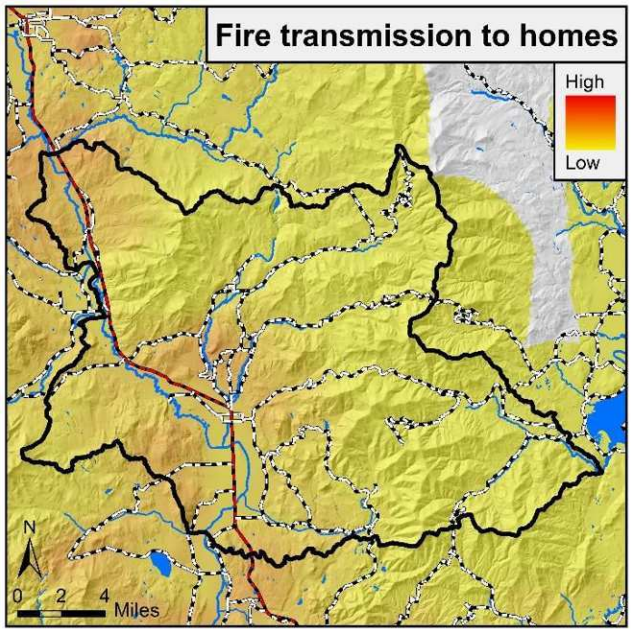


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

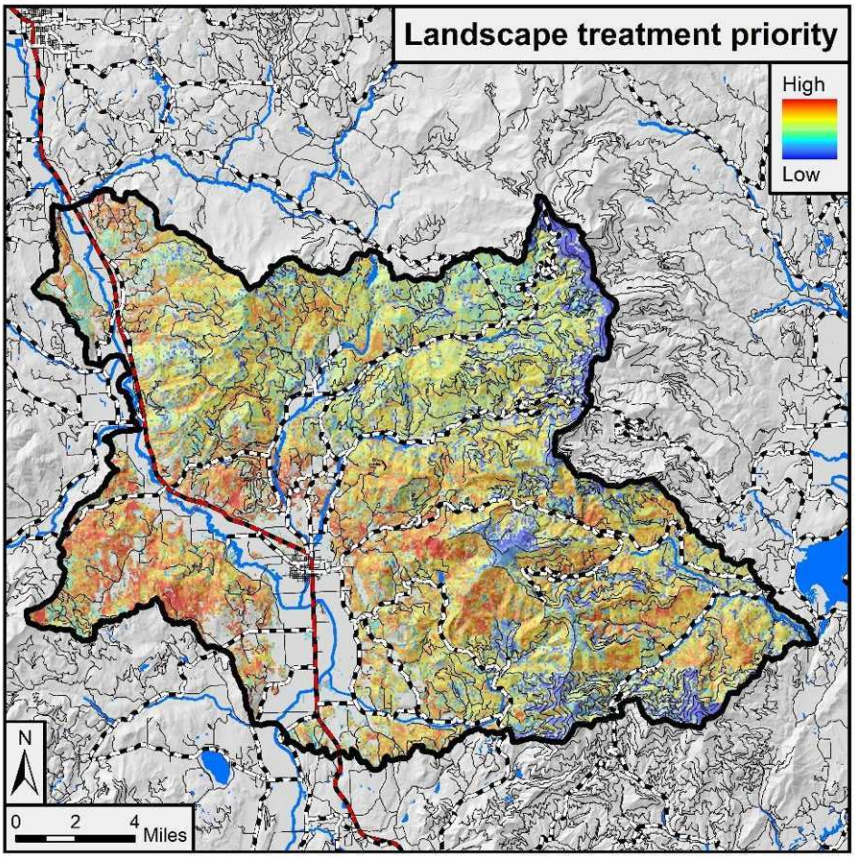


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

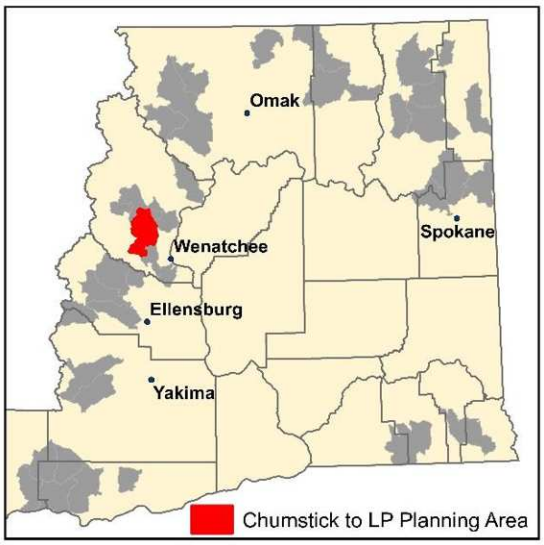
***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

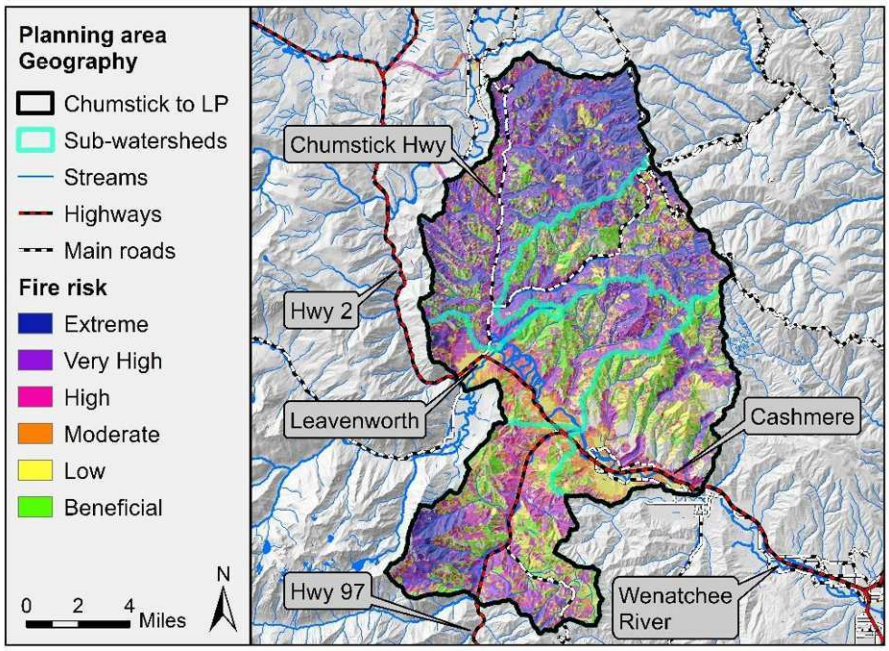
Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fire is allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

CHUMSTICK TO LP PLANNING AREA LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
115,333	84,216	36,500 - 53,000





Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- This planning area extends from Chumstick Creek in the north to Lower Peshastin (LP) Creek in the south. The area is popular for tourism and recreation and includes Leavenworth and other communities in the Wenatchee River corridor.
- The planning area is evenly divided between public and private ownership, with 51% of the total being USFS land.
- Fire risk is very high to extreme across the northern portion and southwest corner of the planning area, representing some of the highest risk areas in eastern WA (Fig. 2).
- Projected warming over the next 20-40 years will likely shift climate conditions suitable for moist forest towards conditions suitable for dry forest. Low elevation areas, including much of the central portion, may no longer support forest.
- Treating 43-63% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- High priority areas for potential treatments that maximize forest health and wildfire response benefit include locations in the northern portion on both sides of the Chumstick Highway.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

CONTACT

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high to extreme across the northern portion and in the southwest corner of the planning area due to high fuel loads and burn probability (Fig. 2). The northern portion represents some of the highest fire risk in eastern WA. High risk areas in the eastern portion occur on private land adjacent to the Wenatchee River corridor. Fuels treatments are needed to break up large patches of dense forest to reduce the likelihood of severe crown fire and to facilitate protection of private property along Highway 2 and Chumstick Highway. In the central-eastern portion and in the 2004 Fischer Fire perimeter, fire is predicted to have low risk or beneficial effects due to reduced fuels from past fuels treatments, harvesting, and fire effects.

Increase resilience and prepare for climate change

By mid-century, the majority of the planning area is projected to have moisture stress levels that are currently associated with dry forest or shrub-steppe (Fig. 3). Substantial acreage in the central, lower elevation portion is projected to shift to non-forest over time. Moderate moisture stress levels are projected to remain on north-facing slopes, primarily in the northeast and southwest portions. Treatments, as well as managed wildfires in roadless and other inaccessible areas, that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is well represented in the planning area, although it is concentrated in large patches in the east. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is currently at the upper end of desired ranges or overabundant and is concentrated in the northern half of the area. In high fire risk locations, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability, help maintain habitat in the most sustainable locations (Fig. 7), and broaden the spatial distribution of open canopy habitat. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is a relatively minor component of this planning area.

Enhance rural economic development

Many of the high treatment priority areas (Fig. 9) have road access and are capable of producing significant timber volume. Although warming trends and high burn probability will necessitate managing for lower densities and fuel loads, long-term timber production will likely be possible in much of the USFS and industrial ownerships. Reducing fire risk will help sustain recreation and tourism while reducing the potential of smoke affecting communities within and near the planning area, including Wenatchee.

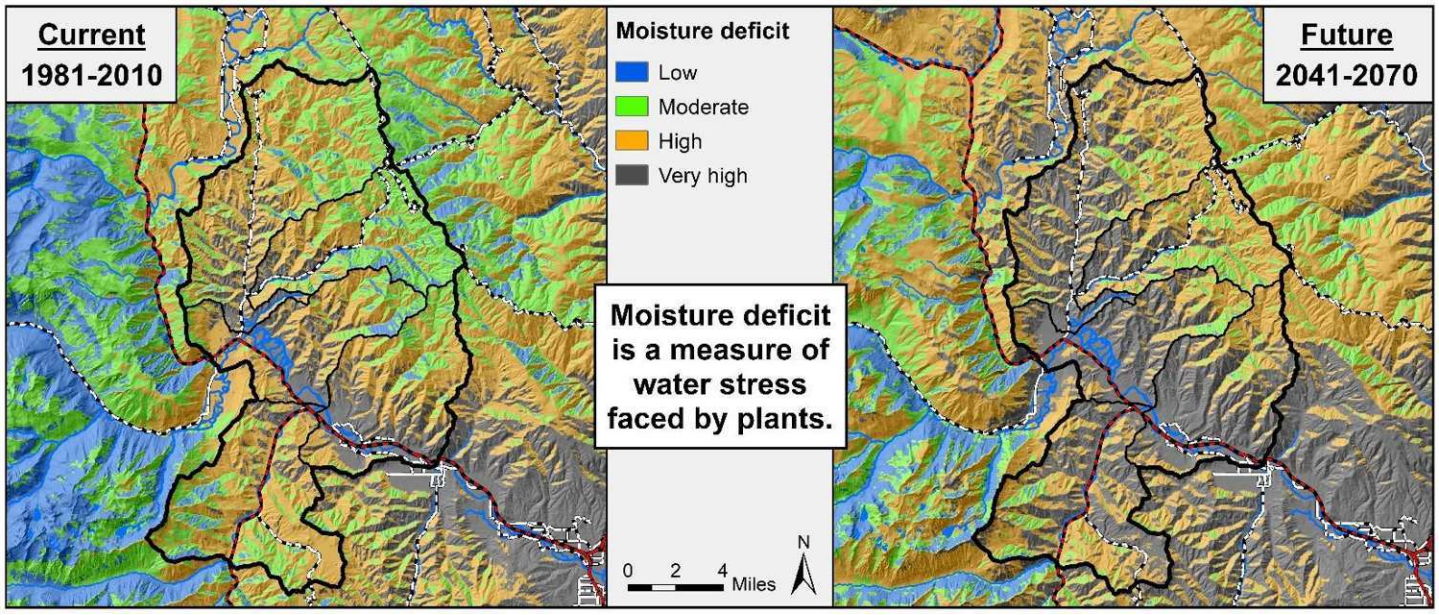


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

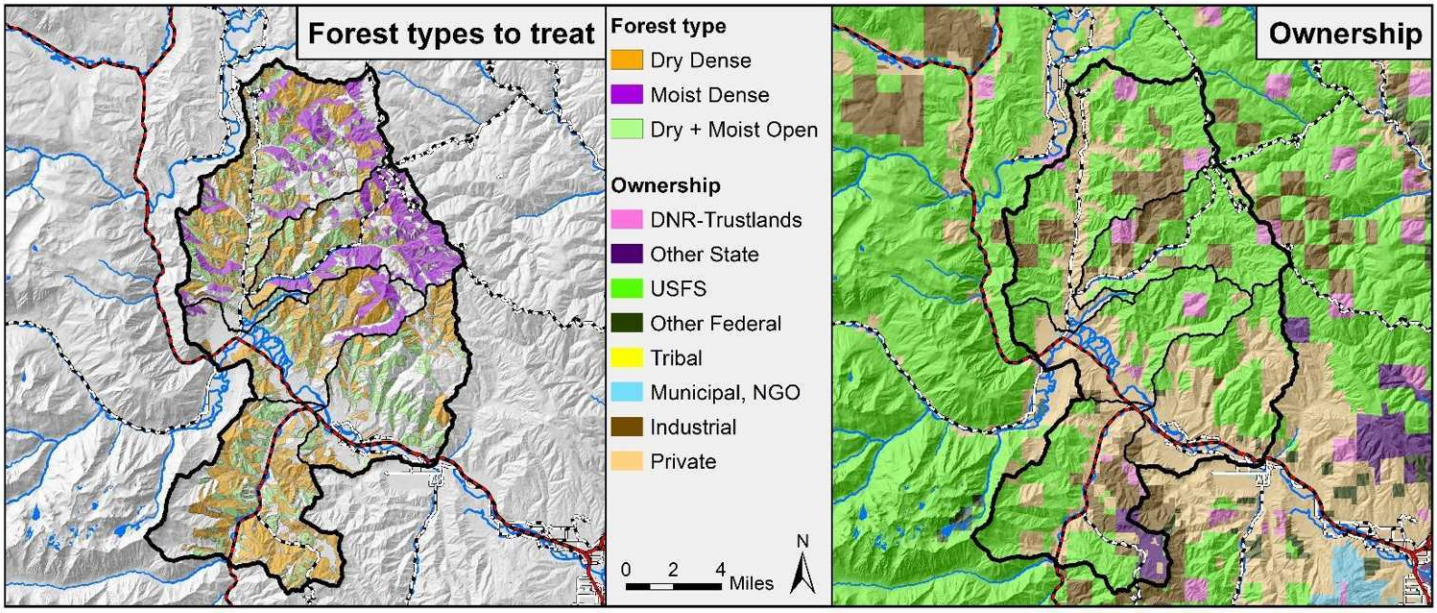
Forest Health Treatment Needs

Treating 36,500 to 53,000 acres is recommended to move the landscape into a resilient condition (43-63% of forested acres; Table 1). This total includes an estimated 26,250-36,500 acres to shift dense to open forest and 10,250-16,500 acres of maintenance treatments in existing open forest, based on current condition data from 2014 aerial photos. Most of the treatment need is located within USFS land, although substantial need exists on private and industrial ownerships as well.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in less accessible locations. Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**USFS**	**Private**	**Industrial**	**DNR Trust**	**Other**
Dry Dense	Small	500 - 1,500	2,739	838	2,200	745	231
	Medium-Large	21,000 - 25,500	17,423	8,483	2,331	1,255	1,266
Moist Dense	Small	750 - 1,250	2,799	393	1,529	277	0
	Medium-Large	4,000 - 8,250	13,328	1,351	971	735	0
Dry + Moist Open	Medium-Large	10,250 - 16,500	11,780	7,446	2,668	500	313
Total		**36,500 - 53,000**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites, especially sites dominated by ponderosa pine and Douglas-fir. The large, contiguous patches of these forest types create high susceptibility to defoliating insects and bark beetles, especially in northern portions of the planning area. Treating 21,500-27,000 acres of this type (Table 1) is recommended to create large patches (~100-1000 ac) of open forest with a component of large trees (Fig. 4), flipping the majority of dry sites from closed to open forest (Fig. 6). Ponderosa pine and other drought-tolerant species will continue to be suitable as climate conditions get warmer and drier.

Moist and cold dense forest treatment need

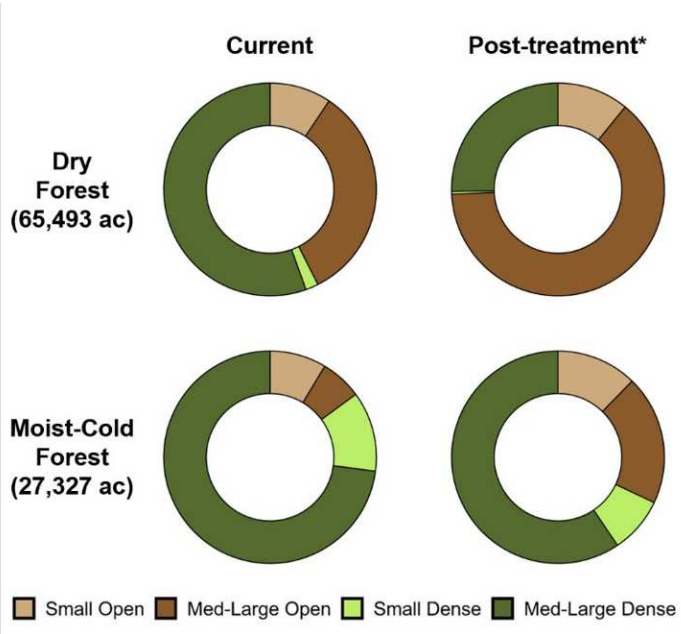
Dense, multistory forest on moist sites exceeds or is at the upper end of desired ranges across the planning area, and these forests occur in large, aggregated patches. In contrast, open canopy forest with medium to large trees, as well as open forest with small trees and shrubs, are at the low end of desired ranges. Treating 4,750-9,500 acres of this forest type (Table 1, Fig. 4) is recommended to create a mosaic of open and dense forest that will reduce risks of large crown fire and insect outbreaks. A range of treatment types will be needed, including thinning, regeneration treatments, and managed wildfire in roadless areas. Increasing the relative composition of ponderosa pine and western larch is also needed to help these sites adapt to a warming climate. Post treatment, over 60% of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

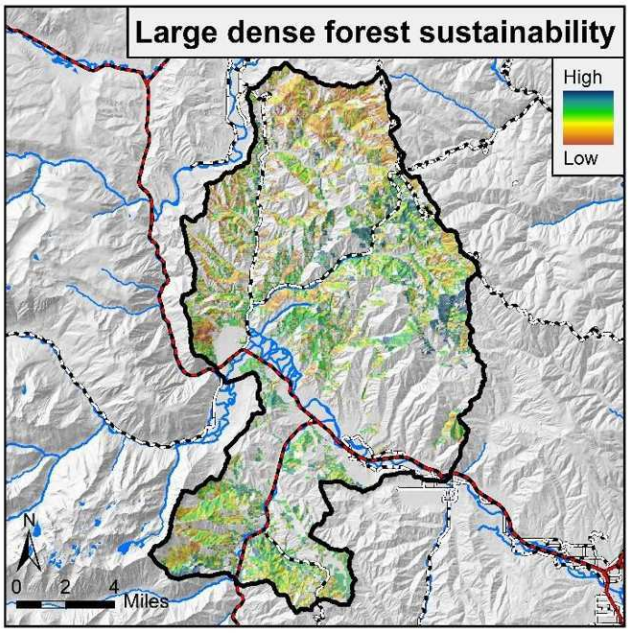
Open forest maintenance treatment need

Over the next 15 years, an estimated 10,250-16,500 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments, as well as parts of the Fischer Fire, Eagle Fire, and other recently burned areas, where additional fuel reduction is needed. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with moderate current and future moisture deficits (Fig. 3) and moderate fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Sustainable locations include north-facing slopes and valley bottoms in eastern and southern portions of the planning area (Fig. 7). The large tree, dense forest sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is high across most of the planning area, indicating that wildfires starting in these locations are expected to expose homes in Leavenworth, Cashmere, and other communities along the Wenatchee River corridor and the Chumstick Highway (Fig. 2).

Treatment priorities

Landscape treatment priority is highest in the northern portion and western edge on USFS land (Fig. 9). North-facing slopes also exhibit relatively high priority due to high fire risk and overabundant moist forest structure. Medium and high priority areas on roadless USFS lands indicate that managed wildfire will be needed to restore portions of the landscape. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes throughout the planning area.

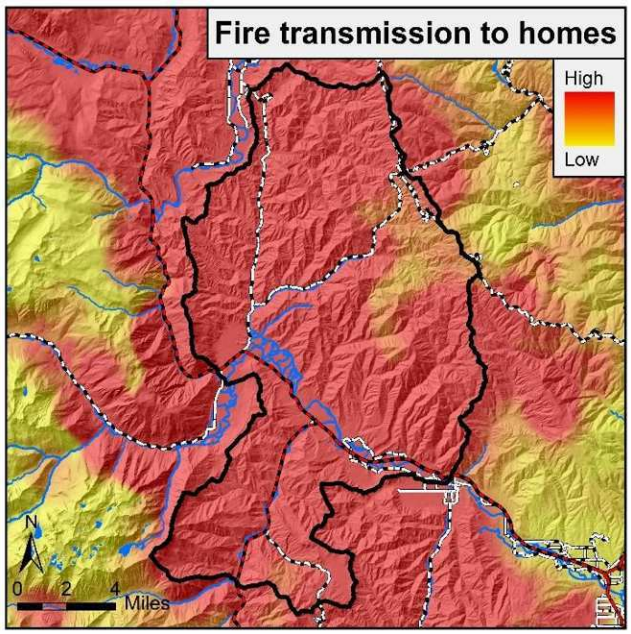


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

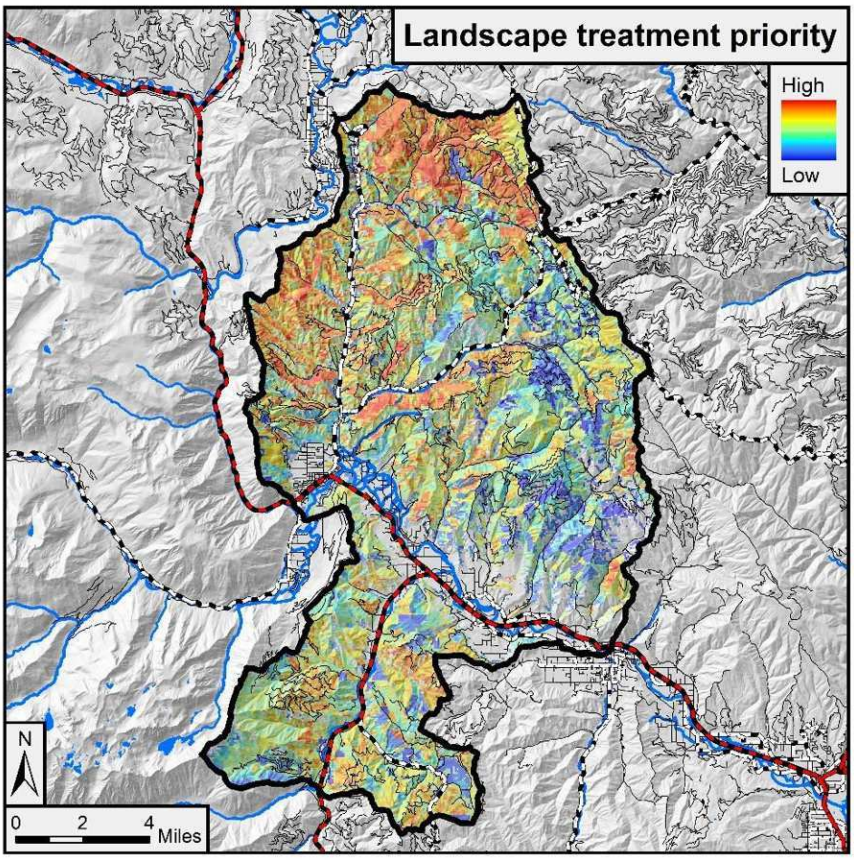


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – and wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires that are allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

Wildfire Response Benefit Prioritization

Dual benefits for forest health and wildfire response

It is necessary to conduct treatments to both improve forest health and reduce fire risk to communities as well as provide conditions where firefighters can safely and efficiently conduct fire operations (e.g. suppression, prescribed burning, and managed wildfire). The wildfire response benefit metric (WRB; Fig. 10) identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes, infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior. Because there are positive feedbacks between healthy, resilient forests and safe, effective fire operations, the WRB metric also integrates the landscape treatment priority map (Fig. 9).

Where WRB is highest, actions may be needed to create and maintain conditions that provide a tactical advantage for fire operations. These actions will vary with the local context and can include landscape-level forest health and fuel treatments, treatments along escape routes, resident and community fire mitigation activities (e.g. defensible space, home hardening), and improving signage and road conditions. The WRB metric provides a high-level prioritization, and additional work at the local level will be required to identify appropriate actions and assess their feasibility. WRB is useful for prioritizing Potential Control Lines (PCLs) for fire operations (Fig. 11). PCLs are a part of Potential Operational Delineations (PODs); see page 7.

In the Chumstick to LP planning area, wildfire response benefit is highest along the east and west sides of Chumstick Highway (Fig. 2) due to interspersed homes, infrastructure, and commercially managed lands (Fig. 5). The entire planning area is a source of surface drinking water (not shown), and crown fire potential is high throughout, except for the area northeast of Cashmere due to low forest cover. The areas of high wildfire response benefit in the southern end of the planning area identify tracts of commercially managed lands.

Definitions (continued)

Wildfire response benefit: Any tactical advantage gained for wildfire response activities from actions on the landscape, including, but not restricted to, identifying and consolidating existing anchor points and control lines and reduction of potential fire behavior. Wildfire response benefit is not restricted to any specific wildfire management strategy and instead is centered on conditions that improve fire operations safety and effectiveness.

Potential Control Lines (PCLs): Boundaries of Potential Operational Delineations (PODs) relevant to fire control operations (e.g. roads, ridgetops, and water bodies).

Potential Operational Delineations (PODs) for wildland fire: Landscape containers whose boundaries are potential control lines (PCLs). PODs are useful for planning strategic response to unplanned ignitions, strategic fuel planning, and prioritizing fuel treatments within PODs.

Commercially managed lands: Commercially managed forestlands include: DNR Trustlands, tribal forests, industrial forests, non-industrial private forests, and US Forest Service forests where timber is a primary management objective.

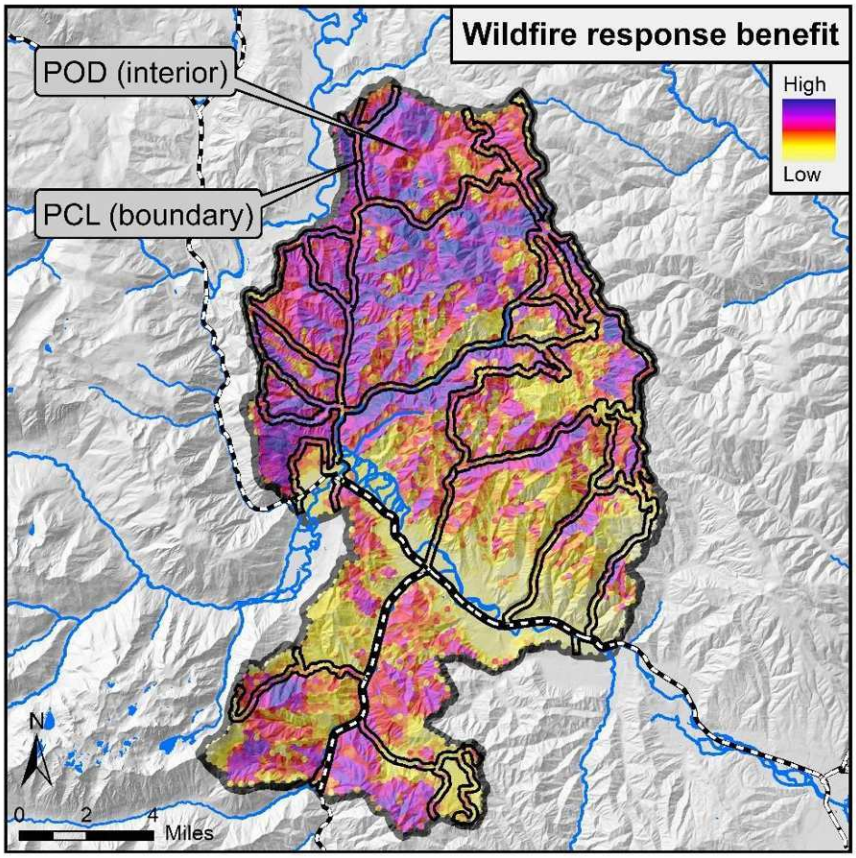


Figure 10. Wildfire response benefit (WRB) integrates multiple fire risk and forest health components. It includes four fire risk metrics representing highly valued resources – risk to homes, infrastructure, drinking water, commercially managed lands – as well as crown fire potential and wildfire transmission to homes (Fig. 8). Combined, these account for 75% of the wildfire response benefit. Landscape treatment priority (Fig. 9) accounts for the remaining 25%. Also shown are PODs: units bounded by PCLs (open black lines). One use of the WRB metric is to prioritize Potential Control Lines (PCLs) for fire operations (Fig. 11).

Prioritizing Landscape Treatments for Dual Benefits

Integration of forest health and wildfire response benefit using PODs

Potential Operational Delineations (PODs) provide a powerful spatial framework to communicate and identify locations that will deliver dual benefits for forest health and wildfire response at the landscape scale. PODs are large landscape areas delimited by Potential Control Lines (PCLs) for fire operations (suppression, prescribed fire, and managed wildfire) delineated by fire operations personnel. PCLs can be roads, ridgelines, or any artificial or natural fuelbreak that provides a strategic opportunity for fire operations. Summarizing landscape treatment priorities (Fig. 9) within PODs and wildfire response benefit priorities (Fig. 10) within PCLs enables planners and managers to identify, at a high level, locations where forest health or fuels treatments can be connected to a high-priority PCL that will support firefighter operations (e.g. ingress/egress route or opportunity for engagement).

Achieving forest health and wildfire response goals will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs.

There is important work to do in all Chumstick to LP PODs to achieve the forest health treatment targets in Table 1. PODs on both sides of the Chumstick highway are the first priority and are mostly surrounded by first priority PCLs. This is due to the spatial alignment between risk layers and landscape treatment prioritization needs on both sides of the highway and high transmission to homes from north of Spromberg Canyon to Leavenworth (Fig. 8). There are a few small, isolated first priority PCLs (e.g. west of Leavenworth) and PODs (e.g. south and east edges of the planning area). Further work is needed to assess PCLs locally for their condition and detailed treatment needs, which will depend on management goals and values at risk. Ideally, landscape treatments will be implemented adjacent to priority PCLs where feasible to maximize both forest health and wildfire response goals.

Achieving forest health and wildfire response dual benefits will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs. These two approaches combined will contribute to restoring and maintaining large portions of the landscape in a resilient condition while providing safe and effective areas for firefighter engagement during suppression, prescribed fire, or managed wildfire operations.

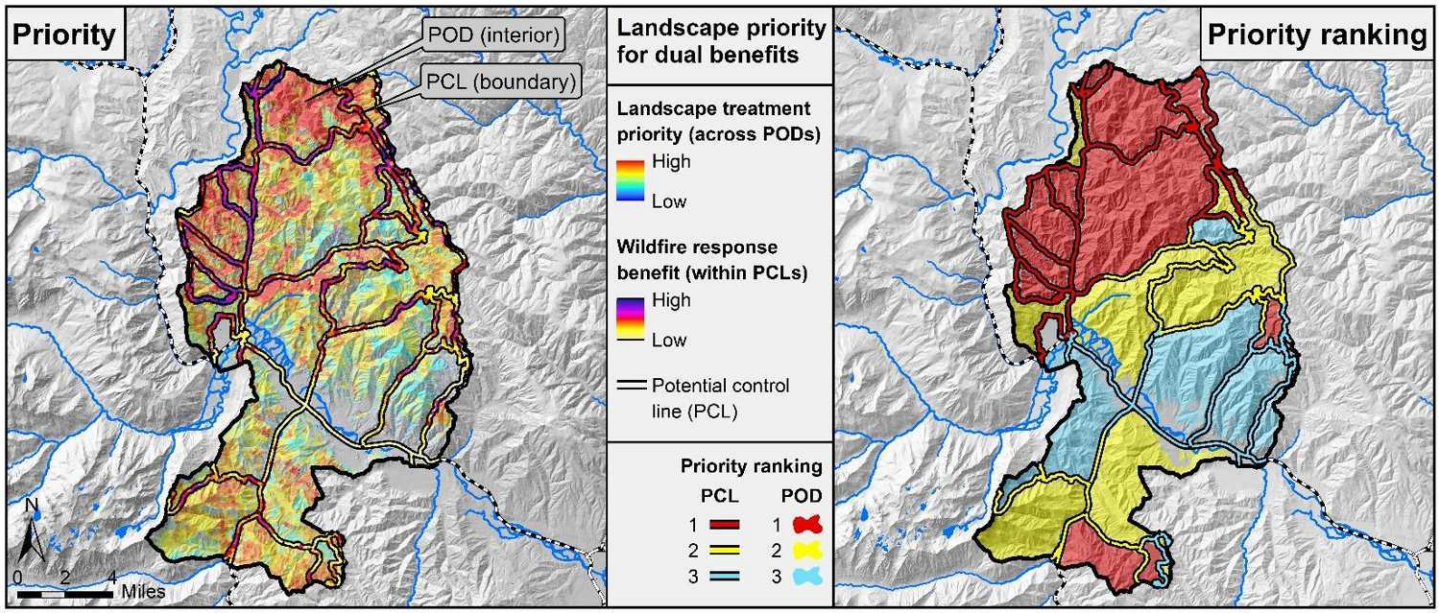
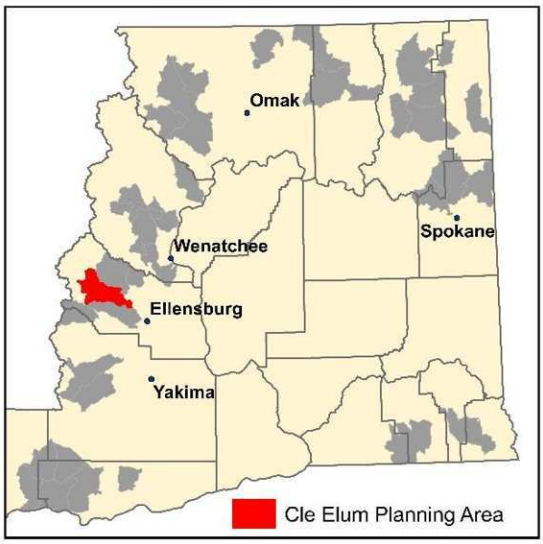
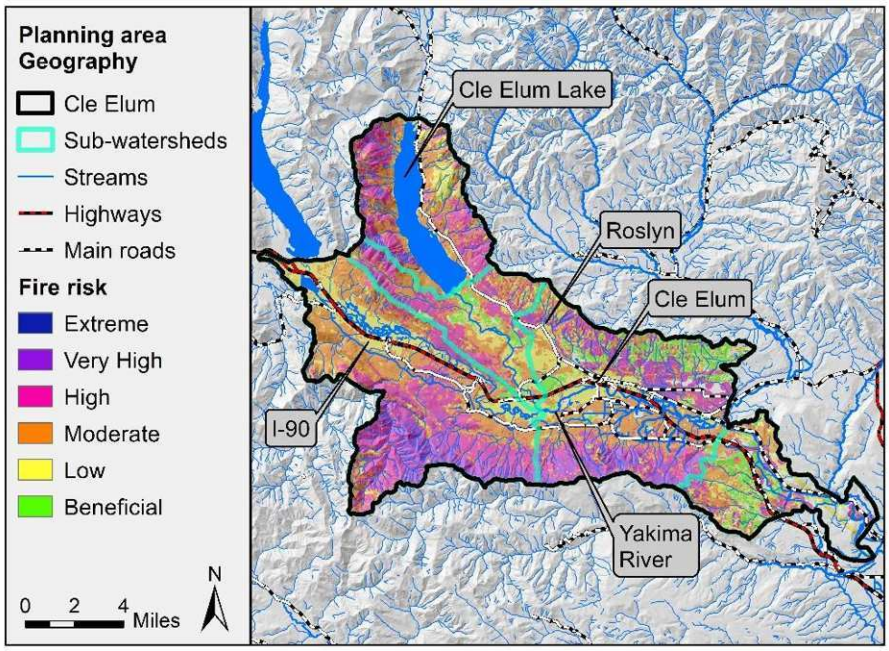


Figure 11. Landscape prioritization of dual benefits using PODs as a spatial framework to summarize treatment priorities. Both maps display landscape treatment priority within PODs and wildfire response benefit within PCLs. The map on the left shows the datasets at the raster level, while the map on the right shows the same information summarized and ranked within PODs and PCLs. PCL width is inflated to display spatial patterns. *PODs shown here are part of an ongoing process towards an all-lands delineation; POD boundaries are subject to change following on-the-ground vetting and continued dialogue among wildfire agencies and stakeholders.*

CLE ELUM PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
109,396	80,300	22,000 - 35,500





Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- A landscape evaluation for this planning area was completed in 2018. This update incorporates an additional sub-watershed (Middle Cle Elum) and identifies treatments that can achieve dual benefits of forest health and wildfire response.
- Ownership is 56% private, 24% US Forest Service, 13% The Nature Conservancy, 5% DNR, and 2% other. USFS management allocation is split between Matrix and Late Successional Reserve.
- 47% of the planning area is dry forest, 21% is moist forest, 6% is cold forest, 7% is shrub-steppe, 14% is developed area or agriculture, and 5% is other.
- This planning area combines high fire risk along the northern and southern ridges with extensive development in the valley and foothills. Burn probability is moderate to high.
- Treating 27-44% of forested acres is recommended to move the landscape into a resilient condition using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- High priority areas for potential treatments that maximize forest health and wildfire response benefit include south-facing slopes of Cle Elum Ridge, north-facing slopes along the southern edge, and locations adjacent to Cle Elum, Roslyn, and nearby communities.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high to very high along most of Cle Elum Ridge (northern boundary) and the ridge to the south that encompass the valley, as well as around most of Cle Elum Lake (Fig. 2). High risk is due to high fuel loading and associated high fire intensity combined with high to moderate burn probability. Landscape treatments are needed to break up the large patches of dense forest to reduce the likelihood of large crown fire that could affect homes on the edges of the valley, as well around Roslyn. In addition, implementing fuel reduction treatments around homes and establishing potential control lines will increase firefighter safety and help protect communities, which is covered in the last two pages of this summary. Some areas in the eastern portion are predicted to burn with low-intensity fires, which will have beneficial effects on surface fuels. In the central part of the valley, fire risk is low on agricultural lands and floodplain forests along the Yakima River.

Increase resilience and prepare for climate change

By mid-century, the eastern half of Cle Elum Ridge is projected to have moisture stress levels currently associated with woodland and shrub-steppe (Fig. 2). Moisture stress levels for much of the moist forest are predicted to shift to levels currently associated with dry forest. Treatments that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is abundant in the planning area, although it is concentrated in large patches along Cle Elum Ridge. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) exceeds or is at the upper end of desired ranges, except for Morrison Canyon where it is low. In high fire risk locations, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability, help maintain habitat in the most sustainable locations (Fig. 7), and broaden the spatial distribution of open canopy habitat. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is also above desired ranges and is at risk from high severity fire.

Enhance rural economic development

Reducing fire risk will help maintain recreational opportunities, tourism, and associated economic activity. Commercial treatments are possible on many of the recommended acres. However, the small size of many parcels, the high number of vacation homes, and limited road access and steep terrain on USFS land make commercial treatments difficult in many areas. Non-commercial treatments will require major investments and will provide a major source of work for local contractors. Warming trends will make it increasingly difficult to sustain long term timber production in the eastern portion.

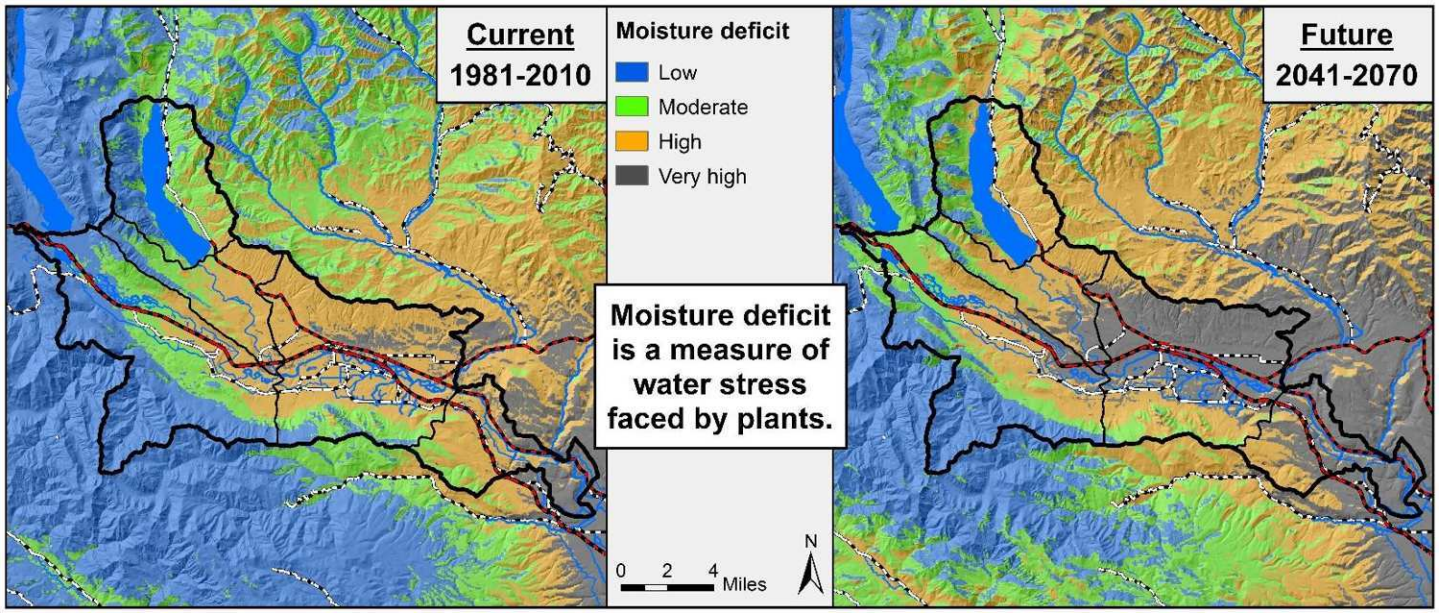


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

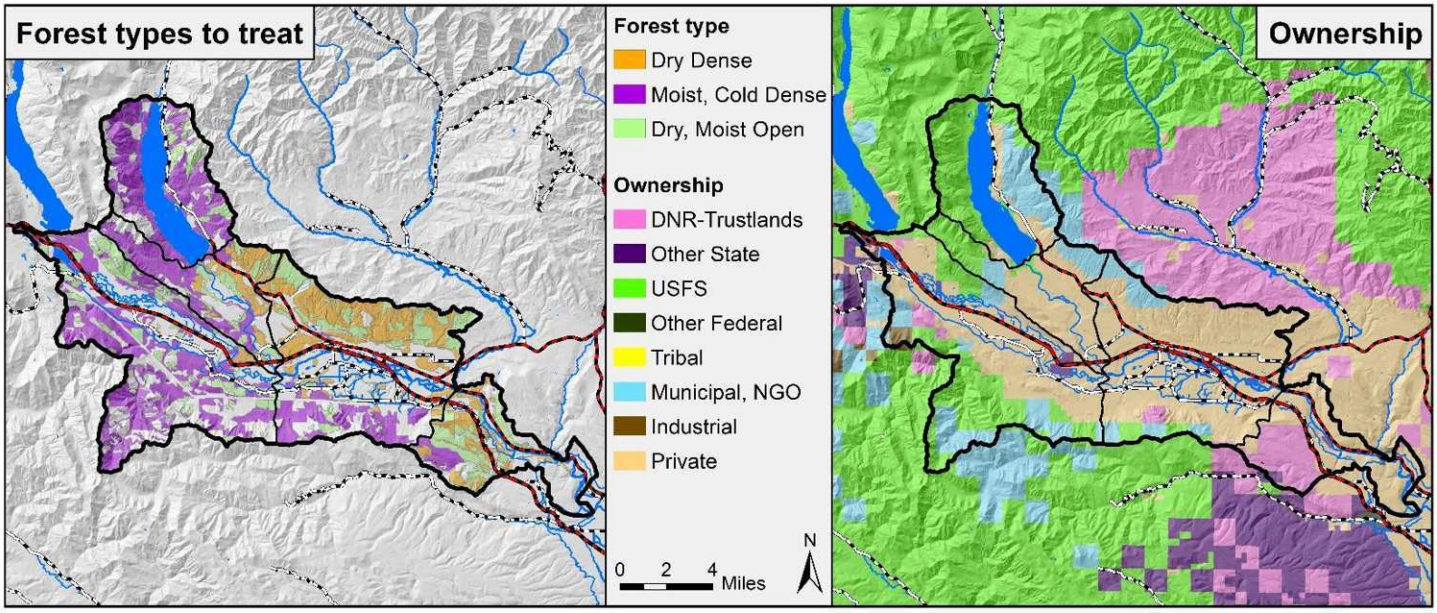
Forest Health Treatment Needs

Treating 22,000 to 35,500 acres is recommended to move the landscape into a resilient condition (27-44% of forested acres; Table 1). This total includes an estimated 17,000-26,500 acres to shift dense to open forest and an estimated 5,000-9,000 acres of maintenance treatments in existing open forest, based on current condition data from 2017 aerial photos. Treatment need in dry forest is primarily on private land and the TNC Central Cascades Forest, while need on moist and cold is distributed among all major landowners.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in the Thorpe Mountain Roadless Area west of Cle Elum Lake. Many areas are commercially viable based on tree size, but treatment type will depend on access, logging systems, markets, and other factors. Individual landowners will conduct their own planning processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**Private**	**USFS**	**TNC**	**DNR Trust**	**Other**
Dry Dense	Small	500 - 1,000	1,363	5	171	239	129
	Medium-Large	8,500 - 10,500	10,681	220	1,500	830	228
Moist Dense	Small	1,000 - 1,500	2,418	1,804	3,914	815	64
	Medium-Large	7,000 - 13,500	11,158	13,427	4,130	1,275	781
Dry + Moist Open	Medium-Large	5,000 - 9,000	8,621	1,457	2,789	2,156	183
Total		**22,000 - 35,500**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites in the eastern 2/3^{rds} of the planning area. The large, contiguous patches of this forest type create high susceptibility to defoliating insects and crown fire. Treating 9,000-11,500 acres of dense, dry forest acres is recommended to flip the dry portion of the landscape from being dominated by dense conditions to open forest (Table 1, Fig. 6). As the retained trees grow over time, much of the dry forest will shift to large tree, open forest, which is currently low. Shifting composition toward ponderosa pine and reducing grand fir and Douglas-fir is also recommended.

Moist and cold dense forest treatment need

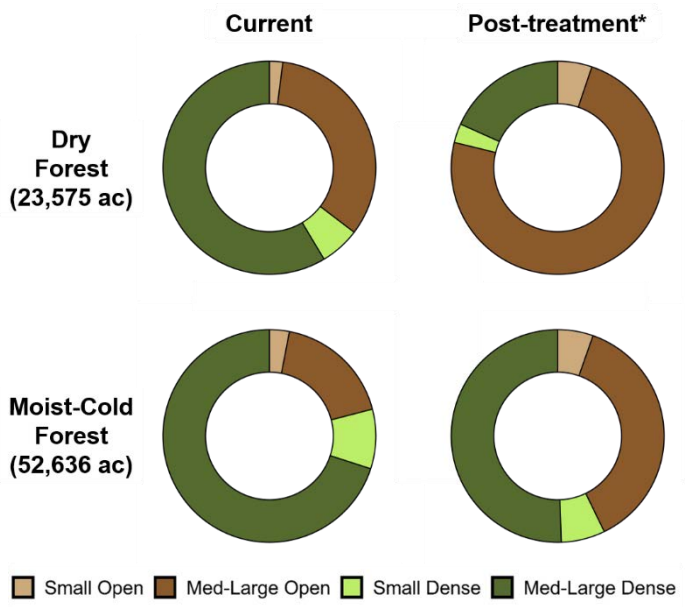
Dense, multistory forest on moist and cold sites exceeds desired ranges across the western half of the planning area. In contrast, open canopy forest with medium to large trees, as well as open forest with small trees and shrubs, are at the low end of desired ranges. Treating 8,000-15,000 acres of dense, moist and cold forest is recommended to convert whole patches of dense, multistory forest to open conditions while avoiding reducing overall patch size of both open and dense forest. Shifting species composition toward ponderosa pine and wester larch is also. Density reduction and shifting composition will reduce risk of a large crown fire and help current moist forests adapt to a warming climate. Following treatment, over half of the total moist and cold forest area would remain dense Fig. 6) to meet habitat, carbon storage, wood production, and other objectives.

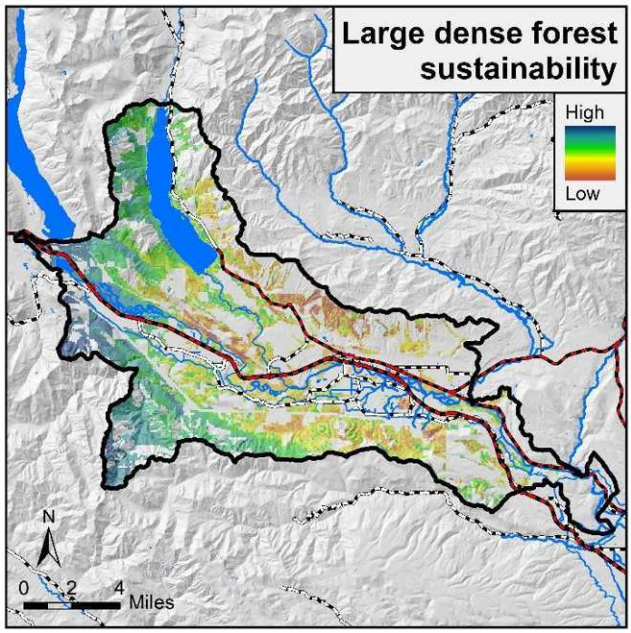
Open forest maintenance treatment need

Over the next 15 years, an estimated 5,000-9,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments, as well as parts of the 2017 Jolly Mountain Fire where additional fuel reduction may be needed. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with moderate current and future moisture deficits (Fig. 3) and moderate fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Sustainable locations include the western end of the planning area, as well as north-facing along the southern edge (Fig. 7). The large tree, dense forest sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is high across almost all of this planning area (Fig. 8), indicating that wildfire ignitions are expected to expose homes in communities along the Yakima River corridor (Fig. 2).

Treatment priorities

Landscape treatment priority is highest on the south-facing slopes of Cle Elum ridge and south of Cle Elum Lake on private and TNC land, as well as the Roslyn Urban Forest (Fig. 9). Most of the north-facing slopes along the southern edge of the planning area are also high and medium priority. This area is a combination of private, USFS, TNC, and DNR land. Some low priority areas may need treatment to address species composition, high risk to large trees, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes throughout the planning area.

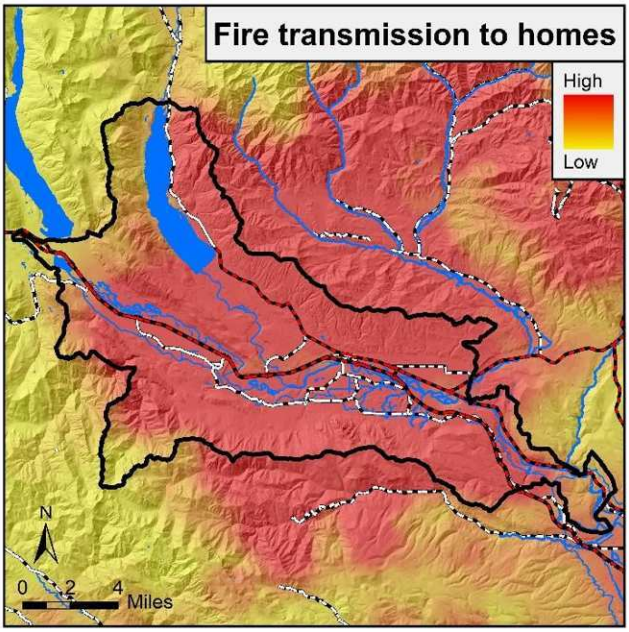


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

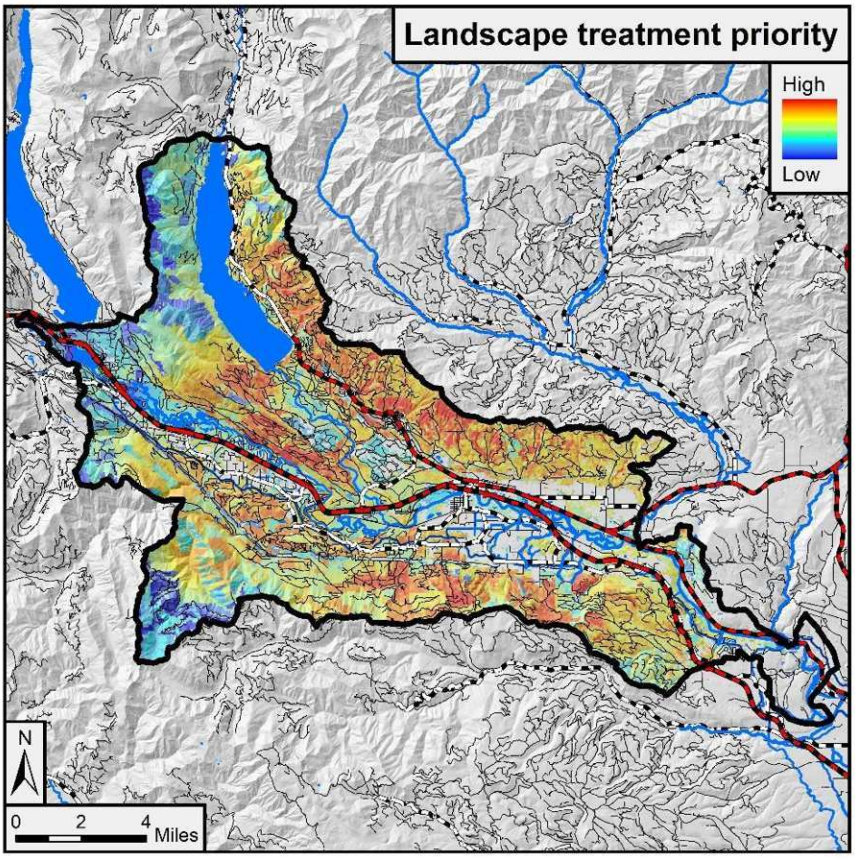


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – and wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires that are allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

Wildfire Response Benefit Prioritization

Dual benefits for forest health and wildfire response

It is necessary to conduct treatments to both improve forest health and reduce fire risk to communities as well as provide conditions where firefighters can safely and efficiently conduct fire operations (e.g. suppression, prescribed burning, and managed wildfire). The wildfire response benefit metric (WRB; Fig. 10) identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes, infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior. Because there are positive feedbacks between healthy, resilient forests and safe, effective fire operations, the WRB metric also integrates the landscape treatment priority map (Fig. 9).

Where WRB is highest, actions may be needed to create and maintain conditions that provide a tactical advantage for fire operations. These actions will vary with the local context and can include landscape-level forest health and fuel treatments, treatments along escape routes, resident and community fire mitigation activities (e.g. defensible space, home hardening), and improving signage and road conditions. The WRB metric provides a high-level prioritization, and additional work at the local level will be required to identify appropriate actions and assess their feasibility. WRB is useful for prioritizing Potential Control Lines (PCLs) for fire operations (Fig. 11). PCLs are a part of Potential Operational Delineations (PODs); see page 7.

In the Cle Elum planning area, wildfire response benefit is high to the north and south of Cle Elum and along the Yakima River corridor (Fig. 2) due to high fire risk to homes, infrastructure, and sources of surface drinking water. These areas coincide with areas of high landscape treatment need, presenting opportunities for dual benefits. Wildfire transmission to homes is also high throughout most of the planning area (Fig. 8).

Definitions (continued)

Wildfire response benefit: Any tactical advantage gained for wildfire response activities from actions on the landscape, including, but not restricted to, identifying and consolidating existing anchor points and control lines and reduction of potential fire behavior. Wildfire response benefit is not restricted to any specific wildfire management strategy and instead is centered on conditions that improve fire operations safety and effectiveness.

Potential Control Lines (PCLs): Boundaries of Potential Operational Delineations (PODs) relevant to fire control operations (e.g. roads, ridgetops, and water bodies).

Potential Operational Delineations (PODs) for wildland fire: Landscape containers whose boundaries are potential control lines (PCLs). PODs are useful for planning strategic response to unplanned ignitions, strategic fuel planning, and prioritizing fuel treatments within PODs.

Commercially managed lands: Commercially managed forestlands include: DNR Trustlands, tribal forests, industrial forests, non-industrial private forests, and US Forest Service forests where timber is a primary management objective.

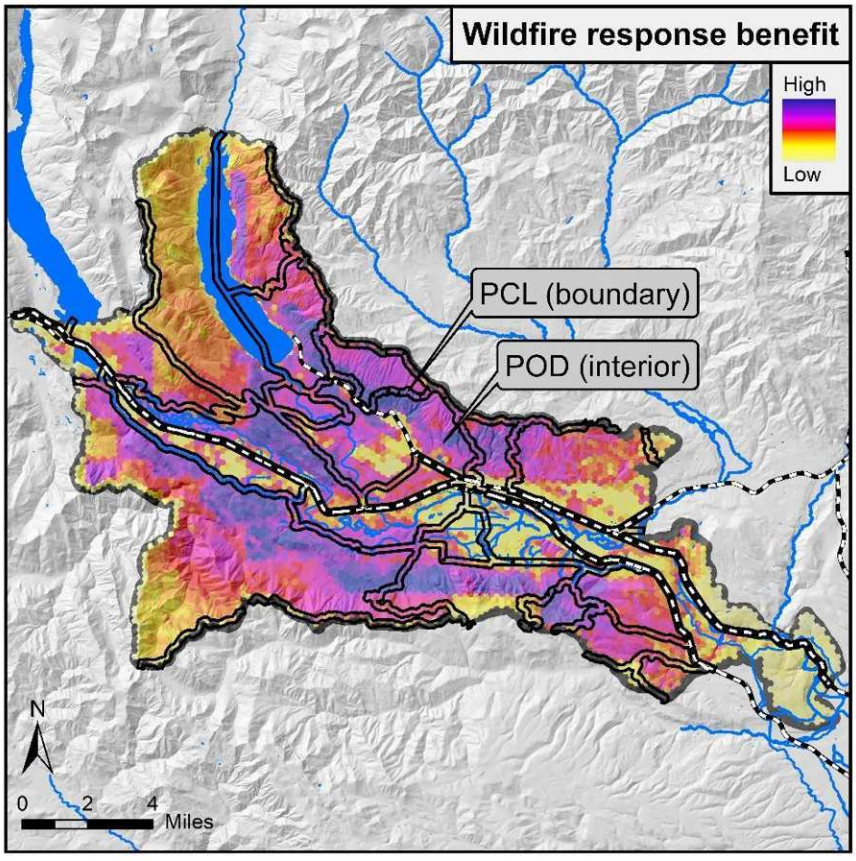


Figure 10. Wildfire response benefit (WRB) integrates multiple fire risk and forest health components. It includes four fire risk metrics representing highly valued resources – risk to homes, infrastructure, drinking water, commercially managed lands – as well as crown fire potential and wildfire transmission to homes (Fig. 8). Combined, these account for 75% of the wildfire response benefit. Landscape treatment priority (Fig. 9) accounts for the remaining 25%. Also shown are PODs: units bounded by PCLs (open black lines). One use of the WRB metric is to prioritize Potential Control Lines (PCLs) for fire operations (Fig. 11).

Prioritizing Landscape Treatments for Dual Benefits

Integration of forest health and wildfire response benefit using PODs

Potential Operational Delineations (PODs) provide a powerful spatial framework to communicate and identify locations that will deliver dual benefits for forest health and wildfire response at the landscape scale. PODs are large landscape areas delimited by Potential Control Lines (PCLs) for fire operations (suppression, prescribed fire, and managed wildfire) delineated by fire operations personnel. PCLs can be roads, ridgelines, or any artificial or natural fuelbreak that provides a strategic opportunity for fire operations. Summarizing landscape treatment priorities (Fig. 9) within PODs and wildfire response benefit priorities (Fig. 10) within PCLs enables planners and managers to identify, at a high level, locations where forest health or fuels treatments can be connected to a high-priority PCL that will support firefighter operations (e.g. ingress/egress route or opportunity for engagement).

Achieving forest health and wildfire response goals will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs.

There is important work to do in all Cle Elum PODs to achieve the forest health treatment targets in Table 1. First priority PODs follow the spatial patterns of forest health treatment needs and occur throughout the planning area. Several first priority PODs are also associated with first priority PCLS (e.g. around Cle Elum, Roslyn, and nearby communities; Fig. 2). Additional on-the-ground work is needed to determine which of these candidate areas provide operational opportunities for fuels treatments with dual benefits. Further work is also needed to assess PCLs locally for their condition and detailed treatment needs, which will depend on management goals and values at risk. Ideally, landscape treatments will be implemented adjacent to priority PCLs where feasible to maximize both forest health and wildfire response goals.

Achieving forest health and wildfire response dual benefits will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs. These two approaches combined will contribute to restoring and maintaining large portions of the landscape in a resilient condition while providing safe and effective areas for firefighter engagement during suppression, prescribed fire, or managed wildfire operations.

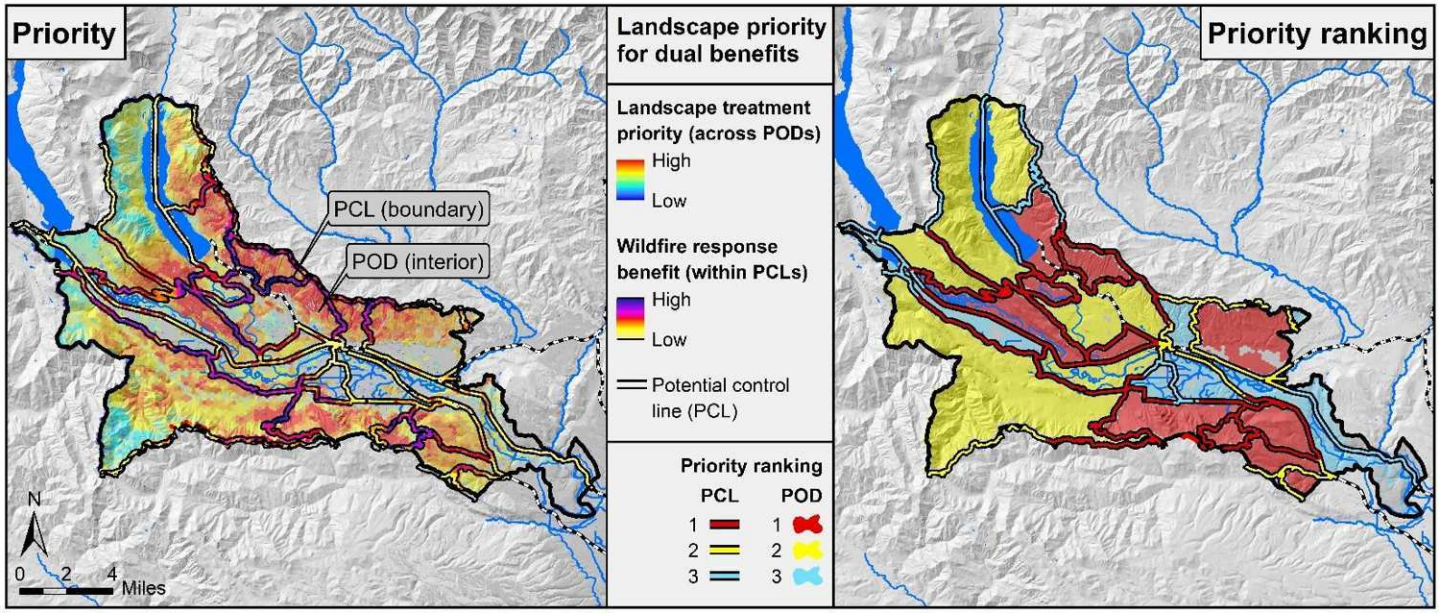
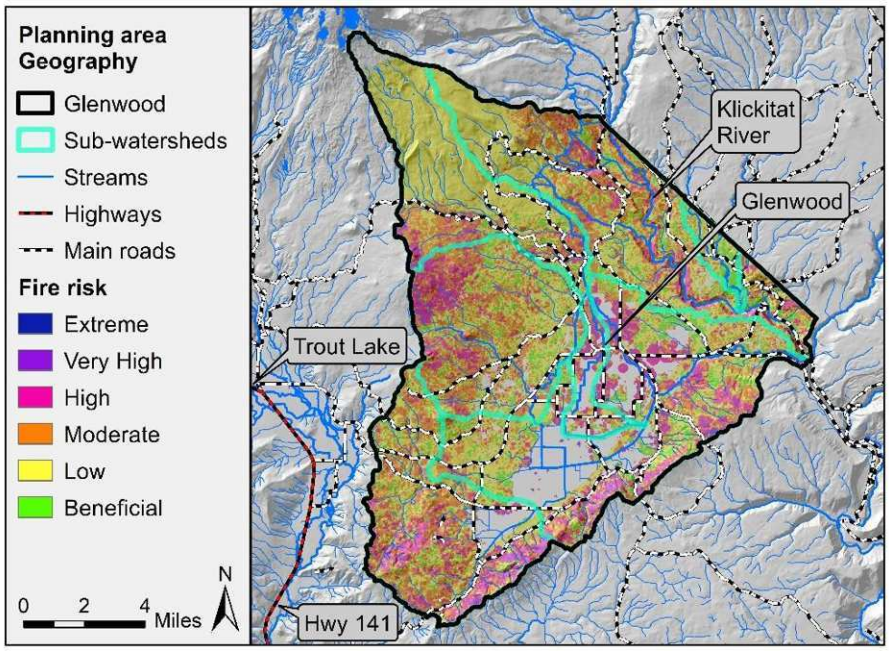


Figure 11. Landscape prioritization of dual benefits using PODs as a spatial framework to summarize treatment priorities. Both maps display landscape treatment priority within PODs and wildfire response benefit within PCLs. The map on the left shows the datasets at the raster level, while the map on the right shows the same information summarized and ranked within PODs and PCLs. PCL width is inflated to display spatial patterns. *PODs shown here are part of an ongoing process towards an all-lands delineation; POD boundaries are subject to change following on-the-ground vetting and continued dialogue among wildfire agencies and stakeholders.*

GLENWOOD PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
104,501	83,758	23,500 - 32,000



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- This planning area spans a steep elevation gradient from subalpine parkland on Mt. Adams to low elevation dry forest and shrub-steppe vegetation within the Klickitat River watershed.
- Ownership across the planning area is mixed, with 33% DNR-Trustlands, 33% industrial, and smaller amounts of private and other owners. Tribal land belonging to the Yakama Nation in the northwest portion represents 8% of the area.
- Fire risk is highest in western, southwestern, and southeastern portions of the planning area, as well as around Glenwood.
- Projected warming over the next 20-40 years will likely shift climate conditions currently suitable for moist and cold forest towards conditions suitable for dry forest throughout the planning area.
- Treating 28-38% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical treatments, prescribed fire, and maintenance treatments.
- Treatment priority is high in central and southern portions of the planning area based on fire risk, drought vulnerability, current forest structure, and fire transmission to communities.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high to very high in western, southwestern, and southeastern portions of the planning area due to high fuel loads and burn probability (Fig. 2). High risk areas in the southeastern portion include land surrounding the community of Glenwood. Fuels treatments are needed to break up large patches of dense forest to reduce the likelihood of large crown fire and to facilitate protection of private property in the center of the planning area. In some central portions and in the northwestern portion within the 2015 Cougar Creek Fire, fire risk is relatively low due to lower burn probability and reduced fuels.

Increase resilience and prepare for climate change

By mid-century, virtually all of the planning area is projected to have moisture stress levels that are currently associated with dry forest (Fig. 3). Moderate moisture stress levels are projected to remain at the highest elevations, on some north-facing slopes, and in valley bottoms. Forest health treatments that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Dry forests are extensive throughout the planning area but generally occur in large, closed-canopy patches. Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is under-represented. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is concentrated in western portions of the planning area, but it is overabundant compared. In high fire risk locations within this habitat type, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability, help maintain habitat in the most sustainable locations (Fig. 7), and broaden the spatial distribution of open canopy habitat. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is a minor component of the planning area, and much of it was burned in the 2015 Cougar Creek Fire. Habitat for western gray squirrel is an important consideration in this area.

Enhance rural economic development

Most of the higher priority areas for commercial treatments have road access and are capable of producing significant timber volume. Although warming trends and high fire risk will necessitate managing for lower densities and fuel loads, long-term timber production will likely be possible. Reducing fire risk will help sustain recreation and tourism while reducing the potential of smoke affecting nearby communities.

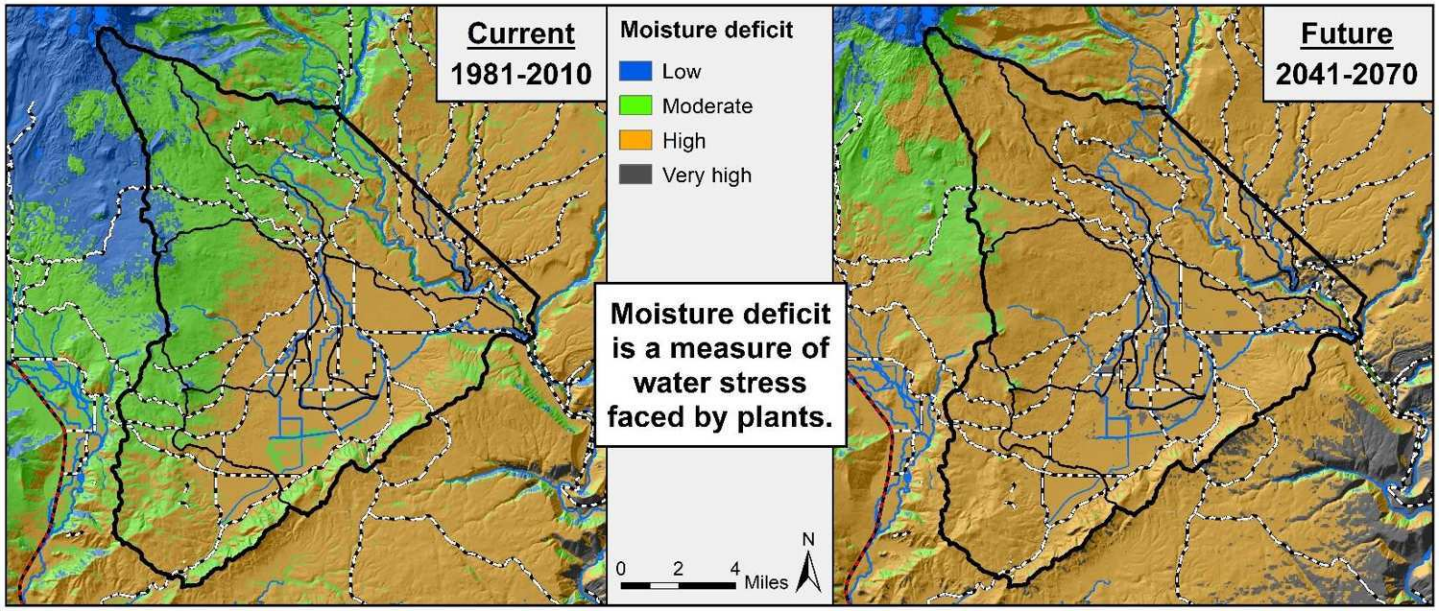


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

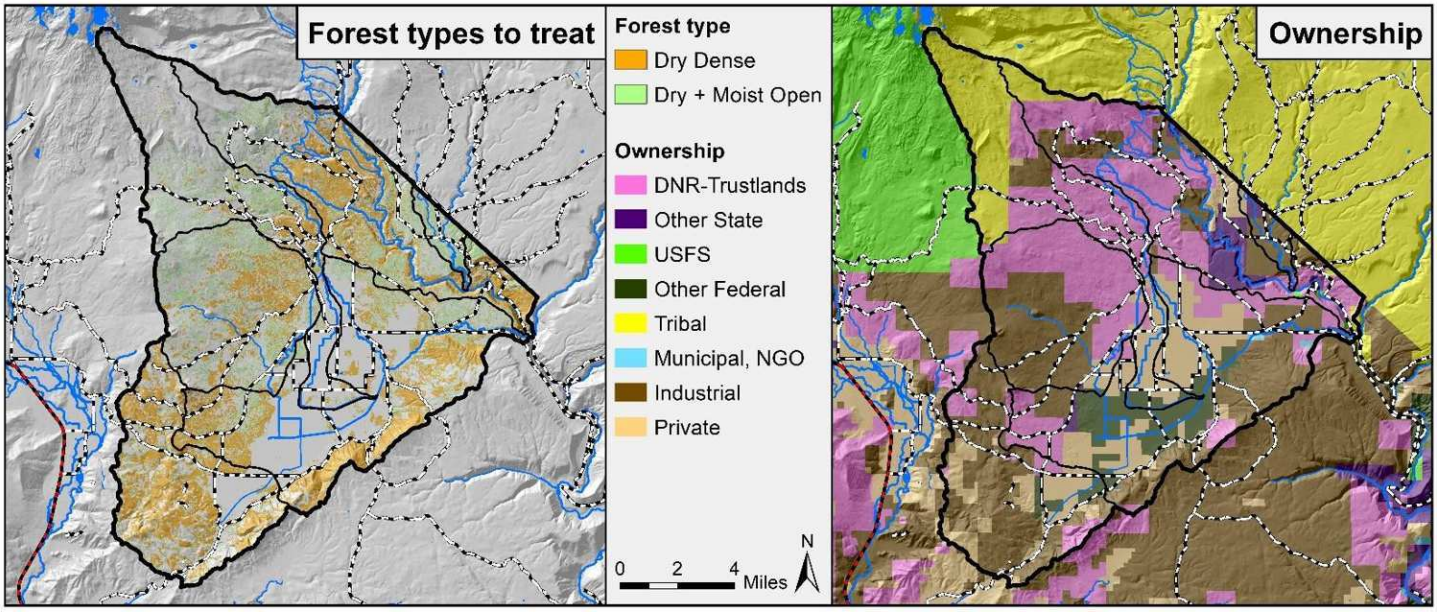
Forest Health Treatment Needs

Treating 23,500 to 32,000 acres is recommended to move the landscape into a resilient condition (28-38% of forested acres; Table 1). This total includes an estimated 17,750-23,000 acres to shift dense to open forest and 5,750-9,000 acres of maintenance treatments in existing open forest, based on current condition data from 2017 aerial photos. Most of the treatment need is located on DNR-Trustlands, industrial, and private land.

Meeting this target range will require multiple treatment strategies (Table 1). Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**DNR Trust**	**Industrial**	**Private**	**Tribal**	**Federal**
Dry Dense	Small	750 - 1,000	265	1,424	162	7	0
	Medium-Large	17,000 - 22,000	12,255	10,252	2,762	240	1,262
Dry + Moist Open	Medium-Large	5,750 - 9,000	5,724	4,706	1,111	589	310
Total		**23,500 - 32,000**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites, elevating crown fire risk. Treating 17,750-23,000 acres of this type (Table 1) is recommended to create large patches (~100-1000 ac) of open forest with a component of large trees (Fig. 4), flipping the majority of dry sites from closed to open forest (Fig. 6). Ponderosa pine and other drought-tolerant species will continue to be suitable as climate conditions get warmer and drier.

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or up to 10% cover of conifers.

Forest structure

Large tree: Overstory diameter > 20 inches; **Medium tree:** Overstory diameter 10-20 inches; **Small tree:** Overstory diameter < 10 inches; **Dense canopy:** Greater than 40% tree canopy; **Open canopy:** Less than 40% tree canopy.

***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels Treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fire is allowed to burn under safe conditions to achieve management goals; can be suppressed if conditions change.

Moist and cold dense forest treatment need

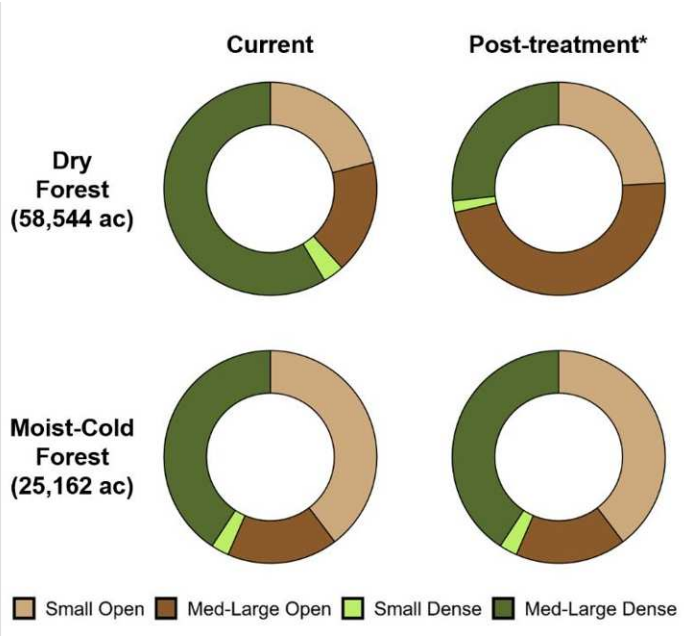
Moist and cold forest structure is within desired ranges and thus not included in Table 1. However, there may be other forest health reasons to treat these forests based on management objectives and field evaluations.

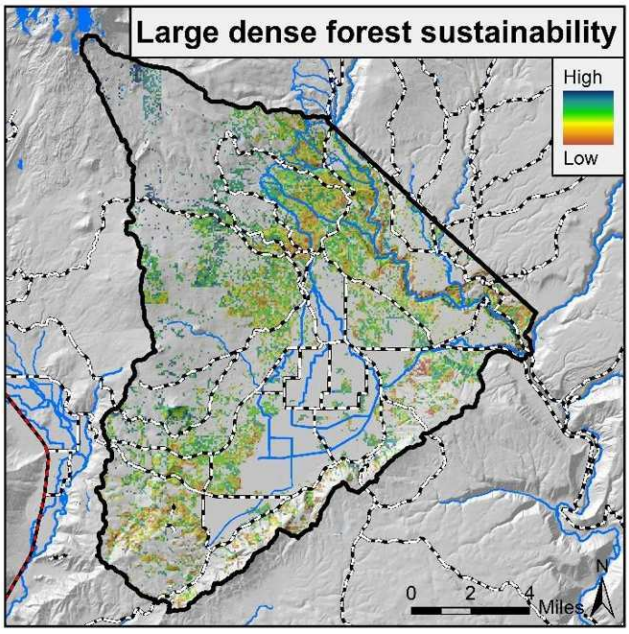
Open forest maintenance treatment need

Over the next 15 years, an estimated 5,750-9,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments, as well as parts of the Cougar Creek Fire where additional fuel reduction is needed. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Current and potential future sustainable locations include northern, northwestern, and southwestern portions of the planning area (Fig. 7). The large tree, dense forest sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is relatively low across most of the planning area, but elevated transmission in the central portion indicates that wildfires starting in these locations are expected to expose homes in and around the community of Glenwood (Fig. 2).

Treatment priorities

Landscape treatment priority is highest in central and southern portions on DNR-Trustlands and industrial land. The southeastern edge is also high priority. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues, such as the areas affected by wildfires in the northwest portion (2008 Cold Springs, 2015 Cougar Creek). In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes and communities.

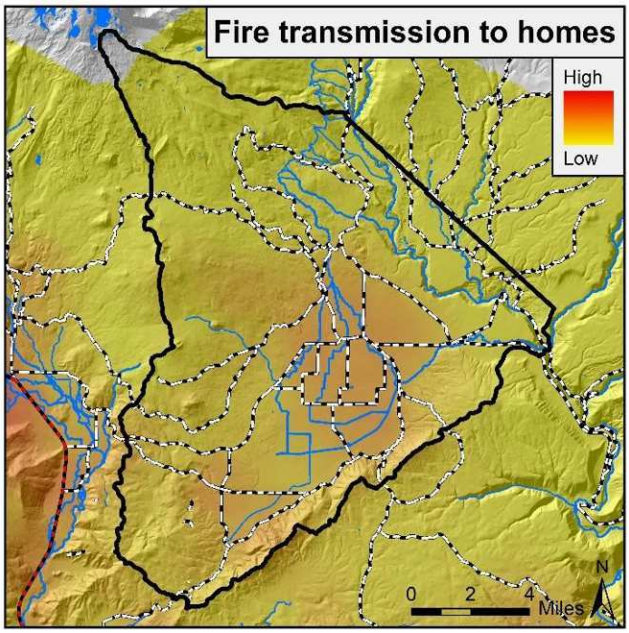


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

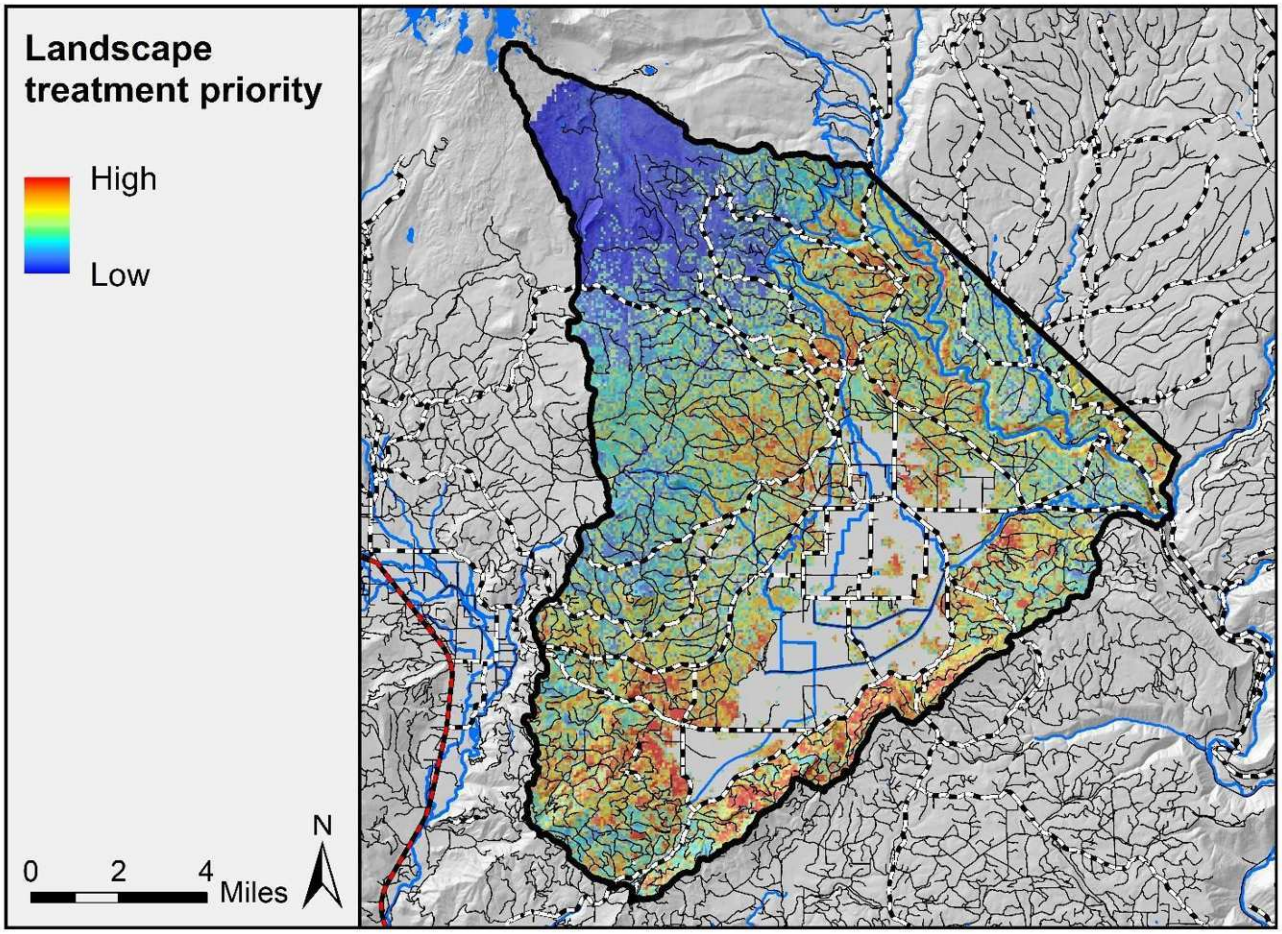
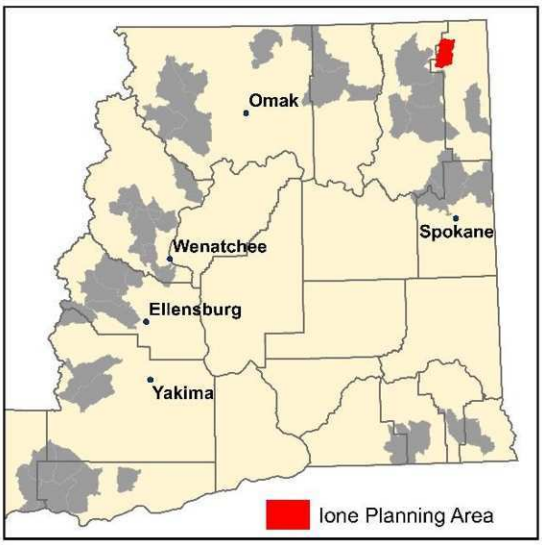
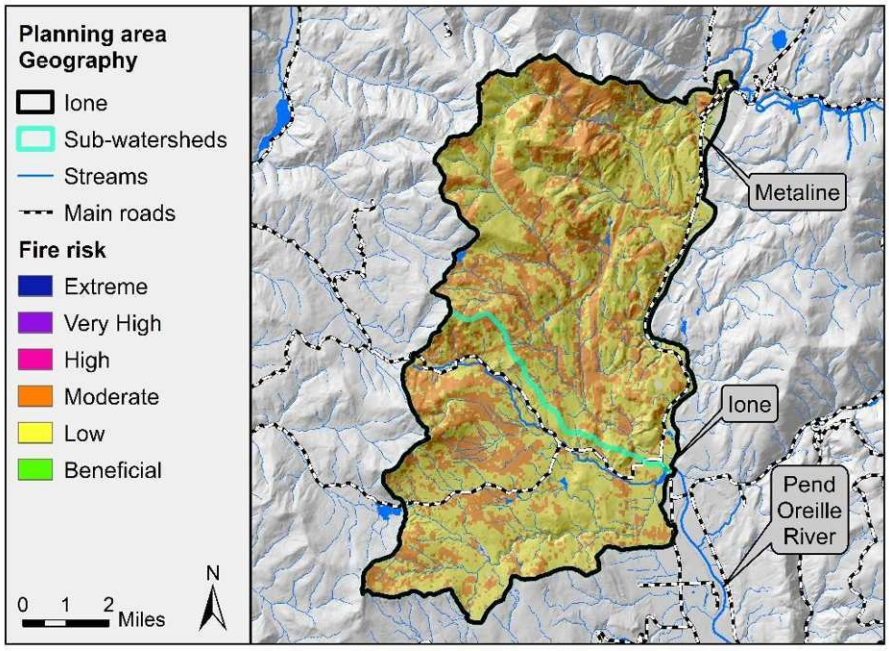


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

IONE PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
44,248	41,784	16,500 - 21,000





Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- Ownership is split between the Colville National Forest (65%), private (15%), industrial forestland (10%), and DNR (8%).
- The planning areas is dominated by large, homogeneous patches of dense, medium-sized forest that make the landscape susceptible to large patches of high-severity fire.
- Projected warming over the next 20-40 years will likely shift climate conditions suitable for moist and cold forest towards conditions suitable for dry forest. Moderate and low moisture stress levels are projected to remain on 40% of the area.
- Treating 39-50% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- The Colville National Forest is currently planning a large forest restoration project in the planning area that will accomplish much of the treatment need on USFS land south of the Abercrombie-Hooknose roadless area in the northwest.
- Managed wildfire can be utilized under the right fire weather and fuel moisture conditions to create a mosaic of open, moderate, and dense forest in roadless and other inaccessible areas. It can also maintain areas over time once the initial treatments have been completed.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Although fuel loads are moderate to high, fire risk to forests and homes is low to moderate across the planning area (Fig. 2) due to low burn probability, which is based on patterns of large fires from 1992-2015. If a fire does occur, however, predicted fire intensity is moderate to high, especially across the large patches of dense forest (Fig. 4). Without treatments, fire risk is predicted to increase in the future as burn probability increases with projected climate warming. Landscape treatments will help reduce the risk of large, high-severity fire and restore conditions conducive to a more characteristic balance of low- and mixed-severity fire, with some high-severity patches. Over time, a restored landscape will provide managers more flexibility to utilize managed wildfire to maintain these fire-dependent ecosystems and thus harness the predicted increase in burn probability. In addition, implementing fuel reduction treatments around homes and establishing potential control line will increase firefighter safety and help protect communities.

Increase resilience and prepare for climate change

By mid-century, the majority of the planning area is projected to transition to moisture stress levels that are currently associated with dry forest (Fig. 3). Moderate and low moisture stress levels are projected to remain on most of the western half of the planning area. Mechanical and fire-based treatments that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

The amount of habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is very low in the planning area, even after accounting for the relatively low proportion of dry forest (33%) vs. cold and moist forest (67%). Thinning and/or fire-based treatments on south-facing slopes to create moderate to large patches (30-500+ acres) of open forest dominated by ponderosa pine will expand this habitat type over time. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Goshawk) is well distributed throughout the planning area, and patch sizes are moderate to large (mostly 50-500 acres). Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is moderately represented, with moderate patch sizes.

Enhance rural economic development

Most of the higher priority areas for commercial treatments have road access and will produce significant timber volume. Meeting restoration treatment needs will provide a large amount of forest products and related economic activity. Although warming trends will necessitate managing for more drought-tolerant species and lower densities and fuel loads on current and future dry sites, forest productivity should remain moderate to high and may even increase at mid to upper elevations. Reducing fire risk will help sustain recreation and tourism while reducing the potential of smoke affecting communities.

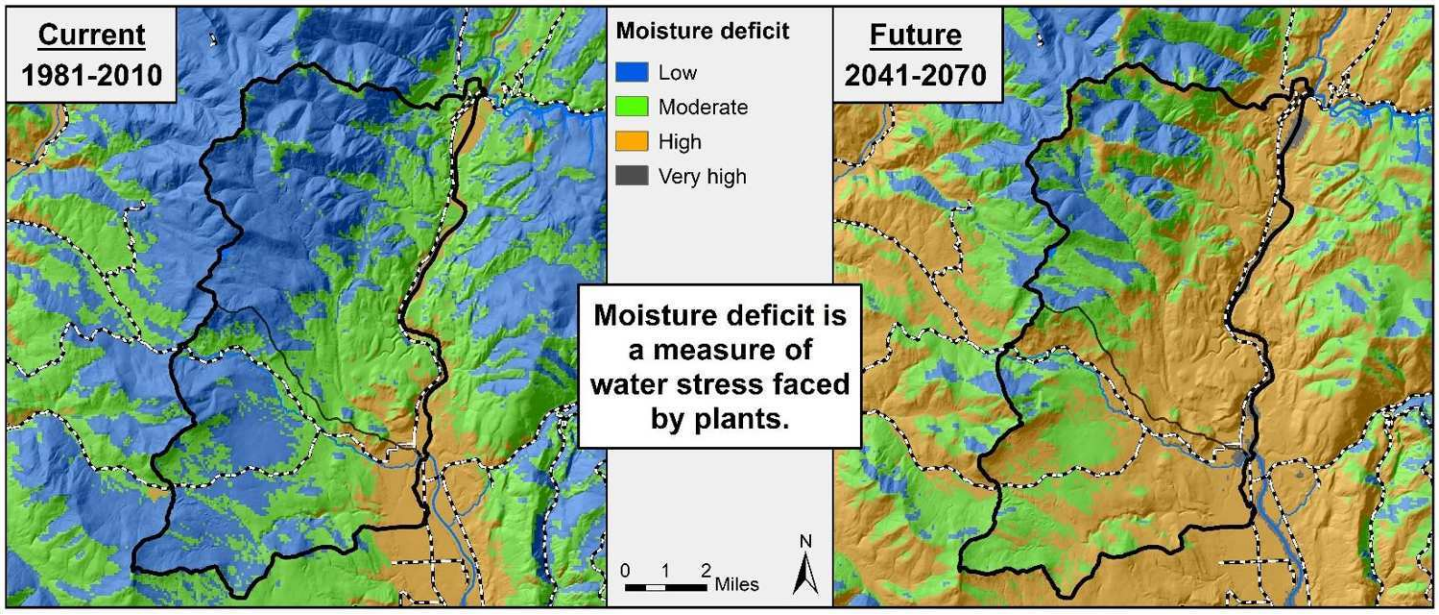


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

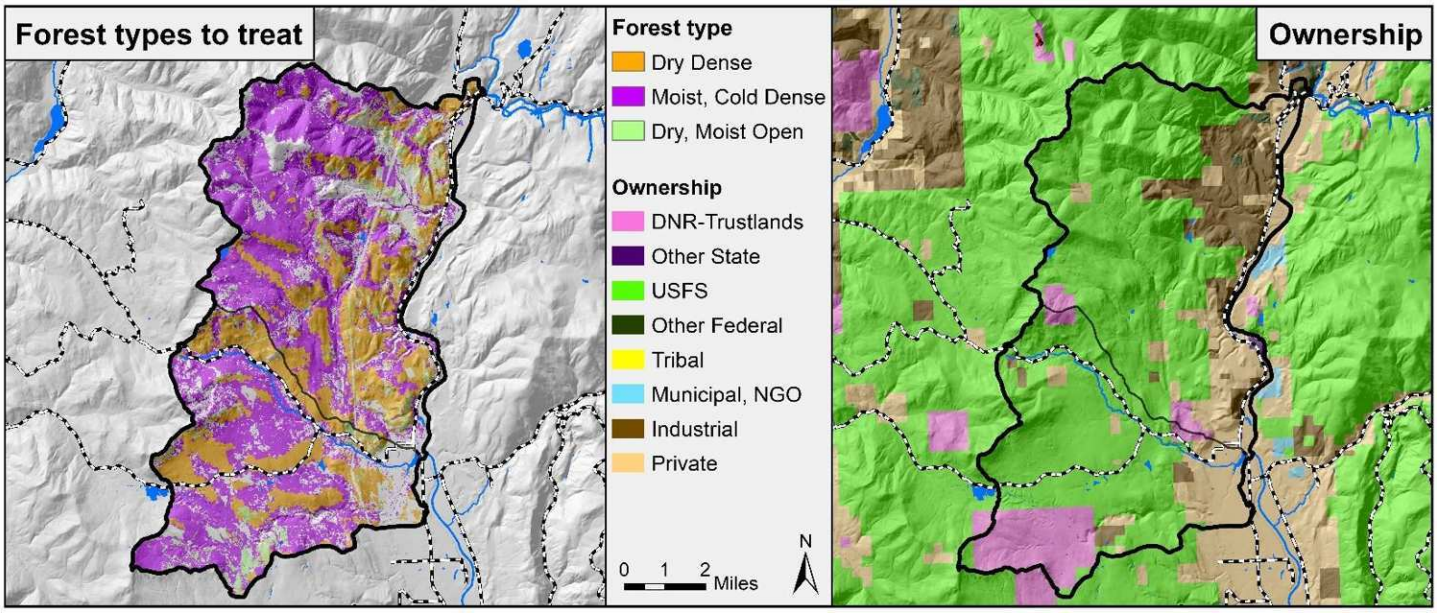
Forest Health Treatment Needs

Treating 16,500 to 21,000 acres is recommended to move the landscape into a resilient condition (39-50% of forested acres; Table 1). This total includes an estimated 15,750-19,500 acres to shift dense to open forest and 750-1,500 acres of maintenance treatments in existing open forest, based on current condition data from 2015 LiDAR imagery. The Colville National Forest is currently planning a large restoration project that will accomplish much of the treatment need on USFS land. Need also exists on private, non-industrial land and DNR land.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in the Abercrombie-Hooknose roadless area (northwestern portion). Most treatments are commercially viable based on tree size. Treatment type will depend, however, on road access, logging systems, markets, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*			
Type	**Size class**		**USFS**	**Private**	**Industrial**	**DNR**
Dry Dense	Small	250 - 500	408	98	229	24
	Large	7,500 - 9,000	7,539	1,704	837	379
Moist + Cold Dense	Medium	8,000 - 10,000	14,808	1,423	1,110	1,996
Dry + Moist Open	Large	750 - 1,500	544	303	658	693
Total		**16,500 - 21,000**	**These are current acres, not targets*			
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).				
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.				
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*				



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense forest structure of all size classes is over-represented on dry sites. Patch sizes are large and aggregated. Much of the dry forest is also dominated by Douglas-fir. These forests are vulnerable to uncharacteristic levels of high- and mixed-severity fire, as well as a combination of drought stress, root disease, and Douglas-fir beetle. Treating 7,750-9,500 acres of dry dense forest (Table 1) is recommended to create large patches (~100-1000 ac) of open forest and shift the majority of dry sites to open forest (Fig. 6). As the retained trees grow over time, much of the dry forest will shift to large tree, open forest, which is currently only at 1% of the dry forest area. Shifting composition toward ponderosa pine and western larch is also needed.

Moist and cold dense forest treatment need

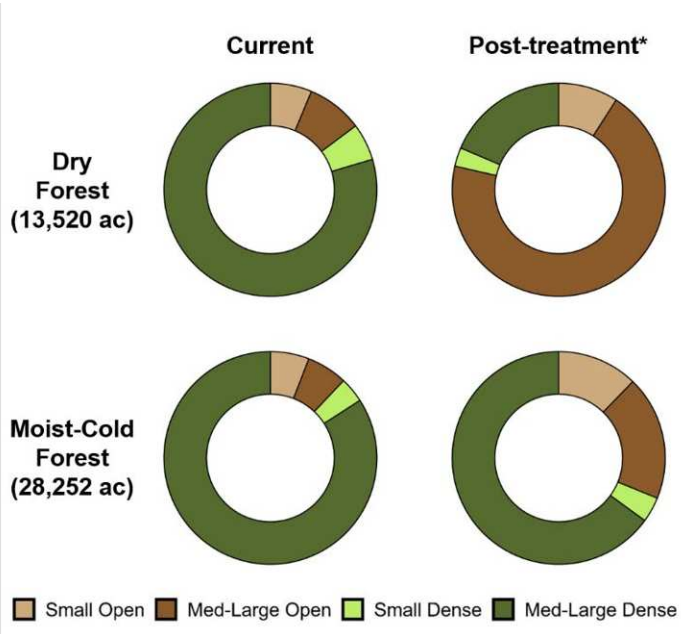
Dense, medium tree forest on moist and cold sites exceeds desired ranges across the planning area. Very large patches (1000s of acres) of this type dominate the planning area and result in high vulnerability to large, high-severity fire. Both open and dense large tree structure is below desired ranges, as is small, open forest. Treating 8,000-10,000 acres of this type (Table 1, Fig. 4) is recommended to create a mosaic of open, moderate, and dense patches. A range of treatment types will be needed, including moderate to heavy thinning, regeneration treatments, and prescribed fire. Managed wildfire can be utilized under the right fire weather and fuel moisture conditions to thin and break up dense forest in roadless and other inaccessible areas. Increasing the relative composition of western larch and ponderosa pine while decreasing grand fir and other fire- and drought-intolerant species is also needed, especially on sites projected to shift to dry forest (Fig. 3). Post treatment, over 60% of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

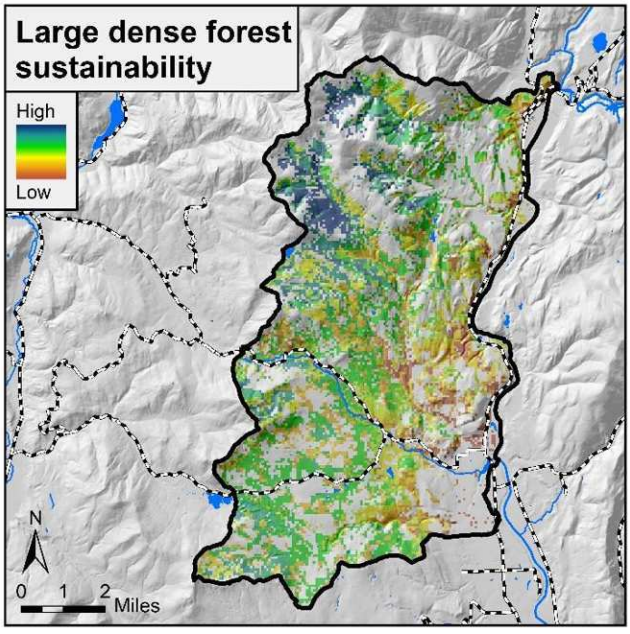
Open forest maintenance treatment need

Over the next 15 years, an estimated 750-1,500 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this habitat type and associated ecosystem functions. More sustainable locations include most of the western half of the planning area (Fig. 7), excluding south-facing slopes at low to mid elevations. Less sustainable locations represent opportunities to create open forest habitat that is in shortly supply.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). We also recommend incorporating the large dense forest sustainability layer (Fig. 7) as an overlay when selecting treatment locations. Transmission potential is low in this planning area compared to areas with higher fire probability. However, treatments close to the communities of Ione and Metaline (Fig. 2) will assist firefighters in protecting structures in the event of a fire.

Treatment priorities

Landscape treatment priority is highest on south-facing slopes in the northern half of the planning area and in central and southern portions. Moderate treatment priority is widespread due to the relatively flat topography and the large, homogenous patches of dense forest. The majority of the moderate and high priority areas are on USFS land but include private, nonindustrial and DNR land. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels across the planning area.

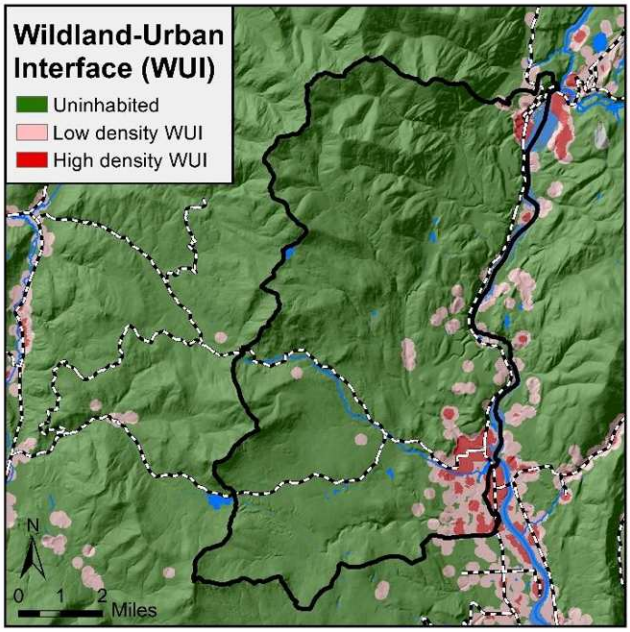


Figure 8. Wildland-Urban Interface (WUI) based on locations of private property with structures.

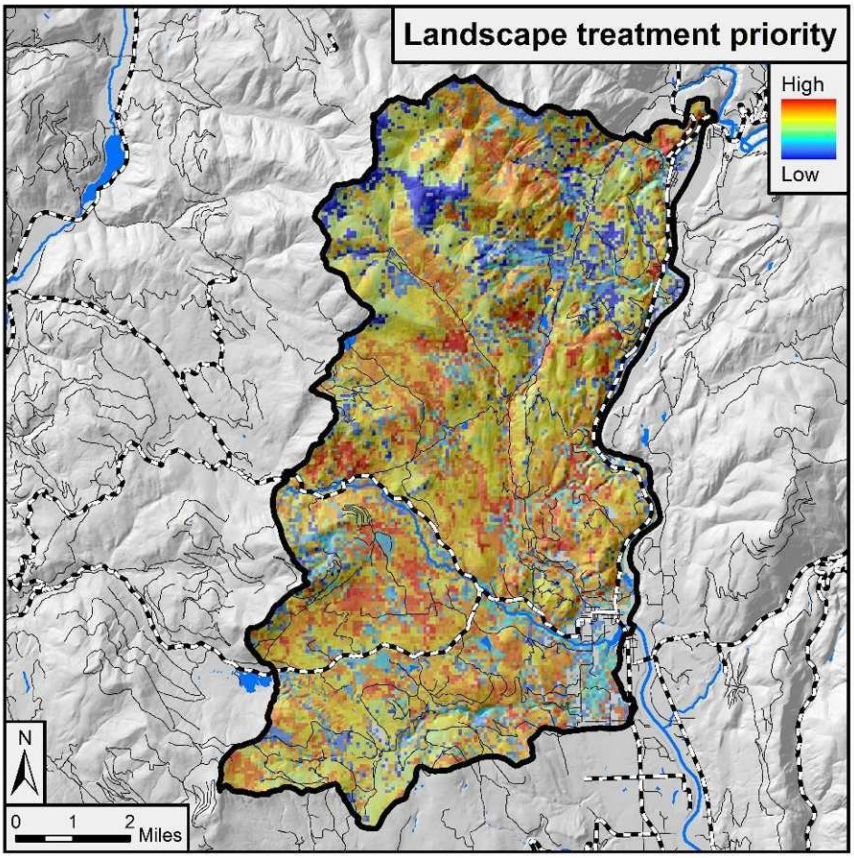


Figure 9. Landscape treatment priority is based on a combination of forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4), and fire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.
Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.
Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.
Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.
Medium tree: Overstory diameter 10-20 inches.
Small tree: Overstory diameter < 10 inches.
Dense canopy: Greater than 40% tree canopy.
Open canopy: Less than 40% tree canopy.

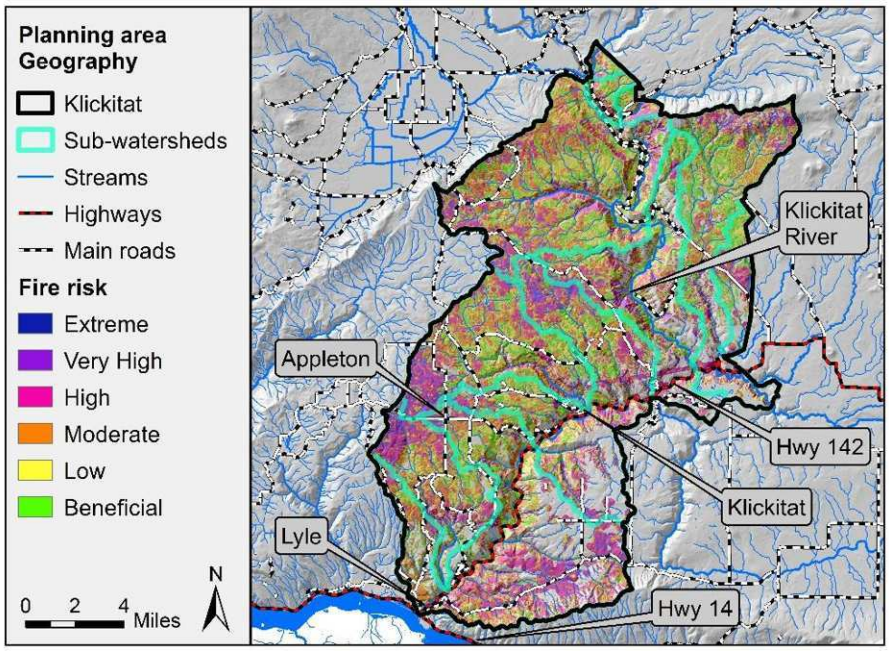
Fuels: Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fire is allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

KLICKITAT PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
149,649	103,274	43,000 - 55,000



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- This planning area is primarily dry forest land surrounding the lower Klickitat River. Non-forest vegetation is an important component of areas east and south of the Klickitat River.
- Land ownership is 40% industrial forestlands, 35% private, 20% state, and 5% other land, including a small portion of Tribal land belonging to the Yakama Nation.
- Fire risk is highest in the central, western, and southern portions of the planning area (Fig. 2).
- Projected warming over the next 20-40 years will likely shift climate conditions currently suitable for dry forest towards widespread conditions that may no longer support forest.
- Treating 42-53% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical treatments, prescribed fire, and maintenance treatments.
- Treatment priority is highest in western and southern portions of the planning area based on fire risk, drought vulnerability, current forest structure, and fire transmission to communities.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high to very high in the central, western, and southern portions of the planning area due to high fuel loads and burn probability (Fig. 2). High risk areas in the central portion include land near the community of Klickitat. Fuels treatments are needed to break up large patches of dense forest to reduce the likelihood of large crown fire and to facilitate protection of private property throughout the planning area. In some central and north-eastern portions, fire risk is relatively low due to lower burn probability and reduced fuels.

Increase resilience and prepare for climate change

This landscape has some of the highest current and projected future moisture stress among all DNR priority planning areas in eastern WA. By mid-century, virtually all of the planning area is projected to have moisture stress levels that are currently associated either with dry forest or with woodland/shrub-steppe (Fig. 3). Although non-forest vegetation currently covers some areas east and south of the Klickitat River, substantial portions of the planning area are projected to shift to non-forest over time. Moderate moisture stress levels are projected to remain on north-facing slopes and in valley bottoms. Forest health treatments that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Dry forests are extensive throughout the planning area but are concentrated in large, closed-canopy patches. Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is under-represented relative to reference conditions. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is a relatively small component of this planning area. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is a minor component of the planning area. Habitat for western gray squirrel is an important consideration in this area.

Enhance rural economic development

Most of the higher priority areas for commercial treatments have road access and are capable of producing significant timber volume. Projected warming trends and high fire risk will necessitate managing for lower densities and fuel loads. As moisture stress increases and forest cover declines over time, long-term commercial timber production will likely become increasingly challenging. Reducing fire risk will help sustain recreation and tourism while reducing the potential of smoke affecting nearby communities.

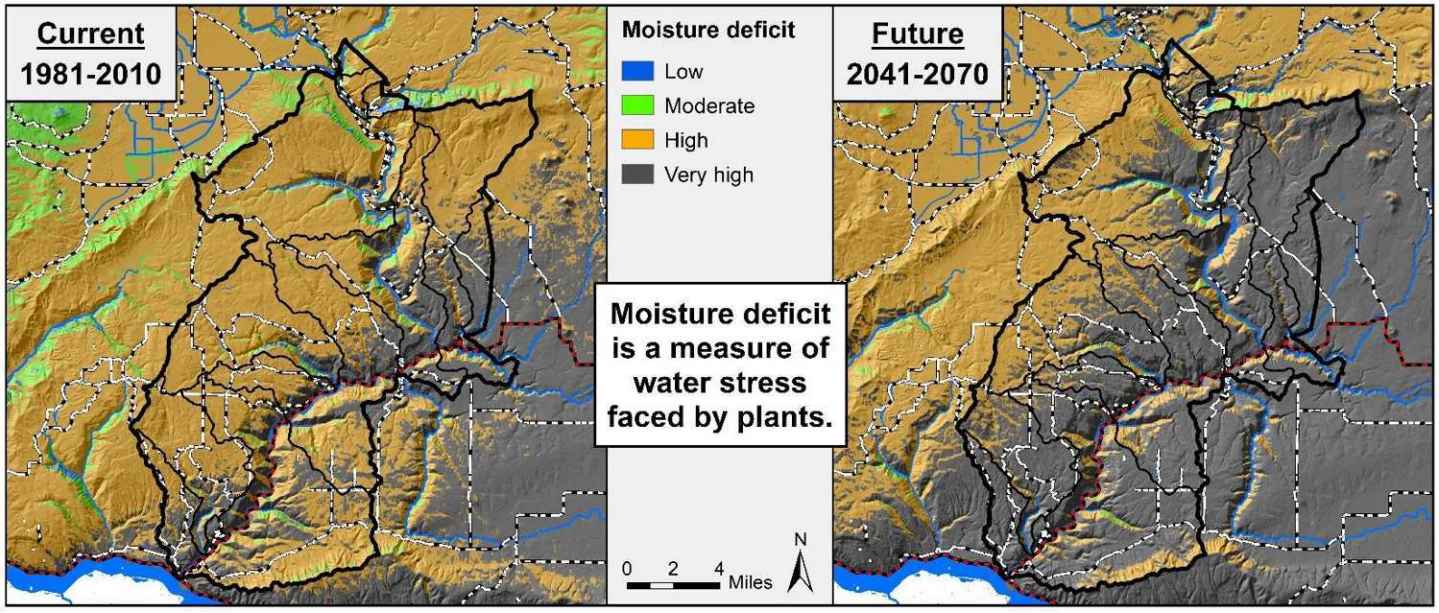


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

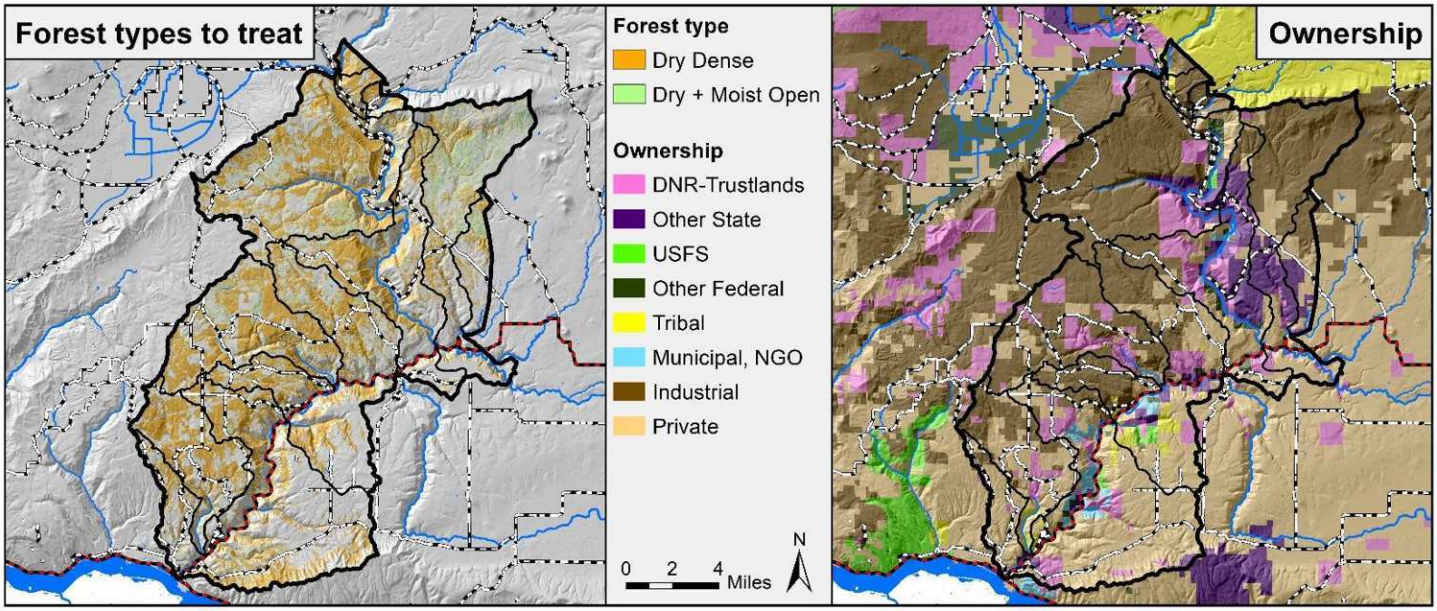
Forest Health Treatment Needs

Treating 43,000 to 55,000 acres is recommended to move the landscape into a resilient condition (42-53% of forested acres; Table 1). This total includes an estimated 38,000-48,000 acres to shift dense to open forest and 5,000-7,000 acres of maintenance treatments in existing open forest, based on current condition data from 2017 aerial photos. Most of the treatment need is located within DNR-Trustlands and industrial land.

Meeting this target range will require multiple treatment strategies (Table 1). Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**Industrial**	**Private**	**DNR Trust**	**DFW**	**Tribal**
Dry Dense	Small	4,000 - 6,500	3,125	3,537	1,196	917	216
	Medium-Large	34,000 - 41,500	23,596	13,097	7,622	3,816	932
Dry + Moist Open	Medium-Large	5,000 - 7,000	6,056	1,556	1,097	627	77
Total		**43,000 - 55,000**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites, elevating crown fire risk. Treating 38,000-48,000 acres of this type (Table 1) is recommended to create large patches (~100-1000 ac) of open forest with a component of large trees (Fig. 4), flipping the majority of dry sites from closed to open forest (Fig. 6). Ponderosa pine, oak, and other drought-tolerant species will continue to be suitable as the climate gets warmer and drier.

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or up to 10% cover of conifers.

Forest structure

Large tree: Overstory diameter > 20 inches; **Medium tree:** Overstory diameter 10-20 inches; **Small tree:** Overstory diameter < 10 inches; **Dense canopy:** Greater than 40% tree canopy; **Open canopy:** Less than 40% tree canopy.

***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels Treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fire is allowed to burn under safe conditions to achieve management goals; can be suppressed if conditions change.

Moist and cold dense forest treatment need

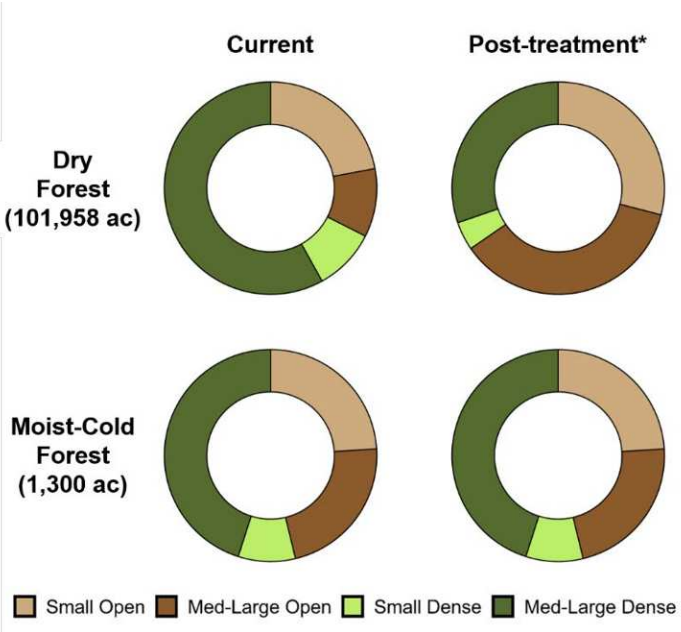
Moist and cold forest structure is within desired ranges and thus not included in Table 1. However, there may be other forest health reasons to treat these forests based on management objectives and field evaluations.

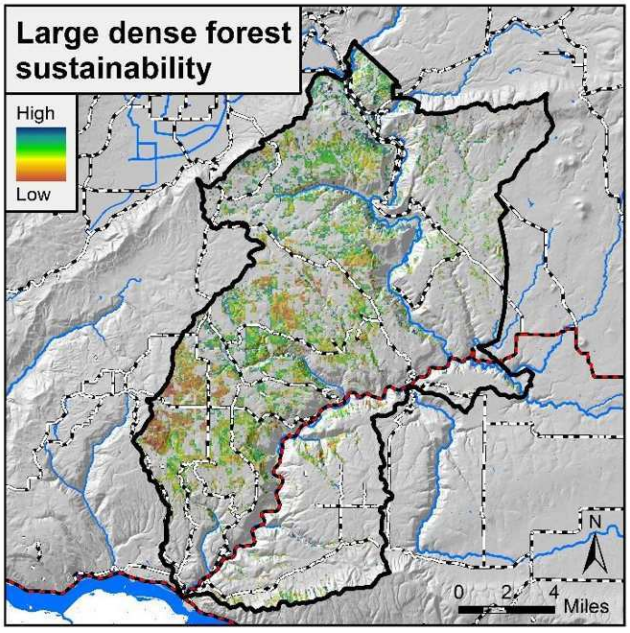
Open forest maintenance treatment need

Over the next 15 years, an estimated 5,000-7,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Sustainable locations occur in western and northern portions of the planning area, particularly on north-facing slopes and in valley bottoms (Fig. 7). The large tree, dense forest sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). We also recommend incorporating the large dense forest sustainability layer (Fig. 7) as an overlay when selecting treatment locations. Wildfire transmission is relatively low to moderate across most of the planning area, but high transmission in southwestern portions indicates that wildfires starting in these locations are expected to expose homes in Appleton, Klickitat, Lyle, and along Highway 142 (Fig. 2).

Treatment priorities

Landscape treatment targets are based on current conditions compared to target conditions for a resilient landscape (Table 1). Landscape treatment priority is highest in western and southern portions on private and industrial land, particularly west of Appleton. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes and property throughout the planning area.

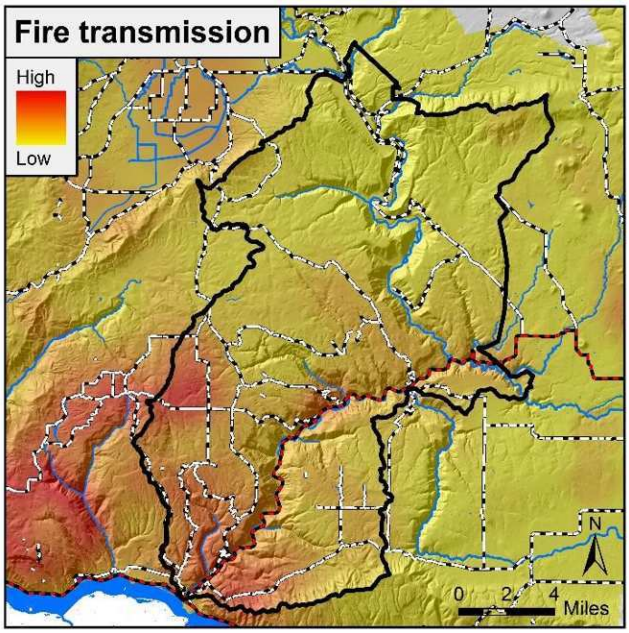


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

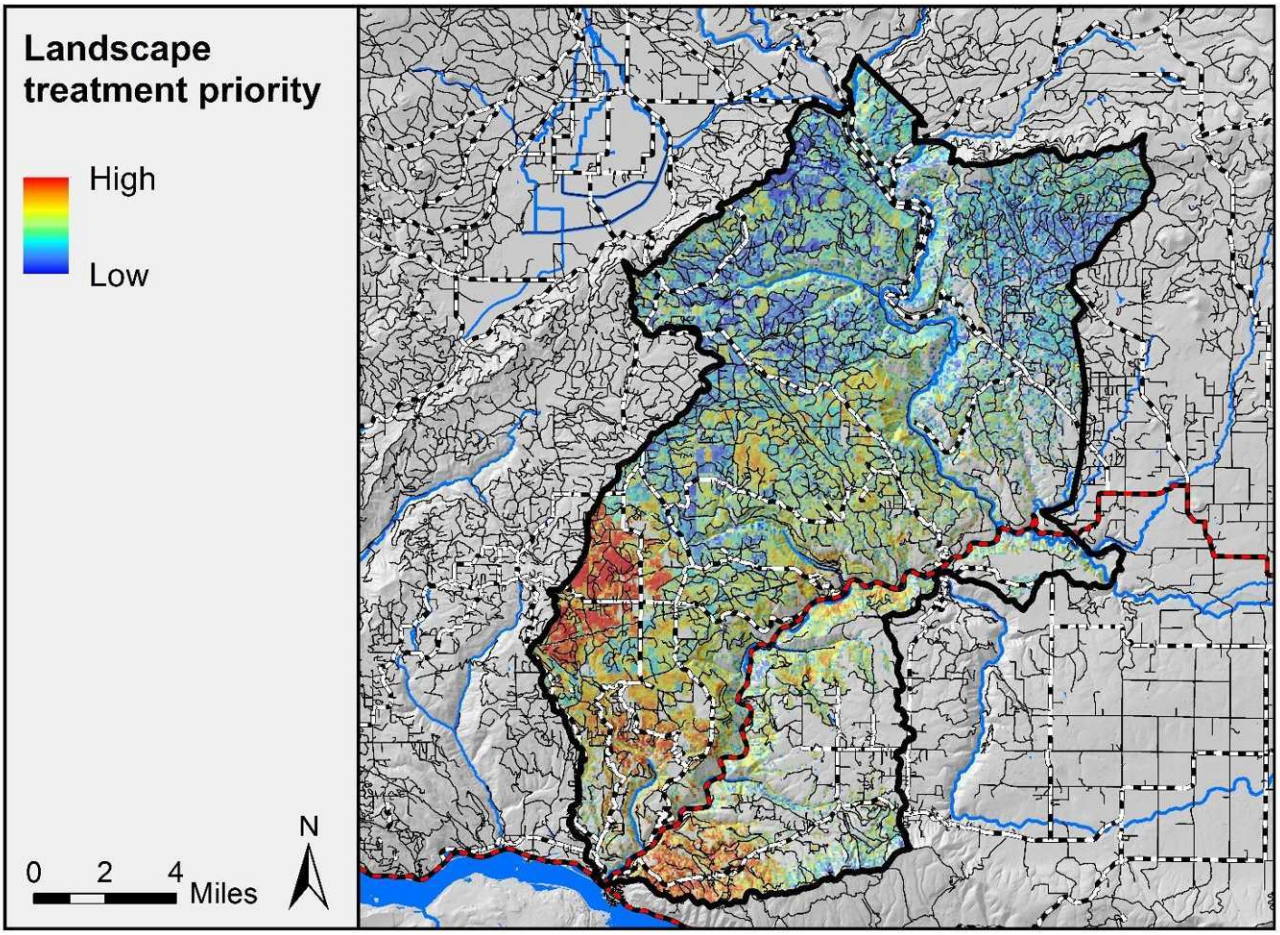
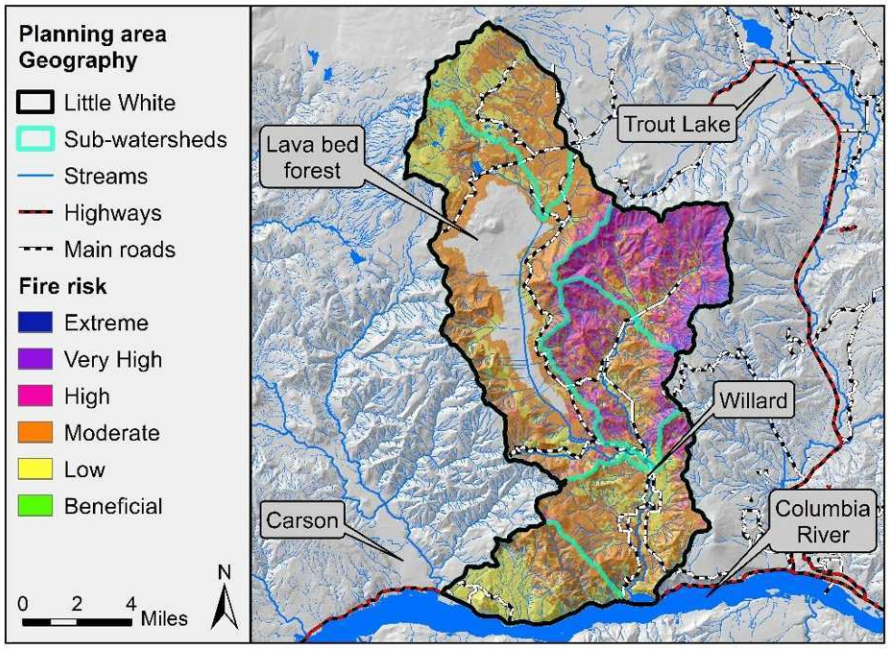


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

LITTLE WHITE SALMON PLANNING AREA LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
95,750	84,705	17,750 - 27,500



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- The Little White planning area occupies a distinct location between the relatively moist west and dry east side of the Cascades. It is the westernmost planning area within the WA DNR 20-Year Forest Health Strategic Plan.
- Land ownership is primarily US Forest Service (79%), with the remainder being Industrial (13%), DNR-Trustlands (5%), and Private (3%) landowners.
- The area is dominated by large patches of dense, multi-layered, mixed-conifer forests with large trees. This structure contributes to relatively high fire risk, particularly in eastern portions.
- Treating 21-32% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical and prescribed fire treatments.
- Treatment priority is high in eastern portions based on forest fire risk, drought vulnerability, current forest structure, and fire transmission to communities.
- Unique features include relatively high biodiversity, a high proportion of large-tree, closed-canopy structure, and the lava bed forest in the northwestern portion of the planning area.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high in the eastern portions of the planning area due to high fuel loads (Fig. 1). Relatively lower fire risk in the southern and western portions is due in part to relatively low burn probability. However, fire risk is still high to very high around the community of Willard. Strong winds in the Columbia Gorge are another important factor influencing fire risk. Fuels treatments are needed to break up the large patches of dense forest to reduce the likelihood of large crown fire and to facilitate protection of private property.

Increase resilience and prepare for climate change

Projected warming will increase moisture stress and associated risk of wildfire and insect outbreaks. By mid-century, as moisture deficit increases, dry forest types are projected to become more widespread throughout eastern and southern portions of the planning area (Fig. 3). Mechanical and fire-based treatments that reduce density and favor fire- and drought-tolerant species in drier portions of the planning area will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is a relatively minor component in the planning area. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is abundant and well distributed in the planning area. In high fire risk locations within this habitat type, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability, help maintain habitat in the most sustainable locations (Fig. 7), and broaden the spatial distribution of open canopy habitat. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is concentrated in large patches in the northwest part of the planning area.

Enhance rural economic development

Because the planning area is very productive, long-term timber management will likely be possible if proactive strategies to adjust species composition and reduce tree density are adopted over time. Reducing fire risk will help sustain recreation and tourism while reducing the potential of smoke affecting nearby communities. Warming trends may make it difficult to sustain moist forest species throughout eastern portions (Fig. 3).

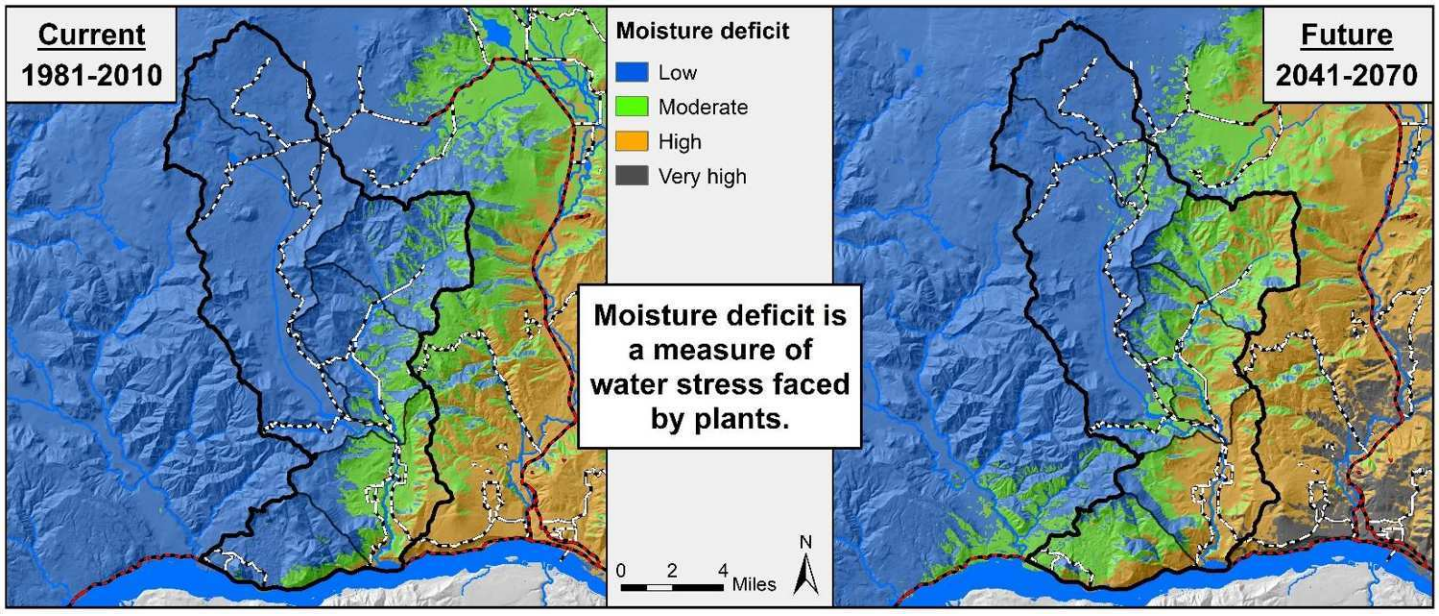


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

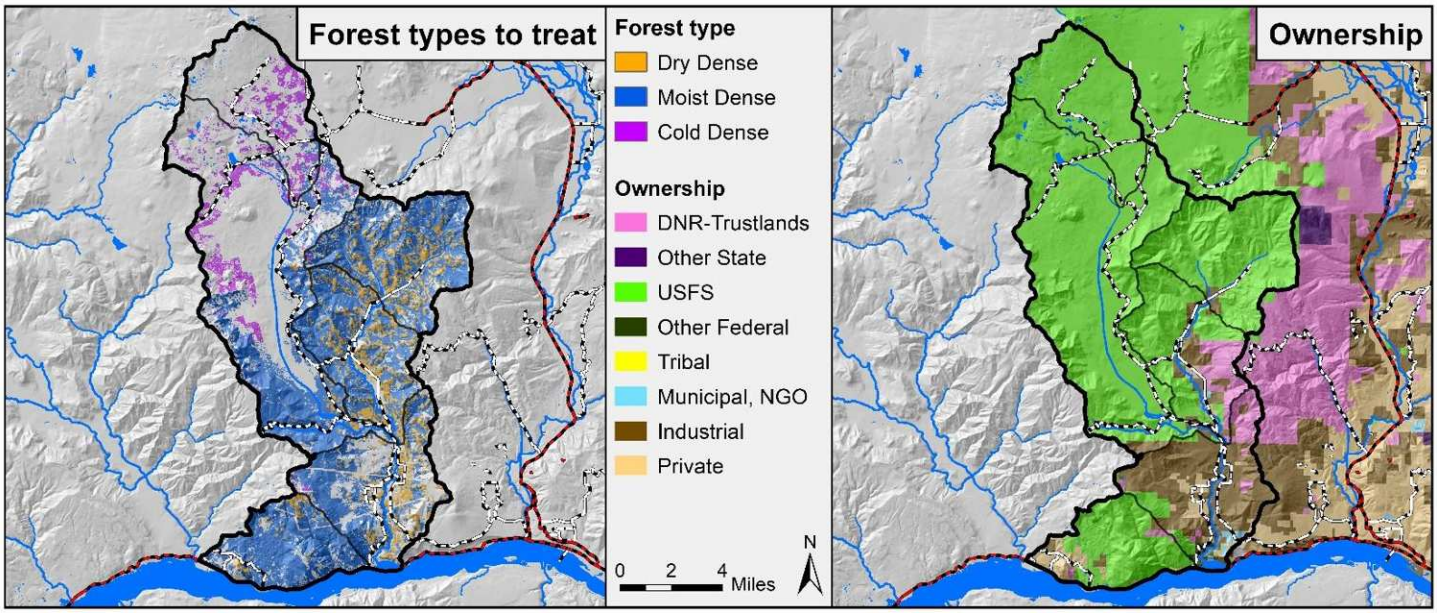
Forest Health Treatment Needs

Treating an estimated 17,750 to 27,500 acres is recommended to move the landscape into a resilient condition (21-32% of forested acres; Table 1). All of these acres are in dense forest but vary by forest type and tree size class, based on current condition data from 2015 and 2016 LiDAR imagery. The majority of the treatment need and opportunity is on USFS land, although substantial need exists on other ownership types, including industrial landowners and DNR-Trustlands (Fig. 5).

Meeting this target range will require multiple treatment strategies (Table 1). Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*			
Type	**Size class**		**USFS**	**DNR**	**Industrial**	**Private**
Dry Dense	Medium	1,000 - 1,500	861	1,185	234	122
	Large	3,000 - 4,500	4733	1,214	907	246
Moist + Cold Dense	Medium	11,750 - 18,000	30,489	5,181	2,065	1,290
	Large	2,000 - 3,500	5,089	36	6	0
Total		**17,750 - 27,500**	**These are current acres, not targets*			
Anticipated treatment type		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.				



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Unique management considerations

Currently, open forests constitute only about 10% of the planning area, so maintenance treatments are less of a priority than in other planning areas. The lava bed forest in the northwestern portion provides unique habitat and is excluded from the treatment need analysis in Table 1. The Little White Salmon River provides important habitat for chinook salmon and other fish and aquatic species.

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or up to 10% cover of conifers.

Forest structure

Large tree: Overstory diameter > 20 inches; **Medium tree:** Overstory diameter 10-20 inches; **Small tree:** Overstory diameter < 10 inches; **Dense canopy:** Greater than 40% tree canopy; **Open canopy:** Less than 40% tree canopy.

***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels Treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fire is allowed to burn under safe conditions to achieve management goals; can be suppressed if conditions change.

Dry dense forest treatment need

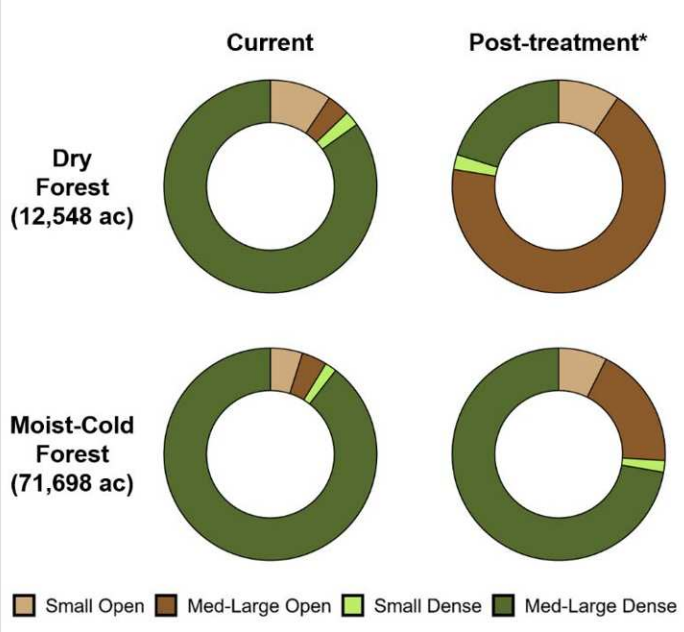
Treating 4,000-6,000 acres of dense forest on dry sites (Table 1) is recommended to shift the landscape from being dominated by large patches of dense forest to open forest. In locations with large trees, removing smaller trees and treating fuels with prescribed fire or mechanical methods would create more fire and drought resistant forest structure. Favoring a mixture of Douglas-fir, western larch, and ponderosa pine is recommended.

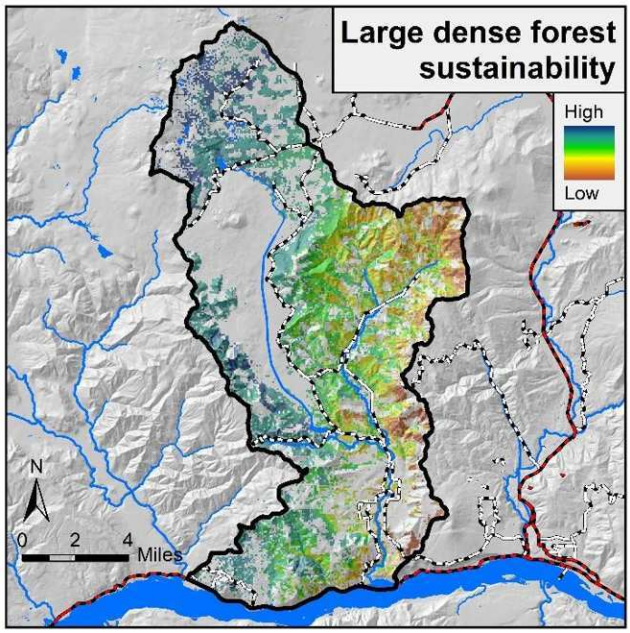
Moist and cold dense forest treatment need

Treating 13,750-21,500 acres of dense forest on moist and cold sites is recommended to reduce risk of large crown fire and help forests adapt to a warming climate. Douglas-fir forests will likely remain dominant, but increasing the relative composition of ponderosa pine and western larch is also recommended. Following treatments, over 70% of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

Sustainable locations for dense forest with large trees

Although substantial areas of forest with large trees and dense structure exist throughout the planning area, forests in the western portion are more suitable for habitat conservation for dependent species. High priority treatments that reduce fire risk in eastern portions of the area (Fig. 9) may support more productive large, dense forest habitat over time.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). We also recommend incorporating the large dense forest sustainability layer (Fig. 7) as an overlay when selecting treatment locations. Wildfire transmission is low throughout the Little White planning area, although there is higher transmission to the east in the White Salmon River corridor.

Treatment priorities

Landscape treatment priority is moderate and high throughout the eastern part of the planning area (Fig. 9), due primarily to high fire risk and drought vulnerability. Some lower priority areas on USFS lands in the northwestern portion overlasssp with the East Crater Fire that burned 480 acres in 2018. Some low priority areas may need treatment to support adaptation to projected increases in dry forests due to climate change. In addition, fuel reduction treatments, defensible space, and home hardening are needed to protect homes in Willard and along the Columbia River. High priority treatments that reduce fire risk in eastern portions of the planning area may support more sustainable large, dense forest habitat over time (Fig. 7).

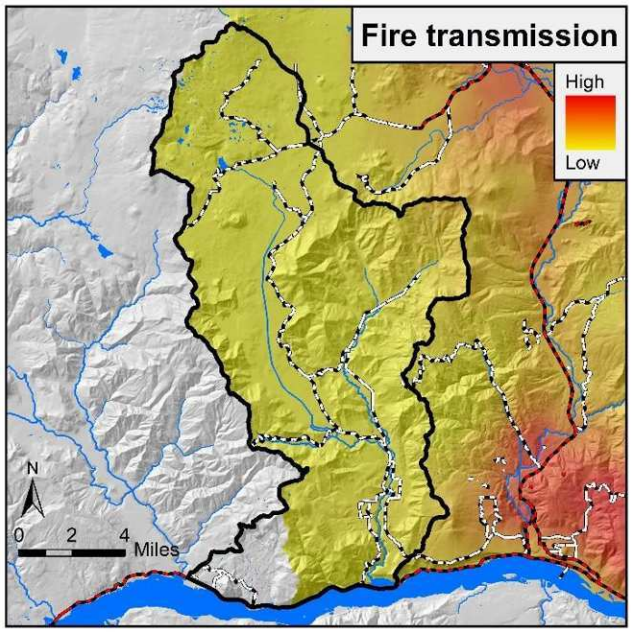


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

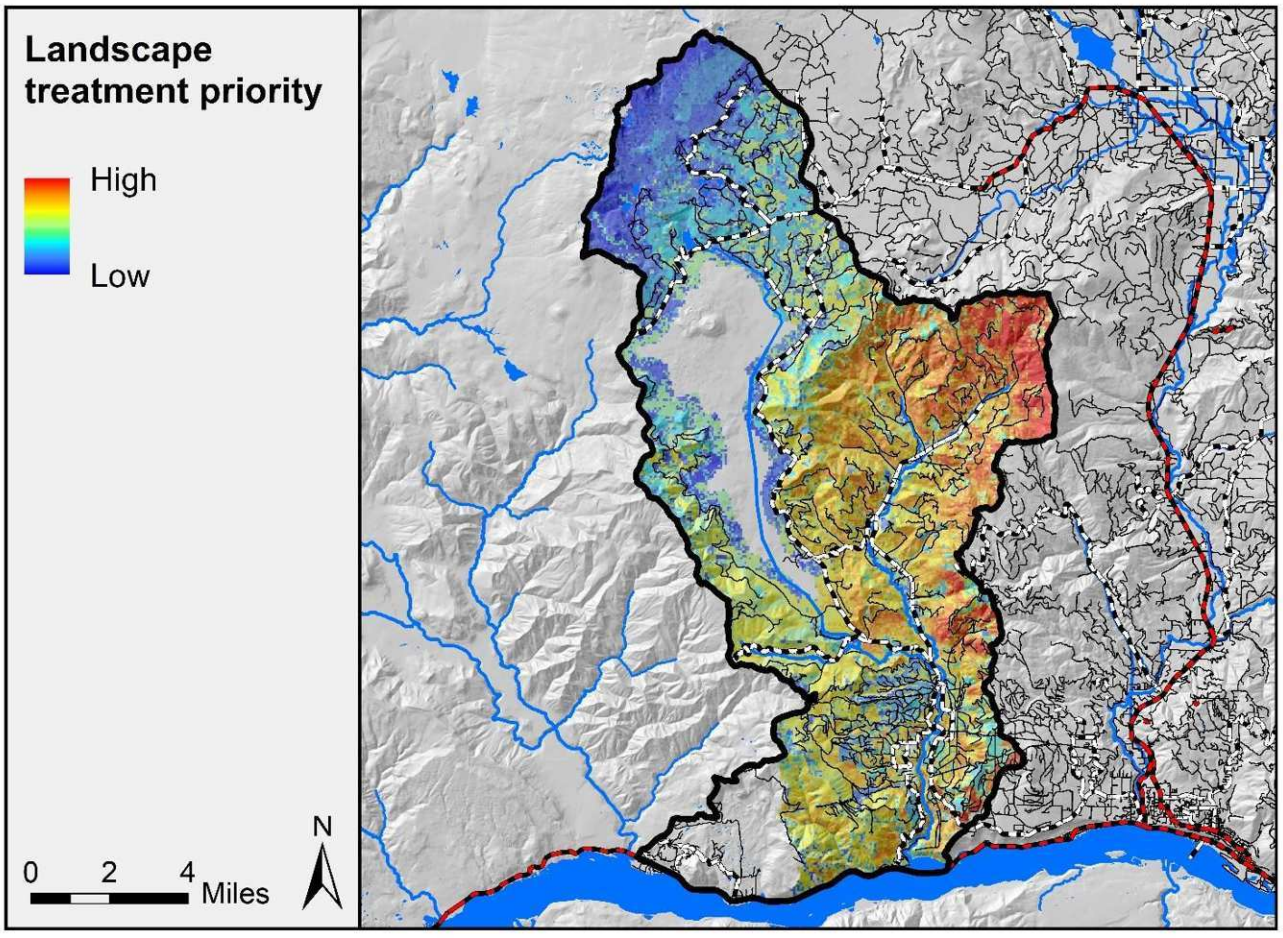
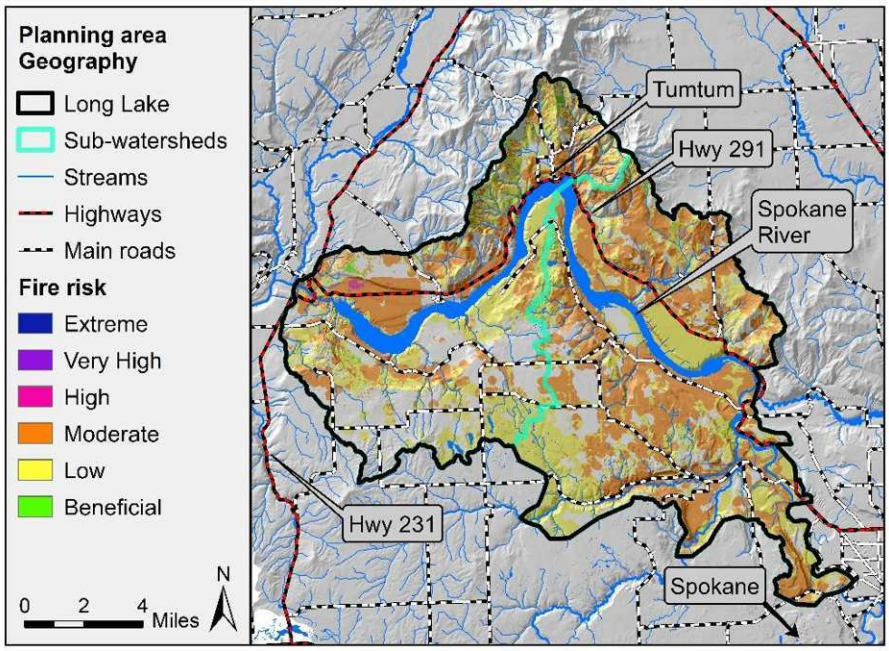


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

LONG LAKE PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
103,291	41,253	14,000 - 20,000



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- Land ownership is 85% small private non-industrial, 7% DNR, 5% State Parks, and 3% other.
- 35% of the planning area is ponderosa pine and dry mixed-conifer forest, 5% is moist forest, 41% is shrub-steppe, 14% agriculture and developed areas, and 5% rocky outcrops.
- Fire risk is currently moderate to low due to low burn probability. If a fire does occur, there is significant risk of it spreading quickly and threatening the many homes in and around the planning area.
- Most of the forest in the planning area is projected to shift to non-forest by mid-century.
- Treating 34-48% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical treatments, prescribed fire, and maintenance treatments in currently open areas.
- Landscape treatment priority is highest in the northern portion on private and DNR land. Other medium and high priority treatment areas are scattered through the planning area, including Riverside State Park along the Spokane River.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Predicted fire risk is moderate across most of the planning area with patches of low risk mixed in (Fig. 2). Moderate risk areas generally have high predicted fire intensity and tree mortality but low burn probability, which is based on patterns of large fires from 1992-2015. Risk to homes is a major concern given that homes are scattered throughout this planning area, as well as to the east and south. Meeting the treatment targets will help reduce the risk of a large fire, especially as burn probability increases with projected climate warming over time. Implementing fuel reduction treatments around homes and establishing potential control lines will increase firefighter safety and wildfire response operations

Increase resilience and prepare for climate change

By mid-century, almost all of the planning area is projected to have moisture stress levels that are currently associated with shrub-steppe (Fig. 3). This does mean that all trees will necessarily die by mid-century, but rather that existing trees will be increasingly vulnerable to drought mortality, drought related insect outbreaks, and wildfire. After a disturbance, trees may have difficulty regenerating due to greater moisture stress. Dry forest will likely persist on north-facing slopes and in pockets of deeper soils that are not well mapped in Figure 3. Treatments that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is somewhat well represented in the planning area. Patches sizes are small to moderate. Significant opportunity exists to increase this habitat type through thinning and/or fire-based treatments to create or expand moderate to large patches (100-500+ acres) of open forest dominated by ponderosa pine. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Goshawk) is limited to a small area in the northern tip. This planning area is almost all ponderosa pine and dry mixed conifer, and thus has relatively little potential for sustainable dense forest habitat. Similarly, there is no cold forest or associated habitat for cold forest, large-tree, closed canopy species (e.g. American Marten).

Enhance rural economic development

Reducing fire risk will help maintain this area as a safe place to live and recreate. Commercial treatments are possible on most of the high and medium priority areas. However, the small size of many parcels, the high number of homes, prevalence of ponderosa pine forest types, and rugged terrain in some places will make commercial treatments challenging. Non-commercial treatments will require major investments but will provide a major source of work for local contractors. Warming trends will make it increasingly difficult to sustain long term timber production this area.

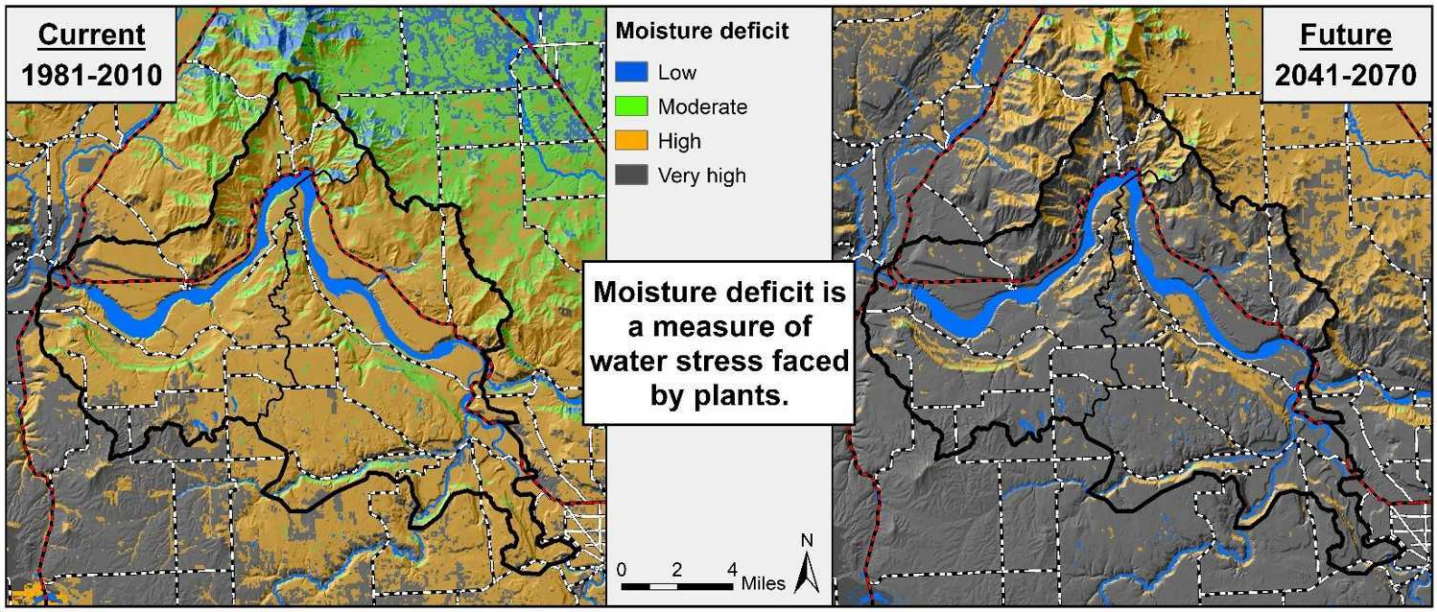


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

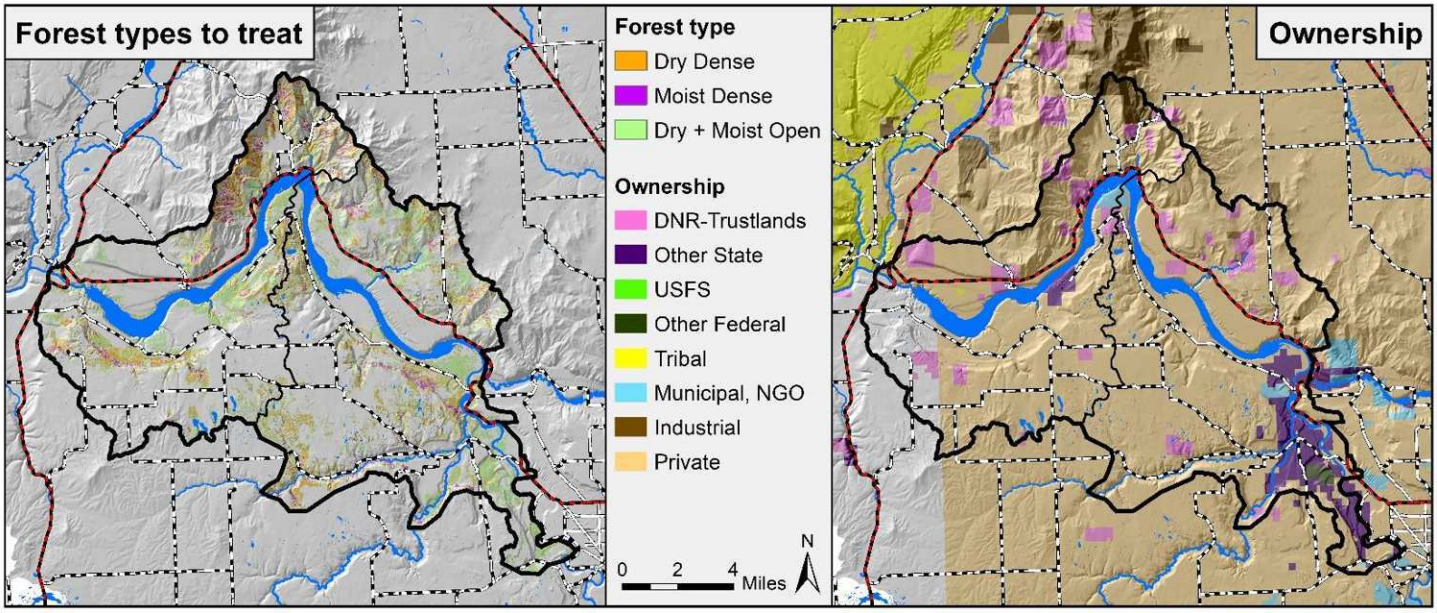
Forest Health Treatment Needs

Treating 14,000 to 20,000 acres is recommended to move the landscape into a resilient condition (34-48% of forested acres; Table 1). This total includes an estimated 6,500-8,250 acres to shift dense to open forest and 7,500-11,750 acres of maintenance treatments in existing open forest, based on current condition data from 2016 and 2019 LiDAR. Most of the treatment need is located on private land with some need on Washington State Parks and DNR land.

Meeting this target range will require multiple treatment strategies (Table 1). Based on tree size class, many areas may be commercially viable, although treatment type will depend on road access, markets, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**Private**	**DNR Trustlands**	**State Parks**	**Private**	**Other**
Dry Dense	Medium-Large	5,500 - 7,000	9,311	767	735	290	119
Moist Dense	Medium-Large	1,000 - 1,250	1,611	113	53	48	9
Dry + Moist Open	Medium-Large	7,500 - 11,750	11,327	1,726	1,985	220	315
Total		**14,000 - 20,000**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, medium tree, dense forest structure is over-represented on dry sites. Significant patches of dense forest are primarily located in the northern tip, and are scattered throughout the rest of the planning area. The landscape has large areas of shrub-steppe, agricultural land, and the basalt cliffs around the Spokane River that break up forest, however. Dense forests on these dry sites are vulnerable to drought stress and related insect outbreaks. Treating 5,500-7,000 acres of dry dense forest (Table 1) is recommended to shift the majority of dry sites to open forest with low fuel loads (Fig. 6). When consistent with landowner objectives, retaining a component of large, fire resistant trees will increase resistance and resilience to fire and insect outbreaks.

Moist and cold dense forest treatment need

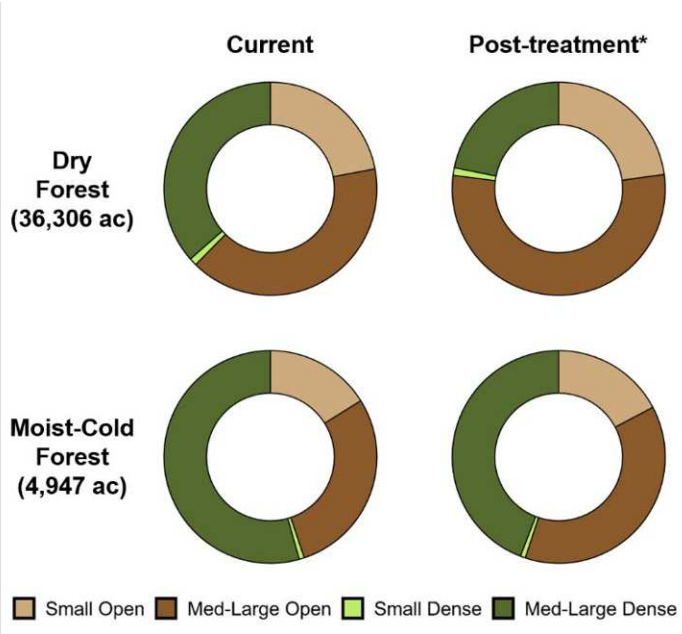
Dense, medium forest on moist sites exceeds desired ranges across the planning area. In contrast, open and closed canopy forest large trees is below desired ranges. Treating 1,000-1,250 acres of this forest type (Table 1, Fig. 4) is recommended to reduce density and increase resistance to drought stress and high-severity fire. Increasing the relative composition of ponderosa pine is also needed to help these sites adapt to a warming climate. Where consistent with landowner objectives, retaining and growing a large tree component will increase resilience. Post treatment, just under half of the total moist forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives. There is no cold forest in this planning area.

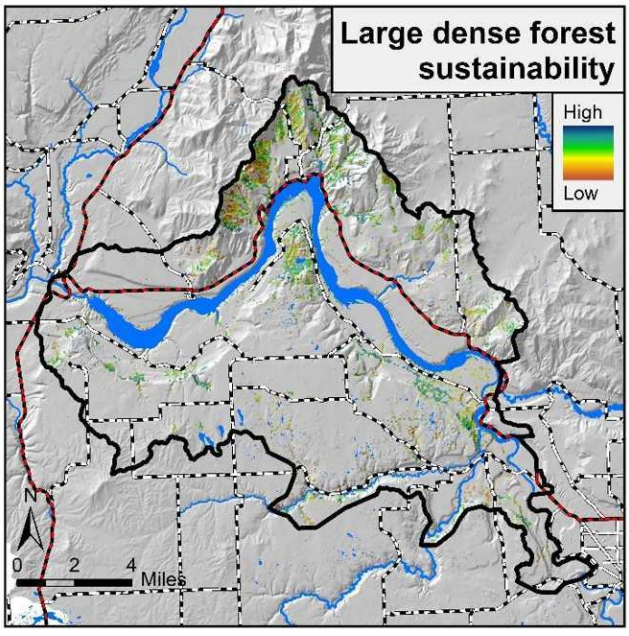
Open forest maintenance treatment need

Over the next 15 years, an estimated 7,500-11,750 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain this forest habitat type and associated ecosystem functions. More sustainable locations are concentrated in the northern tip and on north-facing slopes above the Spokane River (Fig. 7). This map can be used in conjunction with treatment priority (Fig. 9) to select areas to maintain and build this type of forest structure as well as areas better suited to shift towards open canopy structure. While these locations are the best locations for dense forest in this planning area, it will likely may be difficult to sustain this structure type over time given climate change projections for this area.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). We also recommend incorporating the large dense forest sustainability layer (Fig. 7) as an overlay when selecting treatment locations. Wildfire transmission is high in the north eastern, south eastern, and western part of the planning area. This indicates that wildfires starting in these locations are expected to expose homes in and around the planning area (Fig. 2).

Treatment priorities

Landscape treatment priority is highest in the northern portion on private and DNR land (Fig. 9). Other medium and high priority treatment areas are scattered through the planning area on private, DNR, and Riverside State Park. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes throughout the planning area.

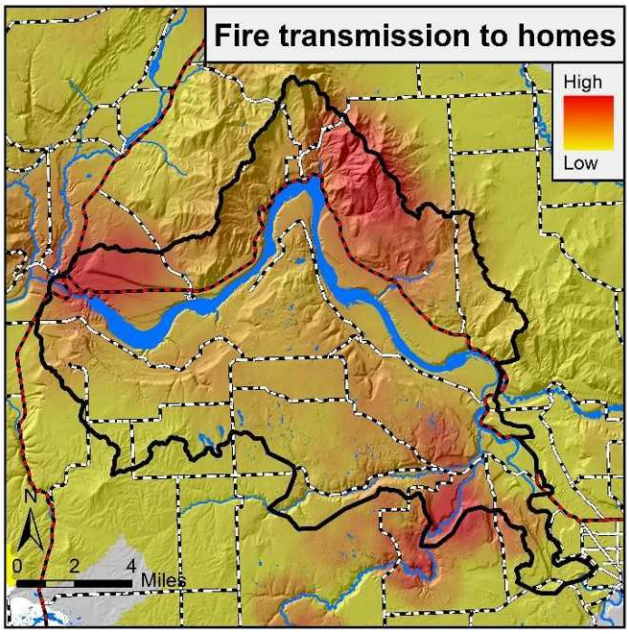


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

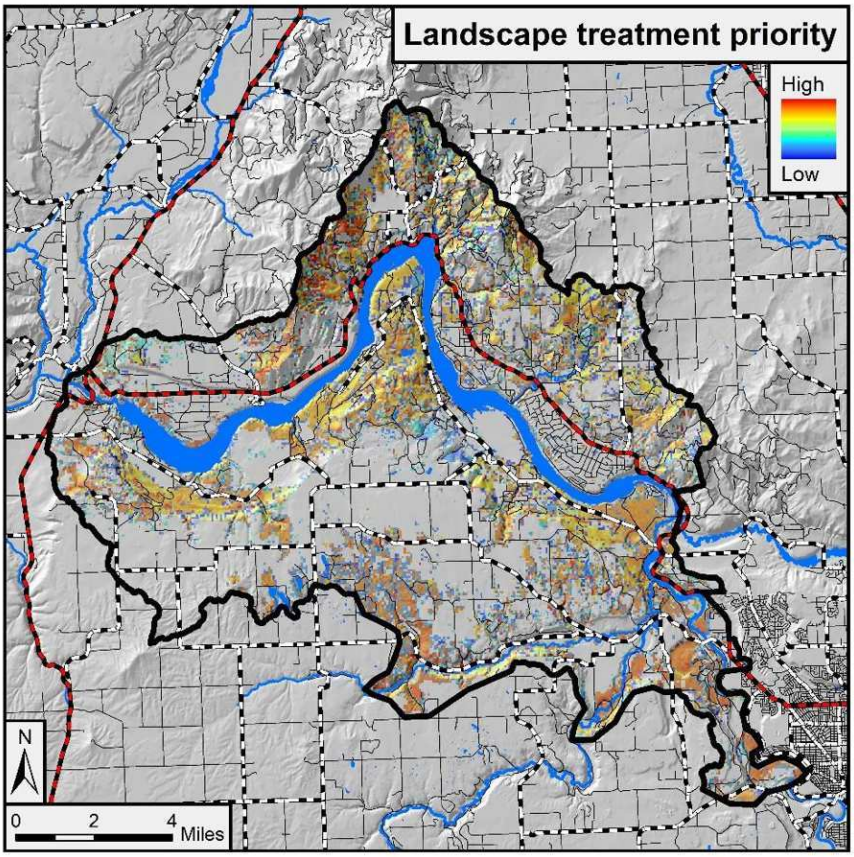


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

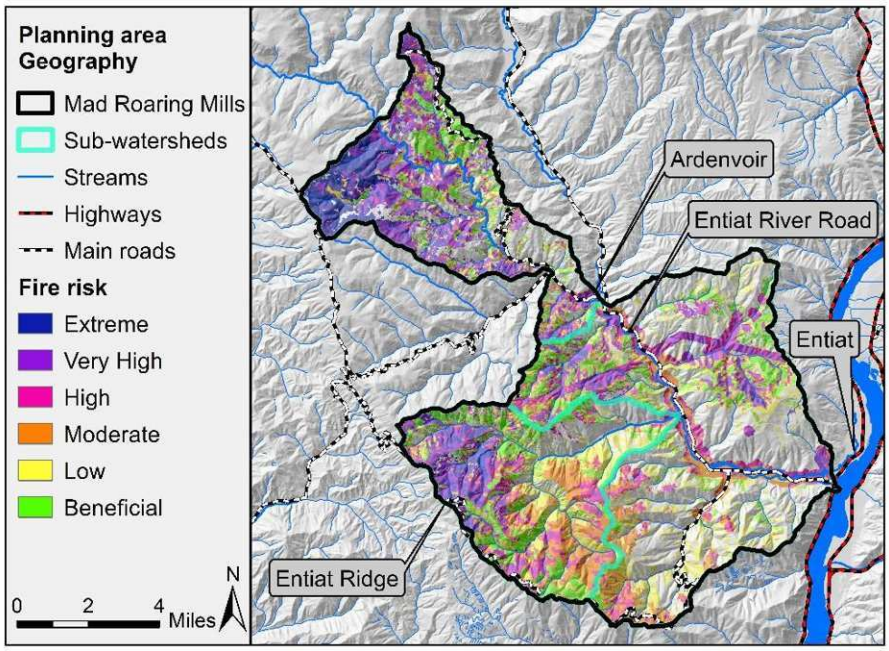
***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires that are allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

MAD ROARING MILLS PLANNING AREA LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
65,008	33,325	13,500 - 20,000



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- This planning area includes three sub-watersheds within the Entiat River drainage (Mad River, Roaring Creek, Mills Creek).
- The area is 63% US Forest Service, 14% private, 8% industrial forestland, and 15% other land owners.
- Fire risk is highest in western portions of the planning area, particularly on the upper slopes northeast of Entiat Ridge.
- Projected warming over the next 20-40 years will likely shift climate conditions suitable for moist and cold forest towards conditions suitable for dry forest. Low elevations and south-facing slopes may no longer support forest.
- Treating 41-60% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- Treatment priority is high in western and eastern portions of the planning area based on fire risk, drought vulnerability, current forest structure, and fire transmission to communities.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high to extreme in western portions of the planning area due to high fuel loads and high burn probability close to Entiat Ridge (Fig. 2). High risk areas in the eastern portion are associated with infrastructure including power lines. Fuels treatments are needed to break up the large patches of dense forest to reduce the likelihood of large crown fire and to facilitate protection of private property along Entiat River Road. Although the fire risk map (Fig. 2) does not directly capture fire risk in non-forest areas, these areas represent high levels of wildfire transmission to homes in and around the community of Entiat (Fig. 8).

Increase resilience and prepare for climate change

By mid-century, the majority of the planning area is projected to have moisture stress levels that are currently associated with dry forest (Fig. 3). South-facing slopes in lower elevation areas are already dominated by non-forest vegetation, and additional areas in the eastern portion area projected to shift to non-forest over time. Moderate moisture stress levels are projected to remain on north-facing slopes and at higher elevations, primarily in the western half. Treatments, as well as managed wildfires in roadless and other inaccessible areas, that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is at the upper end of desired ranges or overabundant, and it is aggregated in large patches. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is a relatively minor component of this area and is within desired ranges, but it is also aggregated in large patches. In high fire risk locations of this habitat type, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability, help maintain habitat in the most sustainable locations (Fig. 7), and broaden the spatial distribution of open canopy habitat. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is a minor component of this planning area.

Enhance rural economic development

Commercial harvest is a relatively small component of the current treatment targets due to small tree size in dense stands (Table 1). Although warming trends and high burn probability will necessitate managing for lower densities and fuel loads, long-term timber production will likely be possible in higher elevation areas on USFS and industrial ownerships. Reducing fire risk will help sustain recreation while reducing the potential of smoke affecting nearby communities.

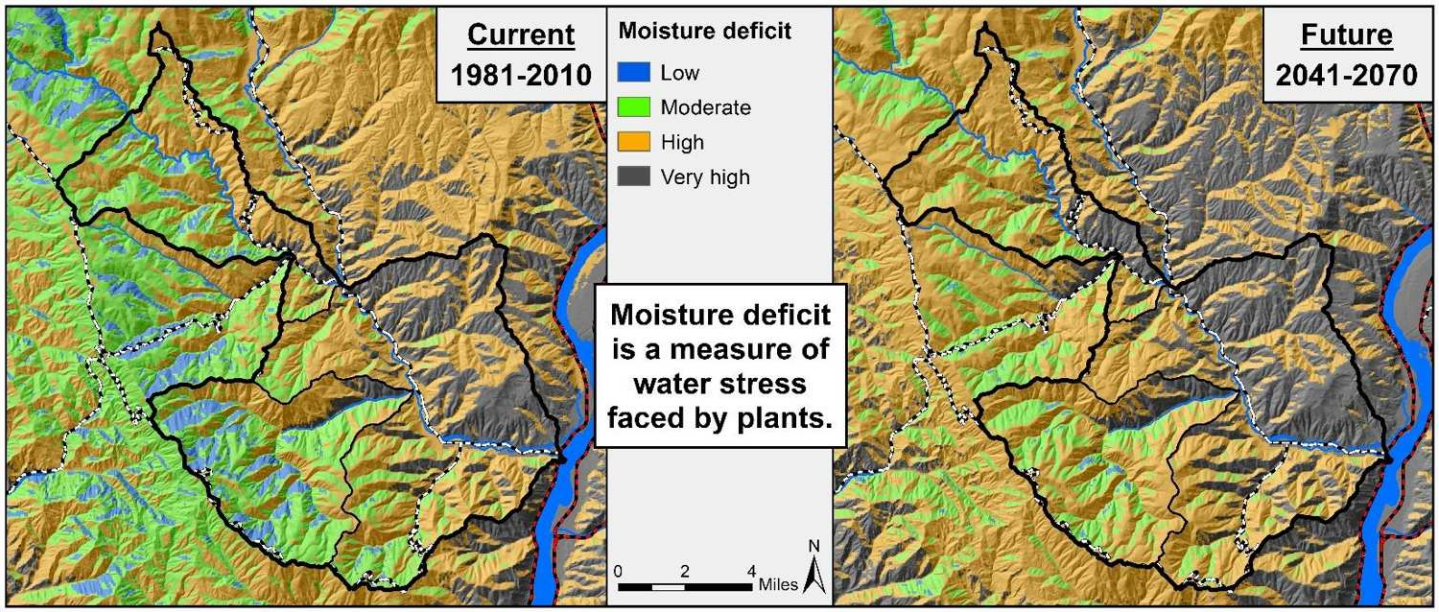


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

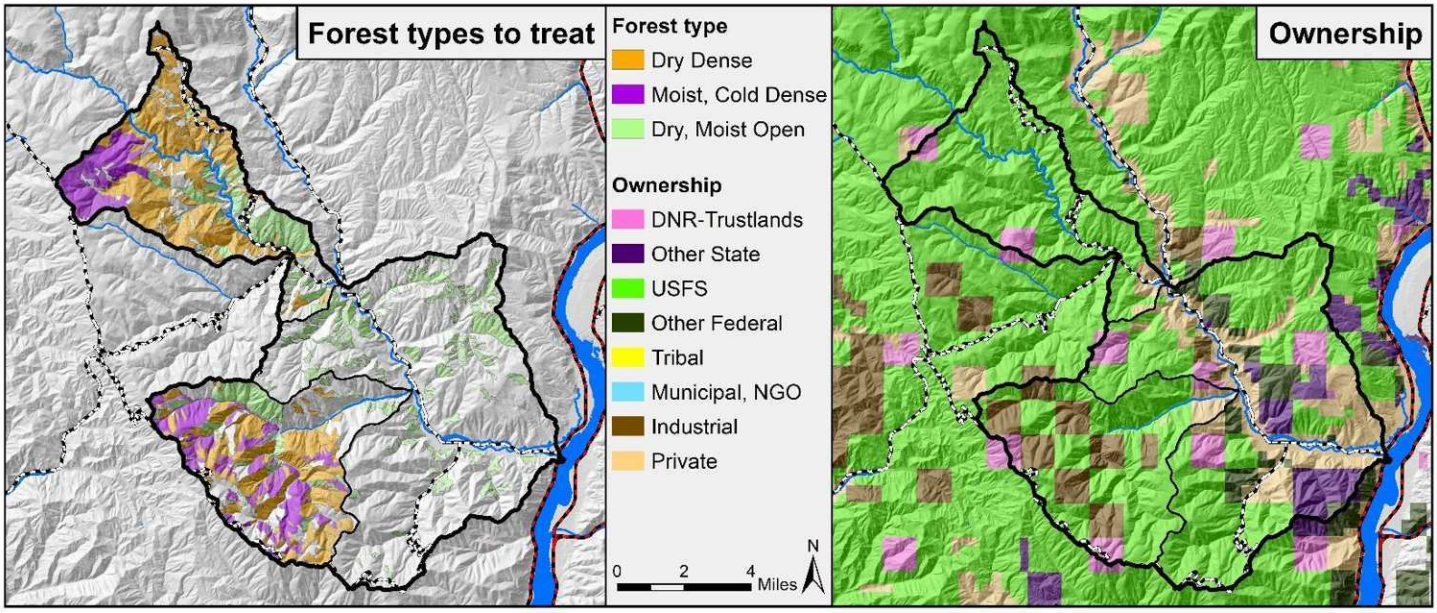
Forest Health Treatment Needs

Treating 13,500 to 20,000 acres is recommended to move the landscape into a resilient condition (41-60% of forested acres; Table 1). This total includes an estimated 8,500-13,000 acres to shift dense to open forest and 5,000-7,000 acres of maintenance treatments in existing open forest, based on current condition data from 2014 aerial photos. Most of the treatment need is located within USFS land, although substantial need exists on industrial ownership in the southwestern portion.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in less accessible locations. Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**USFS**	**Private**	**Industrial**	**DNR Trust**	**Other**
Dry Dense	Small	4,500 - 7,250	10,626	99	1,967	843	81
	Medium-Large	1,000 - 1,750	3,732	363	192	317	120
Moist + Cold Dense	Small	3,000 - 4,000	4,461	84	1,440	618	0
Dry + Moist Open	Medium-Large	5,000 - 7,000	6,221	1,504	642	411	679
Total		**13,500 - 20,000**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites, especially sites dominated by Douglas-fir in the northwestern portion. Dense, young forests dominated by small trees are also overabundant. Treating 5,500-9,000 acres of this type (Table 1) is recommended to create large patches (~100-1000 ac) of open forest with a component of large trees (Fig. 4), increasing the proportion of dry, open forest (Fig. 6). Shifting composition toward ponderosa pine and reducing grand fir and Douglas-fir is also recommended.

Moist and cold dense forest treatment need

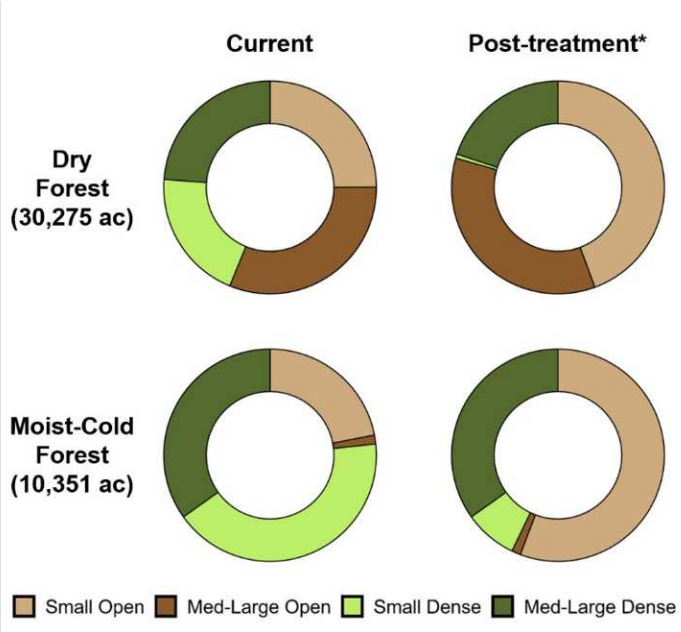
On moist and cold sites in the planning area, young forests dominated by small trees exceed or are at the upper end of desired ranges. In contrast, open canopy forest with medium to large trees, as well as open forest with small trees and shrubs, are at the low end of desired ranges. Treating 3,000-4,000 acres of this forest type (Table 1, Fig. 4) is recommended to create a mosaic of open and dense forest that will reduce risks of large crown fire and insect outbreaks. A range of treatment types will be needed, including thinning, regeneration treatments, and managed wildfire in roadless areas. Increasing the relative composition of ponderosa pine and western larch is also needed to help these sites adapt to a warming climate. Following treatments, over 40% of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

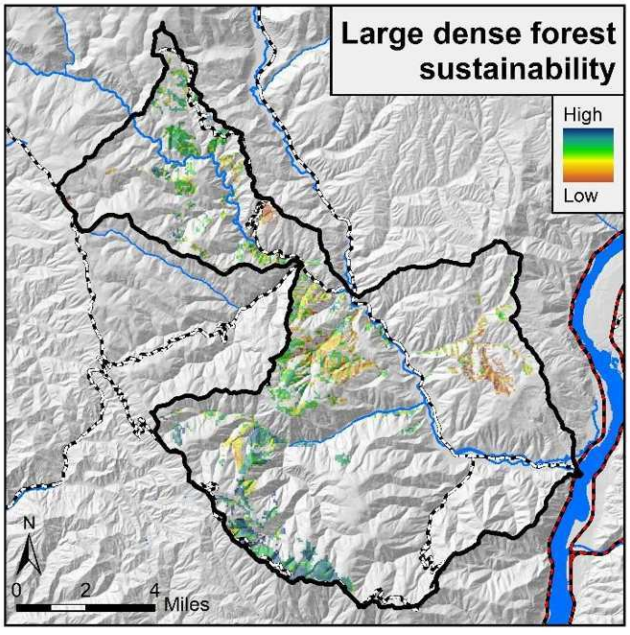
Open forest maintenance treatment need

Over the next 15 years, an estimated 5,000-7,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Sustainable locations include the southwestern edge of the planning area near Entiat Ridge (Fig. 7). The large tree, dense forest sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is high in eastern portions of the planning area, indicating that fires starting in these locations are expected to expose homes in Ardenvoir, Entiat, and along Entiat River Road (Fig. 2).

Treatment priorities

Landscape treatment priority is highest in the northwestern portion of the planning area on USFS land near Entiat Ridge (Fig. 9). Relatively high elevation forests in the southwestern portion and a pocket of dry forest in the eastern portion are also high priority areas. Some medium and low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes along Entiat River Road and nearby communities.

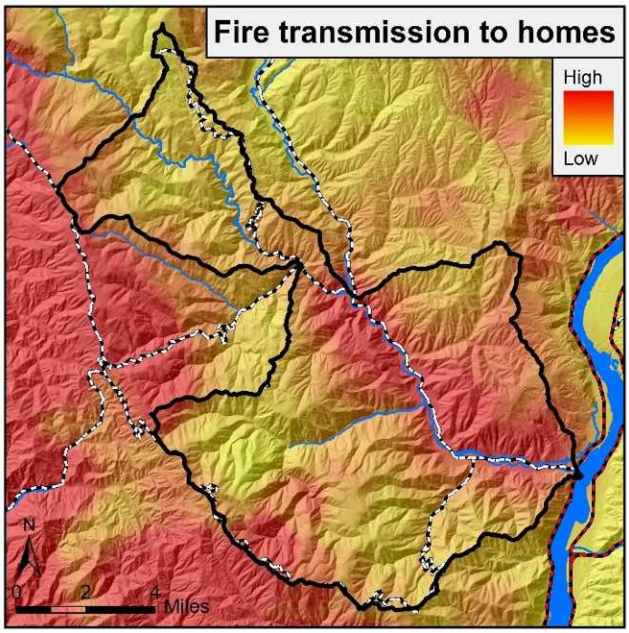


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

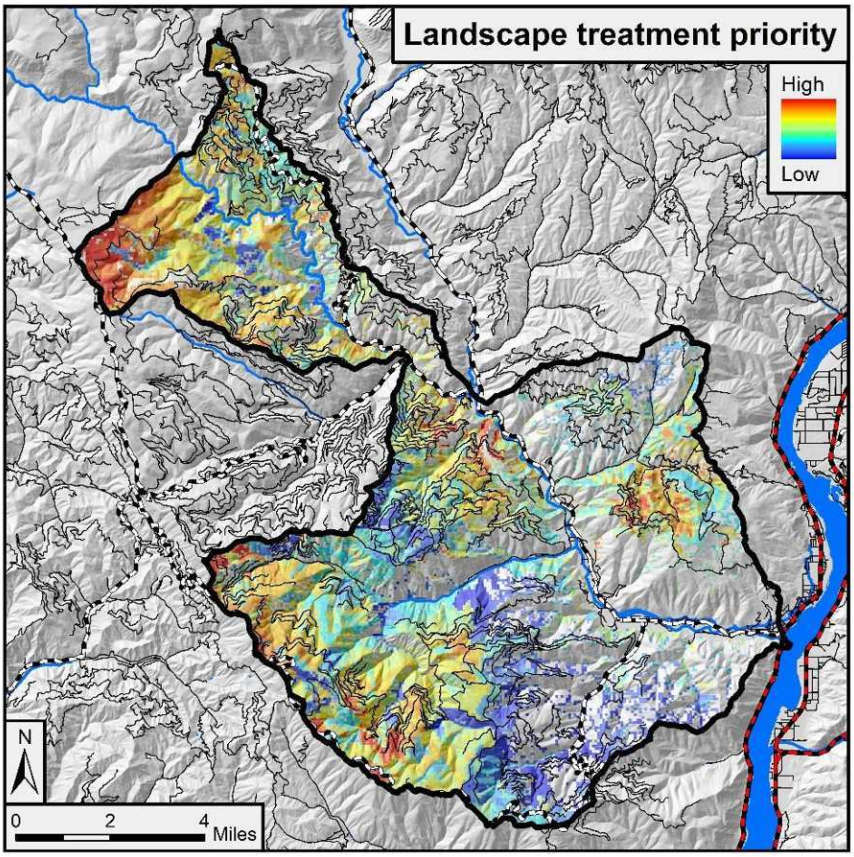


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

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Medium tree: Overstory diameter 10-20 inches.

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***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires that are allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

MANASTASH-TANEUM PLANNING AREA LANDSCAPE EVALUATION SUMMARY (2020)

Update from 2018 Landscape Evaluation

This summary updates the landscape evaluation completed in 2018 to incorporate landscape treatment priority and wildfire response benefit priority. This planning area was part of the WA HB 1784 pilot project to incorporate prioritization for dual benefits (forest health and wildfire response benefit) into the Forest Health Assessment and Treatment Framework.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – fire risk, drought vulnerability, and presence of overabundant forest structure types – with wildfire transmission to homes. To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is highest in the northern and eastern portions of the planning area (Fig. 2), indicating that wildfires starting in these locations are expected to expose homes in Cle Elum and Thorp.

Treatment priorities

Landscape treatment priority is highest in the west-central portion, south of South Cle Elum Ridge (Fig. 1). Some moderate and low priority areas may need treatment to address species composition, insect and disease risk, or other issues. The eastern part of the planning area is sparsely forested but contains private land, agriculture, and homes in the wildland-urban interface. Fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes in Thorp and along the Interstate 90 corridor (Fig. 1).

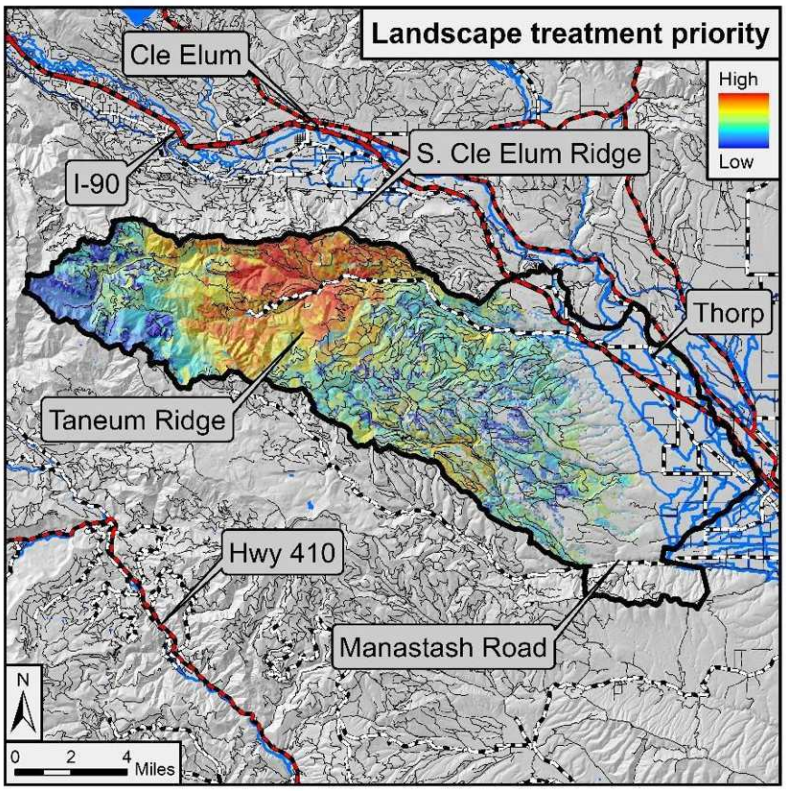

Figure 1. Landscape treatment priority is based on three metrics of forest health – forest fire risk, drought vulnerability, overabundant forest structure – as well as wildfire transmission to homes (Fig. 2).

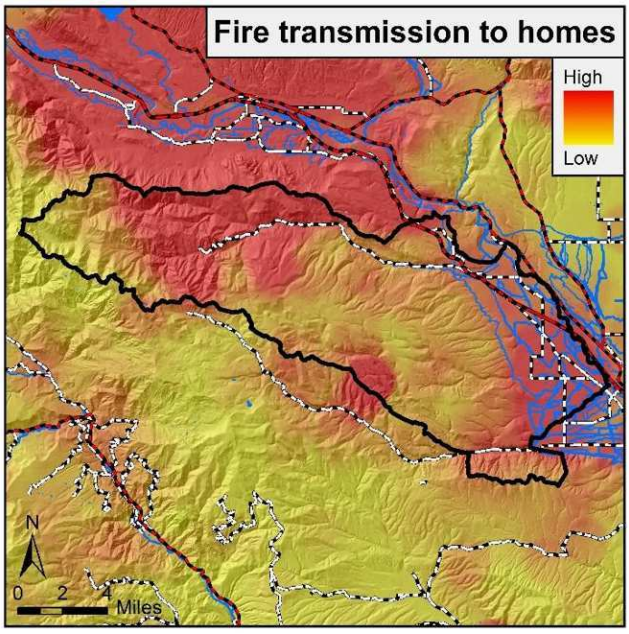

Figure 2. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

Wildfire Response Benefit Prioritization

Dual benefits for forest health and wildfire response

It is necessary to conduct treatments to both improve forest health and reduce fire risk to communities as well as provide conditions where firefighters can safely and efficiently conduct fire operations (e.g. suppression, prescribed burning, and managed wildfire). The wildfire response benefit metric (WRB; Fig. 10) identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes, infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior. Because there are positive feedbacks between healthy, resilient forests and safe, effective fire operations, the WRB metric also integrates the landscape treatment priority map (Fig. 9).

Where WRB is highest, actions may be needed to create and maintain conditions that provide a tactical advantage for fire operations. These actions will vary with the local context and can include landscape-level forest health and fuel treatments, treatments along escape routes, resident and community fire mitigation activities (e.g. defensible space, home hardening), and improving signage and road conditions. The WRB metric provides a high-level prioritization, and additional work at the local level will be required to identify appropriate actions and assess their feasibility. WRB is useful for prioritizing Potential Control Lines (PCLs) for fire operations (Fig. 4). PCLs are a part of Potential Operational Delineations (PODs); see page 3.

In the Manastash-Taneum planning area, wildfire response benefit is highest in the southeastern end of the planning area where there is risk to homes (Thorp) and infrastructure (Interstate 90). Wildfire response benefit is also high in the central portion on parcels of commercially managed lands, and it is relatively lower in the western portion of the planning area.

Definitions (continued)

Wildfire response benefit: Any tactical advantage gained for wildfire response activities from actions on the landscape, including identifying and consolidating existing anchor points and control lines and reducing potential fire behavior. Wildfire response benefit is not restricted to any specific fire management strategy; it is centered on conditions that improve fire operations safety and efficacy during suppression, prescribed fire, or managed wildfire.

Potential Control Lines (PCLs): Boundaries of Potential Operational Delineations (PODs) relevant to fire control operations (e.g. roads, ridgetops, and water bodies).

Potential Operational Delineations (PODs) for wildland fire: Landscape containers whose boundaries are potential control lines (PCLs). PODs are useful for planning strategic response to unplanned ignitions, strategic fuel planning, and prioritizing fuel treatments within PODs.

Commercially managed lands: Commercially managed forestlands include: DNR Trustlands, tribal forests, industrial forests, non-industrial private forests, and US Forest Service forests where timber is a primary management objective.

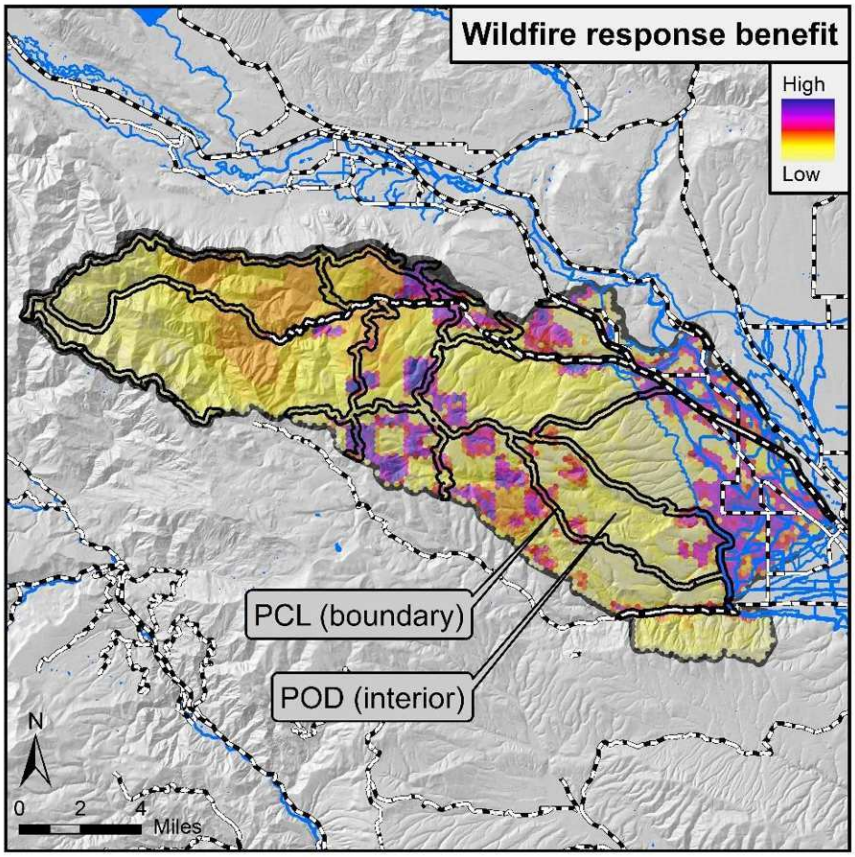

Figure 3. Wildfire response benefit (WRB) integrates multiple fire risk and forest health components. It includes four fire risk metrics representing highly valued resources – risk to homes, infrastructure, drinking water, commercially managed lands – as well as crown fire potential and wildfire transmission to homes (Fig. 2). Combined, these account for 75% of the wildfire response benefit. Landscape treatment priority (Fig. 1) accounts for the remaining 25%. Also shown are PODs: units bounded by PCLs (open black lines). One use of the WRB metric is to prioritize Potential Control Lines (PCLs) for fire operations (Fig. 4).

Prioritizing Landscape Treatments for Dual Benefits

Integration of forest health and wildfire response benefit using PODs

Potential Operational Delineations (PODs) provide a powerful spatial framework to communicate and identify locations that will deliver dual benefits for forest health and wildfire response at the landscape scale. PODs are large landscape areas delimited by Potential Control Lines (PCLs) for fire operations (suppression, prescribed fire, and managed wildfire) delineated by fire operations personnel. PCLs can be roads, ridgelines, or any artificial or natural fuelbreak that provides a strategic opportunity for fire operations. Summarizing landscape treatment priorities (Fig. 9) within PODs and wildfire response benefit priorities (Fig. 10) within PCLs enables planners and managers to identify, at a high level, locations where forest health or fuels treatments can be connected to a high-priority PCL that will support firefighter operations (e.g. ingress/egress route or opportunity for engagement).

Achieving forest health and wildfire response goals will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs.

There is important work to do in all Manastash-Taneum PODs. First priority PODs follow spatial patterns of forest health treatment needs and occur predominantly in the western part of the planning area (Fig. 4; Taneum Ridge). PODs and PCLs in this planning area typically similar priority rankings. One notable exception is a first priority PCL on the west side of the planning area adjacent to South Cle Elum Ridge. Further work is needed to assess PCLs locally for their condition and detailed treatment needs, which will depend on management goals and values at risk. Ideally, landscape treatments will be implemented adjacent to priority PCLs where feasible to maximize both forest health and wildfire response goals.

Achieving dual benefits will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs. These two approaches combined will contribute to restoring and maintaining large portions of the landscape in a resilient condition while providing safe and effective areas for firefighter engagement during suppression, prescribed fire, or managed wildfire operations.

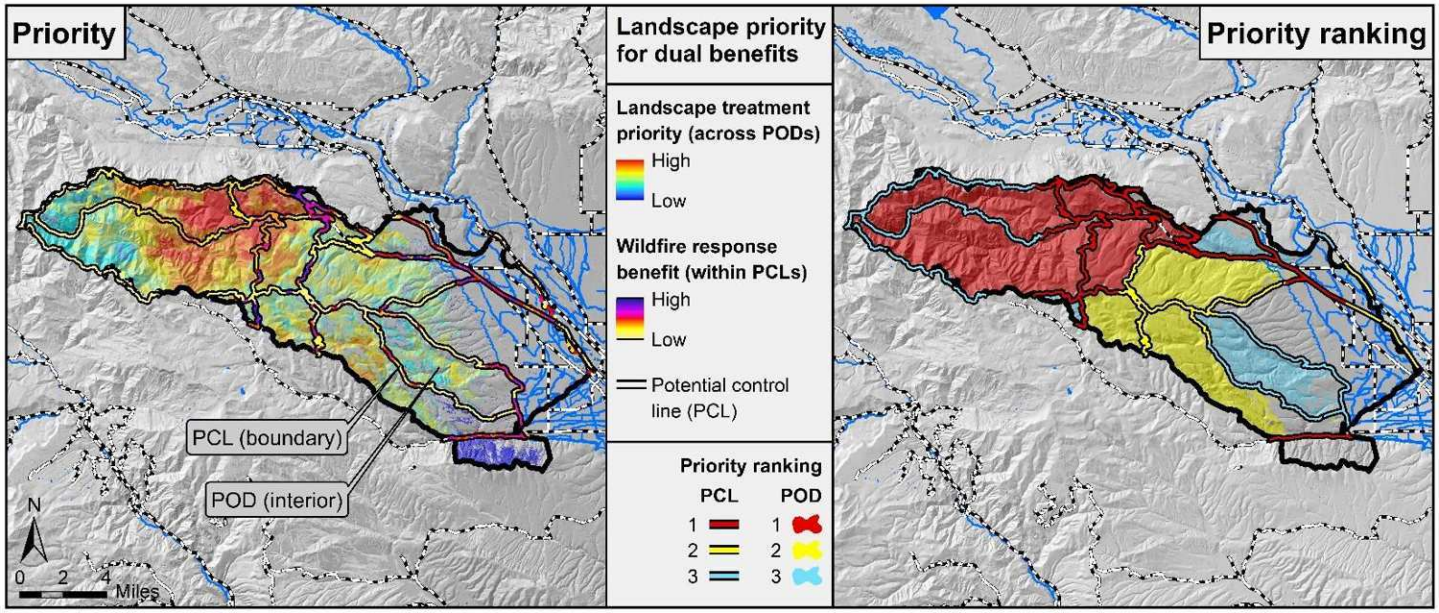

Figure 4. Landscape prioritization of dual benefits using PODs as a spatial framework to summarize treatment priorities. Both maps display landscape treatment priority within PODs and wildfire response benefit within PCLs. The map on the left shows the datasets at the raster level, while the map on the right shows the same information summarized and ranked within PODs and PCLs. Gray within planning area denotes locations without substantial forest cover. PCL width is inflated to display spatial patterns. *PODs shown here are part of an ongoing process towards an all-lands delineation; POD boundaries are subject to change following on-the-ground vetting and continued dialogue among wildfire agencies and stakeholders.*

LEARN MORE

This landscape evaluation was updated in 2020.
More details about DNR's priority planning areas are available on the 20-Year Forest Health Strategic Plan website:
https://www.dnr.wa.gov/ForestHealthPlan

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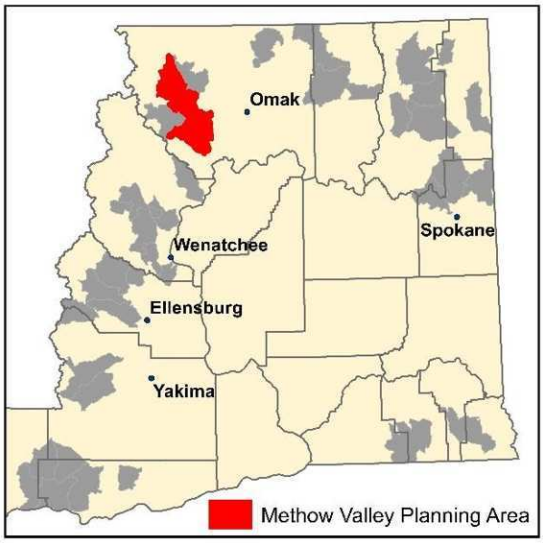
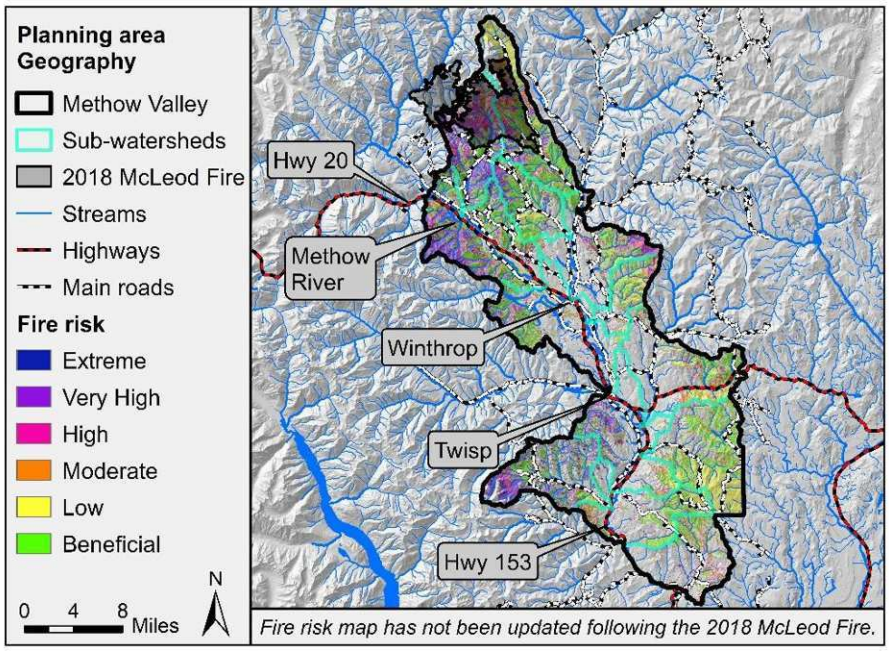
METHOW VALLEY PLANNING AREA LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
338,246	182,937	49,500 - 75,000





Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- Land ownership is split among the Okanogan-Wenatchee National Forest (57%), private (22%), DNR (10%), WDFW (8%), and other (3%). The majority of USFS land is designated as inventoried roadless area and Late Successional Reserve.
- 80% of forest in the planning area is dry forest, while 17% is cold forest, and 3% is moist forest.
- Fire risk is variable due to past fires, completed treatments, and complex topography. Burn probability is among the highest in eastern Washington.
- Projected warming over the next 20-40 years will likely shift much of the dry forest to woodland or grassland.
- Treating 27-41% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- High priority areas for potential treatments that maximize forest health and wildfire response benefit include locations west of Winthrop, northwest of Winthrop, and southwest of Twisp.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk to forests is variable across this large planning area due to past fires, complex topography, and completed treatments (Fig. 2). Large patches of high and very high risk are mixed in with low risk, as well as patches of open forest and grassland where fires are predicted to burn as low-intensity surface fires, which will have beneficial effects by consuming fuels. Recently burned acres have low risk until fuels grow back 10-15 years following fire. Burn probability across most of the planning area, which is based on patterns of large fires from 1992-2015, is among the highest in eastern Washington. Landscape treatments will help reduce the risk of uncharacteristic large patches of high-severity fire, especially as burn probability further increases with projected climate warming. Over time, a restored landscape will provide managers more flexibility to utilize managed wildfire to maintain these fire-dependent ecosystems. In addition, implementing fuel reduction treatments around homes and establishing potential control lines will increase firefighter safety and help protect communities, which is covered in the last two pages of this summary.

Increase resilience and prepare for climate change

By mid-century, a large portion of the dry forest is projected to experience moisture stress levels that are currently associated with woodlands and grasslands (Fig. 3). Some moist and cold forests areas are projected to shift to moisture stress levels that currently support dry forests. Treatments in these areas to reduce density and favor drought-tolerant species will enhance future forest persistence. Moderate and low moisture stress levels are projected to remain in the northern portion of the planning area and on north-facing slopes in other areas.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is somewhat well represented in the planning area, and patch sizes are generally adequate. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is at the lower end of desired ranges and generally restricted to small patches in valley bottoms and north-facing slopes. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is well represented in the northern portion where larger blocks of cold and moist forest exist.

Enhance rural economic development

Reducing fire risk will help sustain recreation and tourism, which is the primary economic driver in the Methow Valley. Much of the high and medium priority treatment area has road access, gentle terrain, and is commercially viable, although significant areas are steep and have no access. Over time, warming trends and increasing burn probability will make it increasingly challenging to manage for wood production on private and DNR lands, which are almost all dry forest.

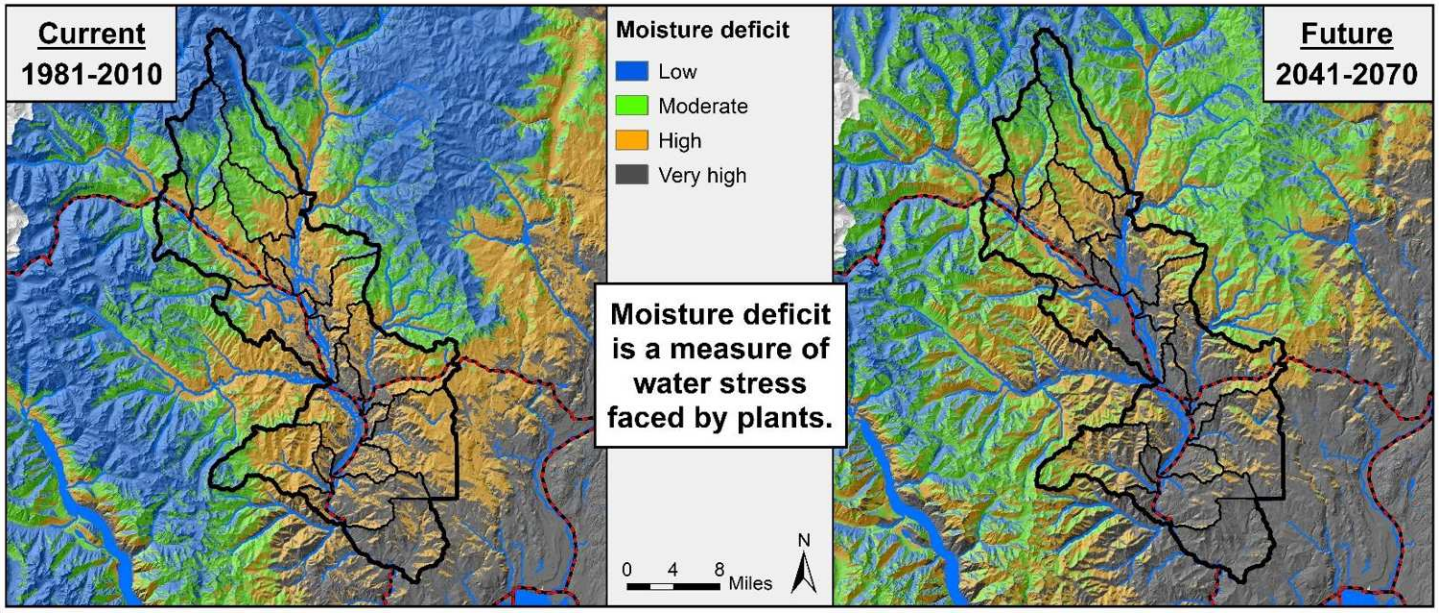


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

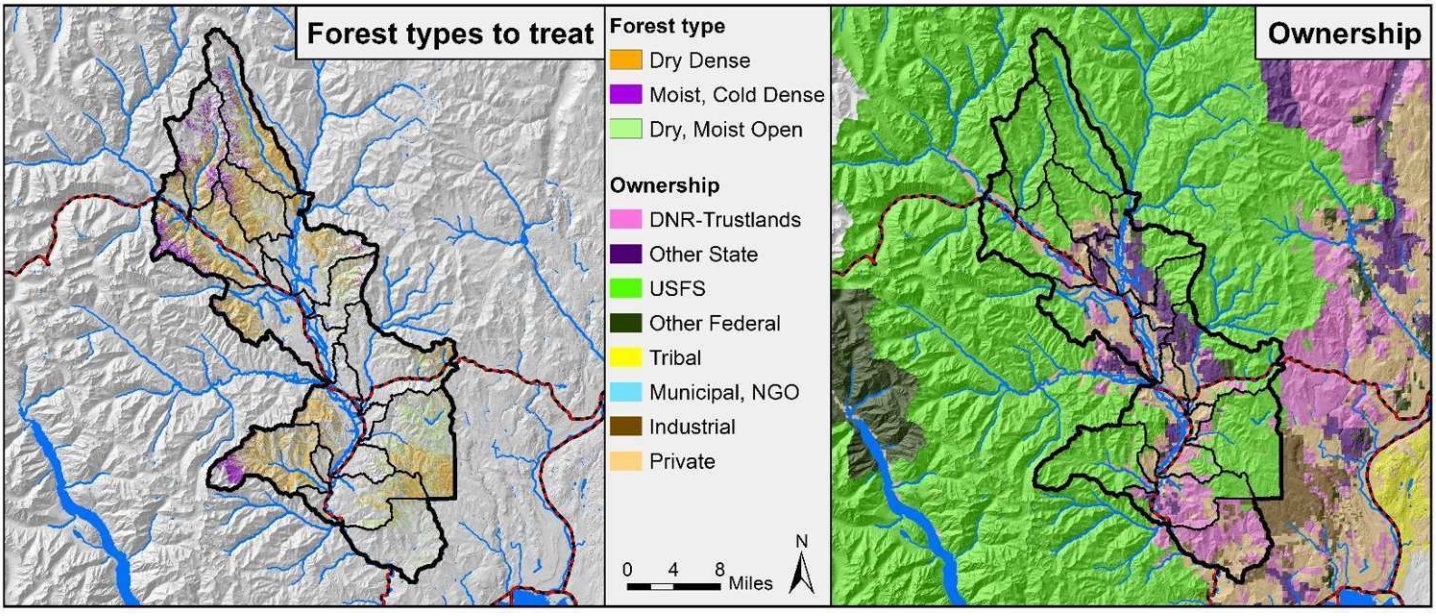
Forest Health Treatment Needs

Treating 49,500 to 75,000 acres is recommended to move the landscape into a resilient condition (27-41% of forested acres; Table 1). This total includes an estimated 33,500-50,500 acres to shift dense to open forest and 16,000-24,500 acres of maintenance treatments in existing open forest, based on current condition data from 2018 LiDAR and Gradient Nearest Neighbor maps. These vegetation maps were updated after the 2018 McLeod Fire. Most of the treatment need is located on USFS land. Significant need also exists on private and DNR land and some WDFW land. Numerous treatments on USFS, DNR, and WDFW have been implemented since the 2018 LiDAR flight, or will be in the next few years.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be a key tool, especially in roadless areas and less accessible locations and for maintenance treatments over time. Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, markets, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**USFS**	**Private**	**DNR Trust**	**WDFW**	**Other Fed.**
Dry Dense	Medium-Large	32,000 - 47,500	61,427	6,925	2,588	1,764	640
Moist + Cold Dense	Medium-Large	1,500 - 3,000	7,749	70	15	11	0
Dry + Moist Open	Medium-Large	16,000 - 24,500	24,460	3,613	3,163	1,064	267
Total		**49,500 - 75,000**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, closed-canopy forests with medium and large trees are over-represented on dry sites. Some overly large, contiguous patches of dense forest exist, but most of the dense forest patches are small to moderate in size and are broken up by open canopy or young forest, as well as non-forest patches. Treating 32,000-47,500 acres of this type (Table 1) is recommended to create larger patches (~100-1000 ac) of open forest with a component of large trees (Fig. 4), flipping the majority of dry sites from closed to open forest (Fig. 6). As the retained trees grow over time, much of the dry forest will shift to large tree, open forest, which is currently represents only 5% of the dry forest area. Shifting composition toward ponderosa pine and reducing Douglas-fir is also recommended.

Moist and cold dense forest treatment need

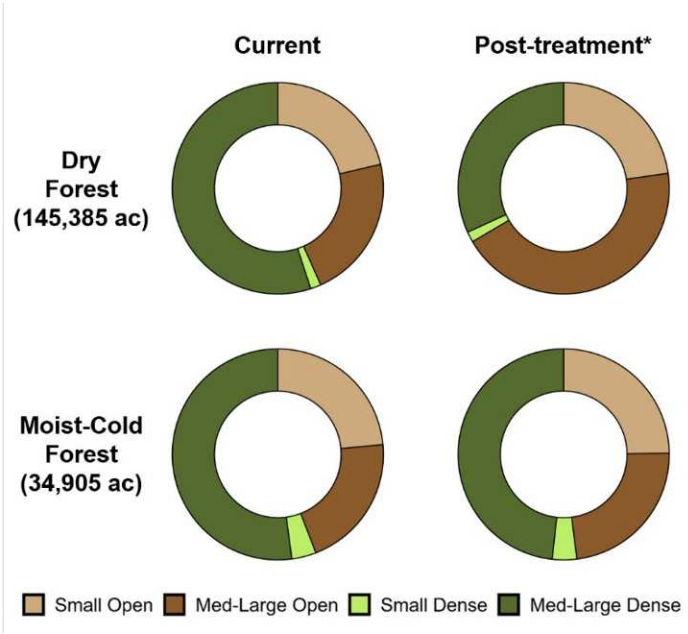
Dense, medium tree forest on moist and cold sites exceeds or is at the upper end of desired ranges across the planning area. In contrast, large tree dense, and to a lesser extent large tree open forest, are below desired ranges and patch sizes are small. Treating 1,500-3,000 acres of this forest type (Table 1, Fig. 4) is recommended to reduce risk of losing medium and large tree structure to high severity fire and to accelerate the growth of large trees. A range of treatment types will be needed, including thinning and mixed severity, managed wildfire in roadless and inaccessible areas. Increasing the relative composition of ponderosa pine and western larch is also needed to help these sites adapt to a warming climate. Following treatments, approximately half of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

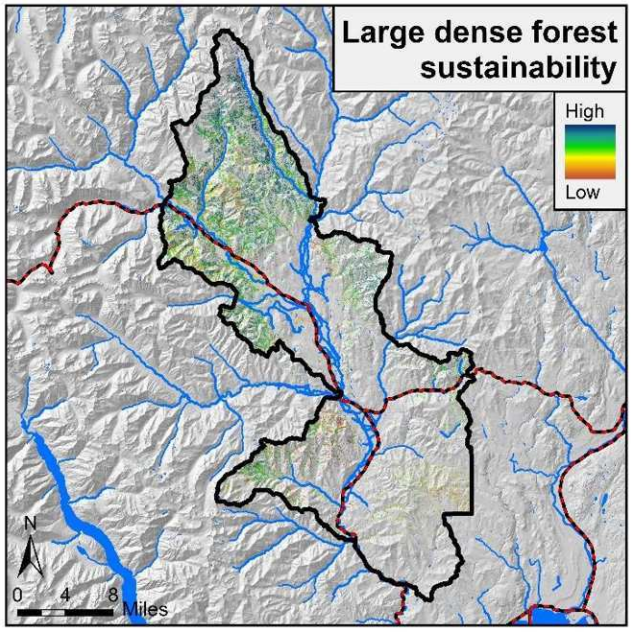
Open forest maintenance treatment need

Over the next 15 years, an estimated 16,000-24,500 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include some recently burned areas where surface fuels may accumulate more quickly due to regrowth of vegetation and burned trees falling to the ground. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. The majority of the more sustainable locations are in the northern portion of the planning area, as well as some higher elevation areas in the Libby Creek drainage (Fig. 7). The large tree, dense forest sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is high across the central part of the planning area, indicating that wildfires starting in these locations are expected to expose homes through the Methow Valley (Fig. 2).

Treatment priorities

Landscape treatment priority is highest south of the town of Twisp (Fig. 9) on USFS and private. Other medium and high priority areas occur on private and WDFW land north and west of Winthrop, in the southeastern corner, and in higher elevation areas in the Libby creek drainage. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes throughout the Methow Valley.

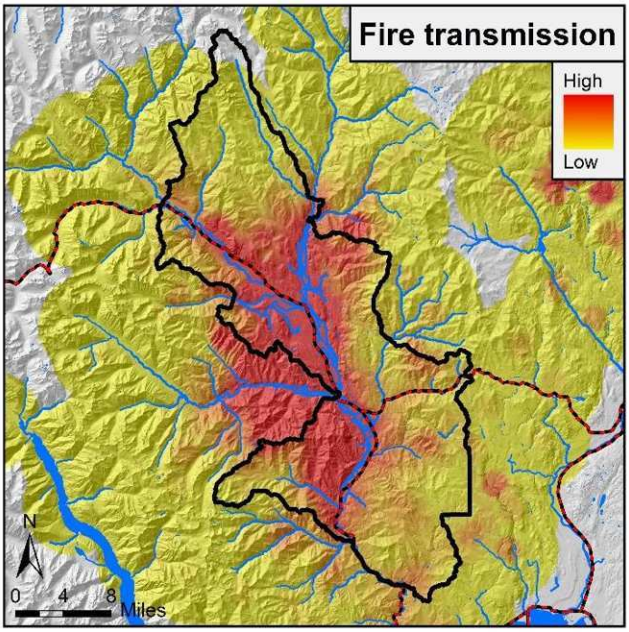


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

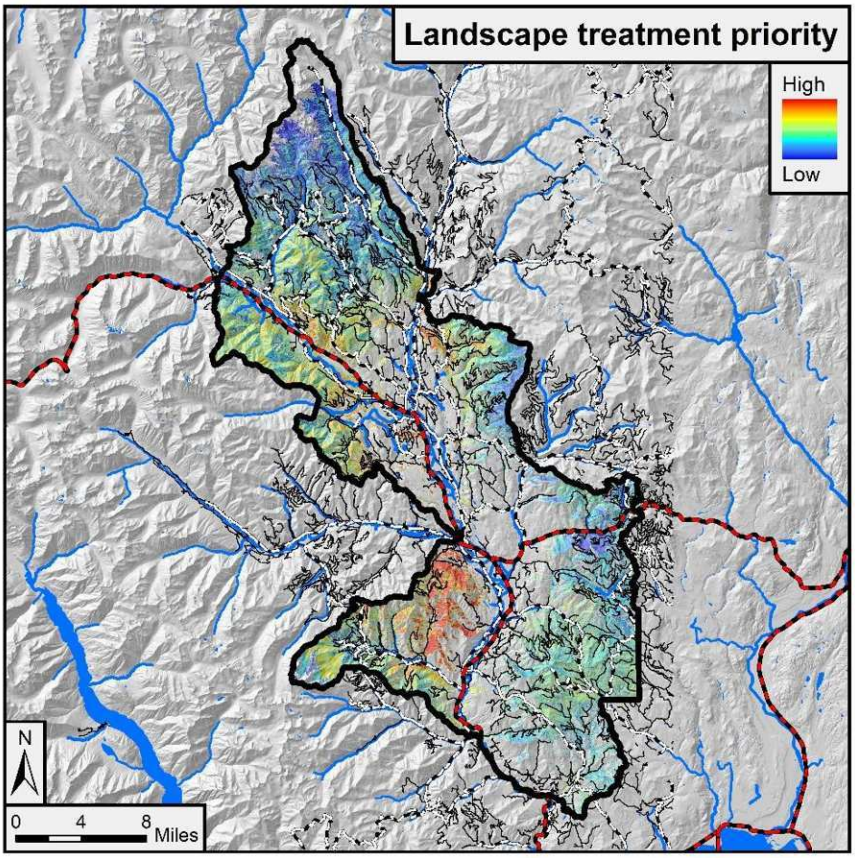


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires that are allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

Wildfire Response Benefit Prioritization

Dual benefits for forest health and wildfire response

It is necessary to conduct treatments to both improve forest health and reduce fire risk to communities as well as provide conditions where firefighters can safely and efficiently conduct fire operations (e.g. suppression, prescribed burning, and managed wildfire). The wildfire response benefit metric (WRB; Fig. 10) identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes, infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior. Because there are positive feedbacks between healthy, resilient forests and safe, effective fire operations, the WRB metric also integrates the landscape treatment priority map (Fig. 9).

Where WRB is highest, actions may be needed to create and maintain conditions that provide a tactical advantage for fire operations. These actions will vary with the local context and can include landscape-level forest health and fuel treatments, treatments along escape routes, resident and community fire mitigation activities (e.g. defensible space, home hardening), and improving signage and road conditions. The WRB metric provides a high-level prioritization, and additional work at the local level will be required to identify appropriate actions and assess their feasibility. WRB is useful for prioritizing Potential Control Lines (PCLs) for fire operations (Fig. 11). PCLs are a part of Potential Operational Delineations (PODs); see page 7.

In the Methow Valley planning area, wildfire response benefit is high along the Highway 20 corridor (Fig. 2), corresponding to high risk to homes and infrastructure combined with high transmission to homes along this major road (Fig. 8). There are also two hotspots, one located southwest of Winthrop and the other located south of Twisp. The north hotspot is due to the additional risk to a source of surface drinking water in the area. The south hotspot is due to high risk to commercially managed lands combined with high wildfire transmission to homes.

Definitions (continued)

Wildfire response benefit: Any tactical advantage gained for wildfire response activities from actions on the landscape, including identifying and consolidating existing anchor points and control lines and reducing potential fire behavior. Wildfire response benefit is not restricted to any specific fire management strategy; it is centered on conditions that improve fire operations safety and efficacy during suppression, prescribed fire, or managed wildfire.

Potential Control Lines (PCLs): Boundaries of Potential Operational Delineations (PODs) relevant to fire control operations (e.g. roads, ridgetops, and water bodies).

Potential Operational Delineations (PODs) for wildland fire: Landscape containers whose boundaries are potential control lines (PCLs). PODs are useful for planning strategic response to unplanned ignitions, strategic fuel planning, and prioritizing fuel treatments within PODs.

Commercially managed lands: Commercially managed forestlands include: DNR Trustlands, tribal forests, industrial forests, non-industrial private forests, and US Forest Service forests where timber is a primary management objective.

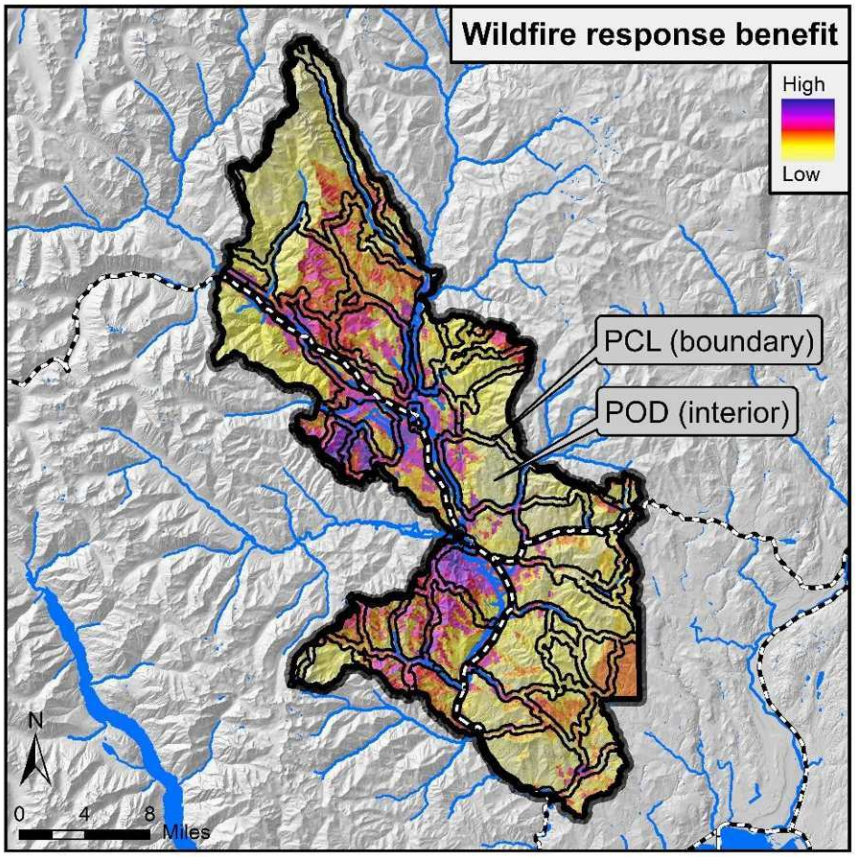


Figure 10. Wildfire response benefit (WRB) integrates multiple fire risk and forest health components. It includes four fire risk metrics representing highly valued resources – risk to homes, infrastructure, drinking water, commercially managed lands – as well as crown fire potential and wildfire transmission to homes (Fig. 8). Combined, these account for 75% of the wildfire response benefit. Landscape treatment priority (Fig. 9) accounts for the remaining 25%. Also shown are PODs: units bounded by PCLs (open black lines). One use of the WRB metric is to prioritize Potential Control Lines (PCLs) for fire operations (Fig. 11).

Prioritizing Landscape Treatments for Dual Benefits

Integration of forest health and wildfire response benefit using PODs

Potential Operational Delineations (PODs) provide a powerful spatial framework to communicate and identify locations that will deliver dual benefits for forest health and wildfire response at the landscape scale. PODs are large landscape areas delimited by Potential Control Lines (PCLs) for fire operations (suppression, prescribed fire, and managed wildfire) delineated by fire operations personnel. PCLs can be roads, ridgelines, or any artificial or natural fuelbreak that provides a strategic opportunity for fire operations. Summarizing landscape treatment priorities (Fig. 9) within PODs and wildfire response benefit priorities (Fig. 10) within PCLs enables planners and managers to identify, at a high level, locations where forest health or fuels treatments can be connected to a high-priority PCL that will support firefighter operations (e.g. ingress/egress route or opportunity for engagement).

Achieving forest health and wildfire response goals will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs.

There is important work to do in all Methow Valley PODs to achieve the forest health treatment targets in Table 1. First priority PODs correspond to areas with high forest health landscape treatment priority along the east boundary of the planning area, west of Winthrop, and southwest of Twisp. Many first priority PODs are associated with first priority PCLs, thus providing dual benefit opportunities. There are multiple first priority PCLs along the Highway 20 corridor. Some of these are surrounded PODs that are sparsely forested and rank as a third priority in the planning area.

Achieving forest health and wildfire response dual benefits will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs. These two approaches combined will contribute to restoring and maintaining large portions of the landscape in a resilient condition while providing safe and effective areas for firefighter engagement during suppression, prescribed fire, or managed wildfire operations.

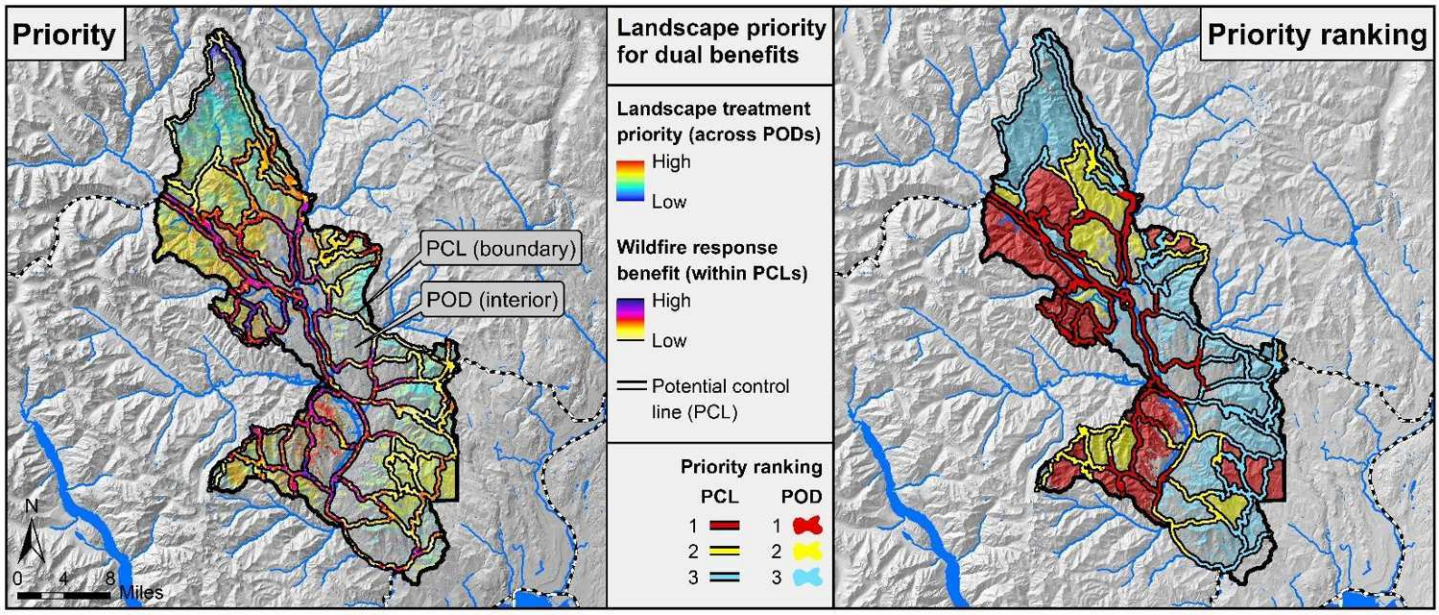
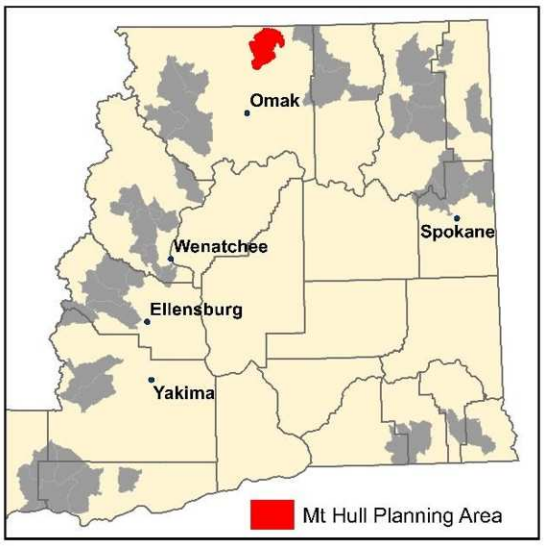
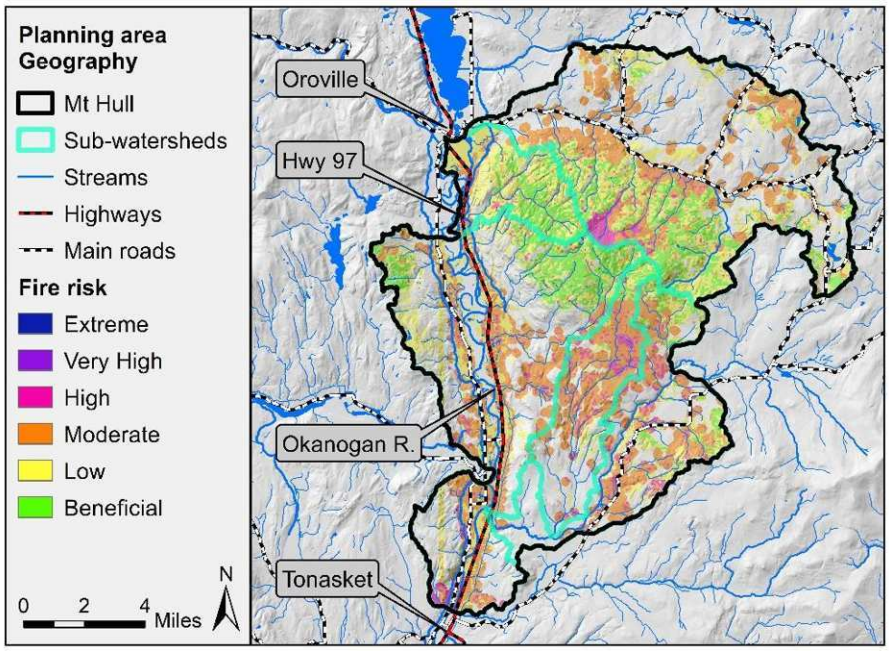


Figure 11. Landscape prioritization of dual benefits using PODs as a spatial framework to summarize treatment priorities. Both maps display landscape treatment priority within PODs and wildfire response benefit within PCLs. The map on the left shows the datasets at the raster level, while the map on the right shows the same information summarized and ranked within PODs and PCLs. Gray within planning area denotes locations without substantial forest cover. PCL width is inflated to display spatial patterns. *PODs shown here are part of an ongoing process towards an all-lands delineation; POD boundaries are subject to change following on-the-ground vetting and continued dialogue among wildfire agencies and stakeholders.*

MT HULL PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
105,431	34,809	12,000 - 18,500





Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- This planning area encompasses Mt Hull and surrounding forest and shrub-steppe in the Okanogan River watershed. Some currently dense forests occur on mollisol soils that historically supported open forest and meadow habitats.
- The total area is 69% private land, 21% US Forest Service, and 10% other land owners.
- Fire risk to forests is high in the center of the planning are near the top of Mt Hull. Fire risk to homes in the wildland-urban interface is widespread in northern and southern portions of the planning area.
- Projected warming over the next 20-40 years will likely shift climate conditions suitable for moist and cold forest towards conditions suitable for dry forest. Some low elevation areas that are currently forested may no longer support forest.
- Treating 34-53% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments. The US Forest Service has planned 20,000 acres of thinning and prescribed fire in the area as part of the Mt Hull Restoration Project.
- Treatment priority is high in the south-central and western edge of the planning area based on fire risk, drought vulnerability, current forest structure, and fire transmission to communities.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high in the center of the planning are near the top of Mt Hull, due primarily to high fuel loads in the cold forest type (Fig. 2). Fire risk to homes in the wildland-urban interface is widespread in northern and southern portions of the planning area. Fuels treatments are needed to break up the large patches of dense forest to reduce the likelihood of large crown fire and to facilitate protection of private property throughout the planning area. Recent fires, including the Palmer Fire and Cold Springs Fire in 2020, underscore the threat of wildfire to ecosystems and communities on this area.

Increase resilience and prepare for climate change

By mid-century, the majority of the planning area is projected to have moisture stress levels that are currently associated with dry forest or shrub-steppe, particularly at lower elevations (Fig. 3). Treatments that reduce density and favor drought-tolerant species will enhance future forest persistence. At most elevations, moisture stress is projected to increase due to earlier snow melt, less summer precipitation, and warmer spring and summer temperatures. Some high elevation areas, however, are projected to have lower moisture stress levels. Lower moisture stress is due to warmer and more rain-dominated winter and spring conditions, offsetting mild decreases in summer precipitation.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is generally within desired ranges, and it is aggregated in large patches in the center of the planning area. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is a minor component of this planning area. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is also a minor component of this area, and it is limited to upper slopes on the north side of Mt Hull.

Enhance rural economic development

Most of the higher priority areas for commercial treatments have road access and are capable of producing significant timber volume. Although warming trends and high burn probability will necessitate managing for lower densities and fuel loads, long-term timber production will likely be possible on USFS land. Planned treatments on USFS land will help address a substantial portion of the treatment need. Reducing fire risk will help sustain recreation while reducing the potential of smoke affecting nearby communities.

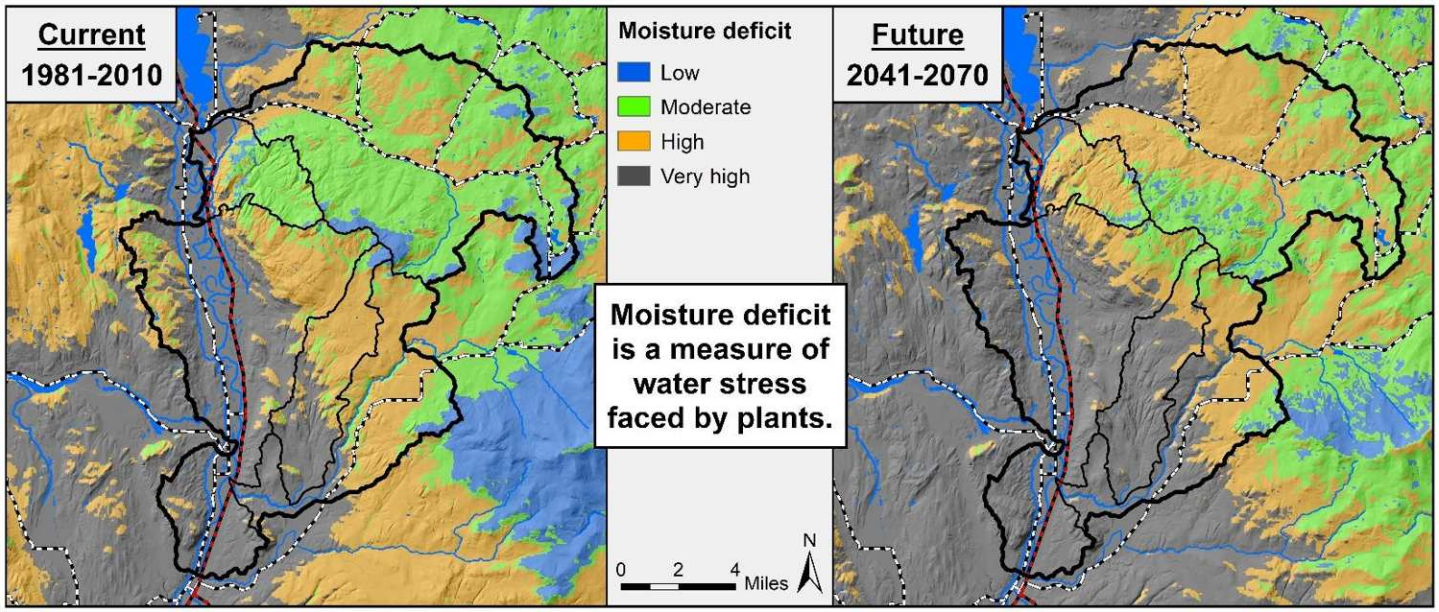


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

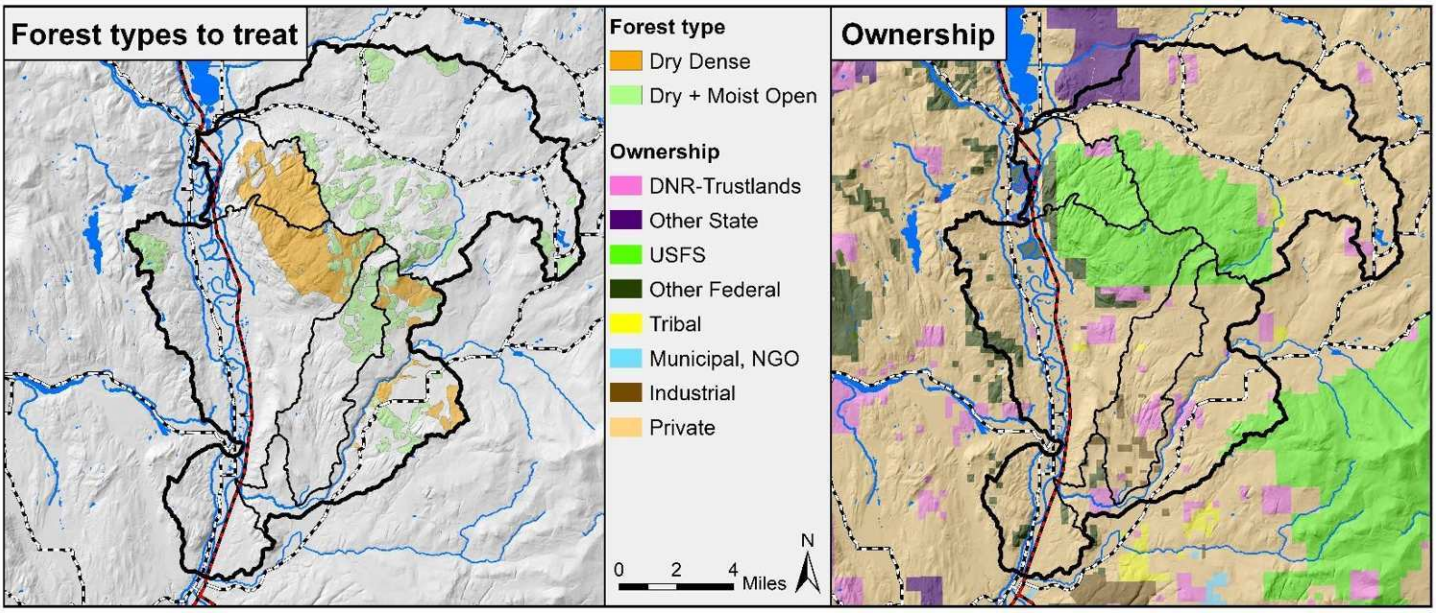
Forest Health Treatment Needs

Treating 12,000 to 18,500 acres is recommended to move the landscape into a resilient condition (34-53% of forested acres; Table 1). This total includes an estimated 7,000-10,500 acres to shift dense to open forest and 5,000-8,000 acres of maintenance treatments in existing open forest, based on current condition data from 2014 aerial photos. Most of the treatment need is located within USFS land.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in less accessible locations. Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**Private**	**USFS**	**DNR Trust**	**Federal**	**Other**
Dry Dense	Small	250 - 900	1,380	1,842	3	0	0
	Medium-Large	6,750 - 9,600	2,711	9,650	419	47	154
Dry + Moist Open	Medium-Large	5,000 - 8,000	5,517	4,403	577	15	21
Total		**12,000 - 18,500**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites, especially sites dominated by Douglas-fir. The large, contiguous patches of this forest type create high susceptibility to defoliating insects and crown fire. Treating 7,000-10,500 acres of this type (Table 1) is recommended to create large patches (~100-1000 ac) of open forest with a component of large trees (Fig. 4), flipping the majority of dry sites from closed to open forest (Fig. 6). Shifting composition toward ponderosa pine and reducing grand fir and Douglas-fir is also recommended. The US Forest Service has planned 20,000 acres of thinning and prescribed fire in the area as part of the Mt Hull Restoration Project.

Moist and cold dense forest treatment need

Moist and cold forest structure is within desired ranges and thus not included in Table 1. However, there may be other forest health reasons to treat these forests based on management objectives and field evaluations.

Open forest maintenance treatment need

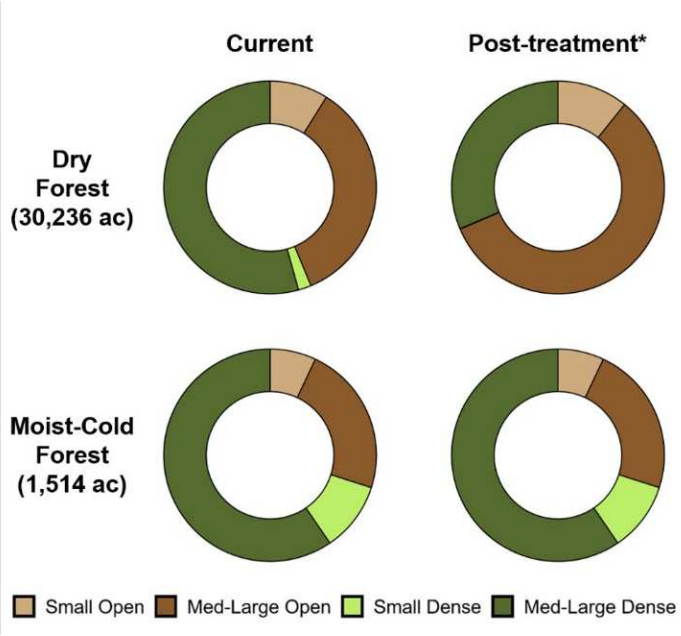
Over the next 15 years, an estimated 5,000-8,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments. Specific maintenance strategies depend on landowner objectives and time since treatment.

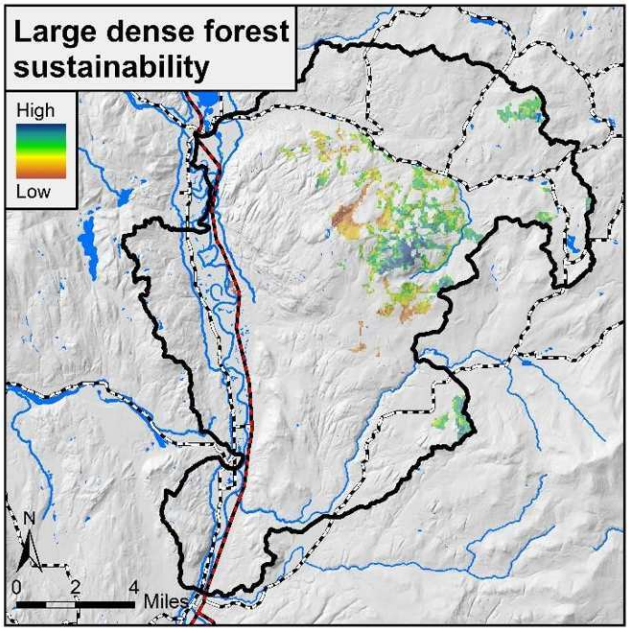
Unique management considerations

Unique features of the Mt Hull planning area include widespread mollisol soils, which indicate that some sites with currently dense forests formerly supported open forest and meadow habitats. This planning area also includes substantial private land that is currently agricultural land or shrub-steppe vegetation with direct implications for fire risk in the wildland-urban interface. In addition, the area is home to the Mt Hull bighorn sheep herd, co-managed by the Washington Department of Fish and Wildlife and the Colville Confederated Tribes. The herd primarily uses open habitats adjacent to rocky terrain and cliffs, features where grasslands, shrub-steppe, dry forests, and mountains converge. There is potential for restoration efforts to benefit both bighorn habitat and fuels reduction goals. Finally, the planning area lies within an important north-south connected network of shrub-steppe habitats for wildlife today and in a changing climate.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain this forest habitat type and associated ecosystem functions. Sustainable locations include upper elevation headwaters of Tonasket Creek in the east-central portion of the planning area (Fig. 7). The large tree, dense forest sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). We also recommend incorporating the large dense forest sustainability layer (Fig. 7) as an overlay when selecting treatment locations. Wildfire transmission is high in western and south-central portions of the planning area, indicating that wildfires starting in these locations are expected to expose homes in Oroville, Tonasket, and along the Highway 97 corridor (Fig. 2).

Treatment priorities

Landscape treatment priority is highest in south-central portion on USFS ownership and adjacent private land, particularly for maintenance treatments. The western edge of the planning area is also high priority for maintenance treatments (Fig. 9). Some moderate and low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes throughout the planning area.

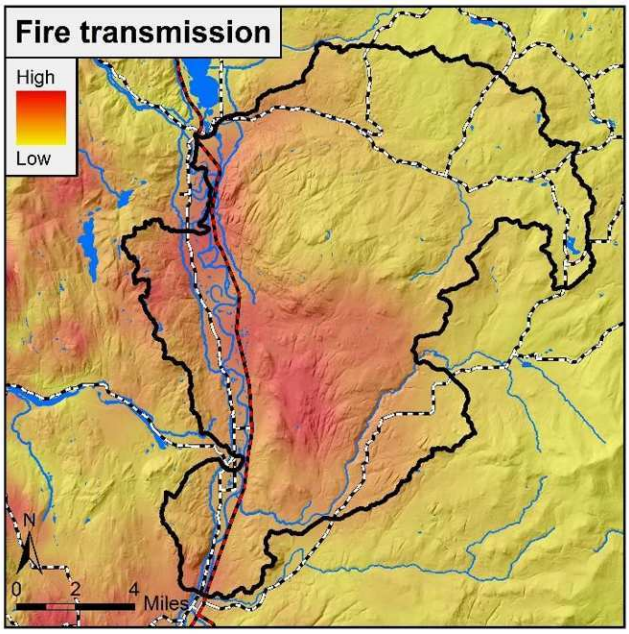


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

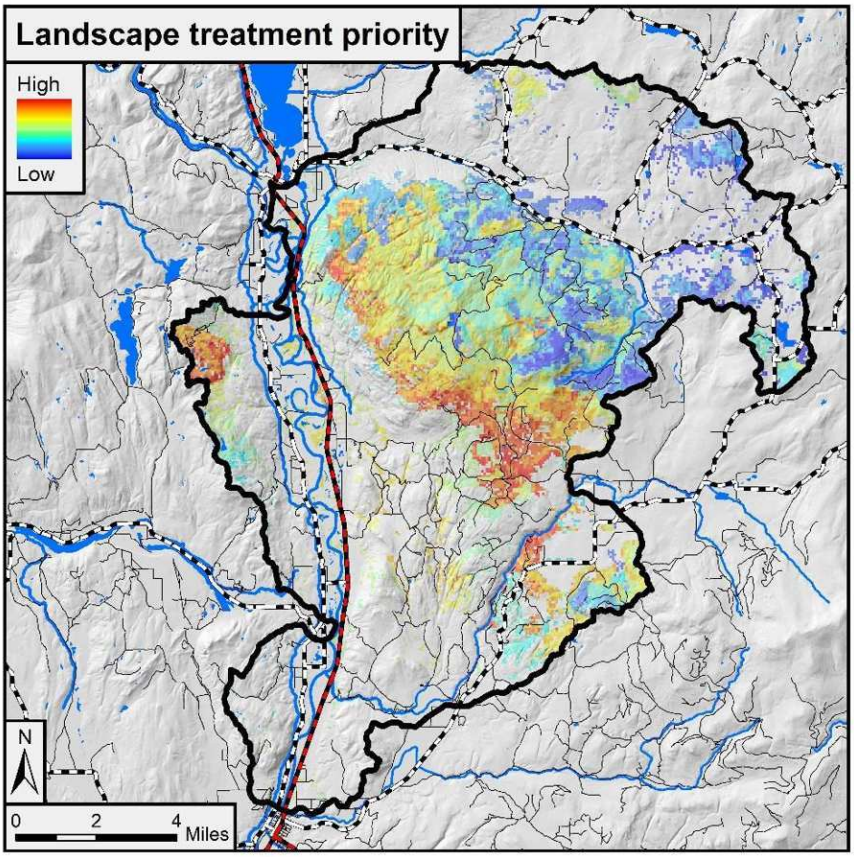


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

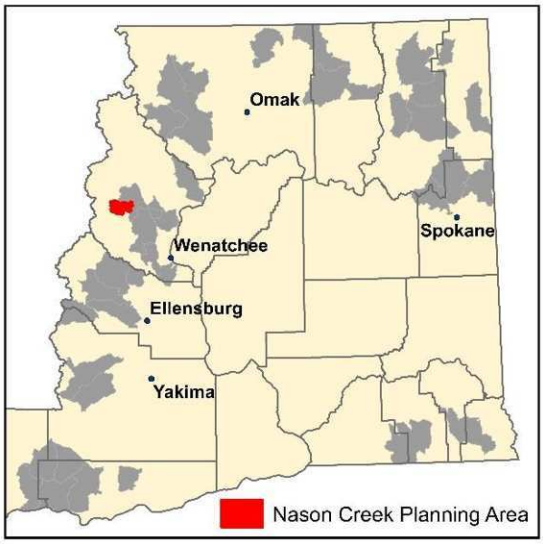
***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

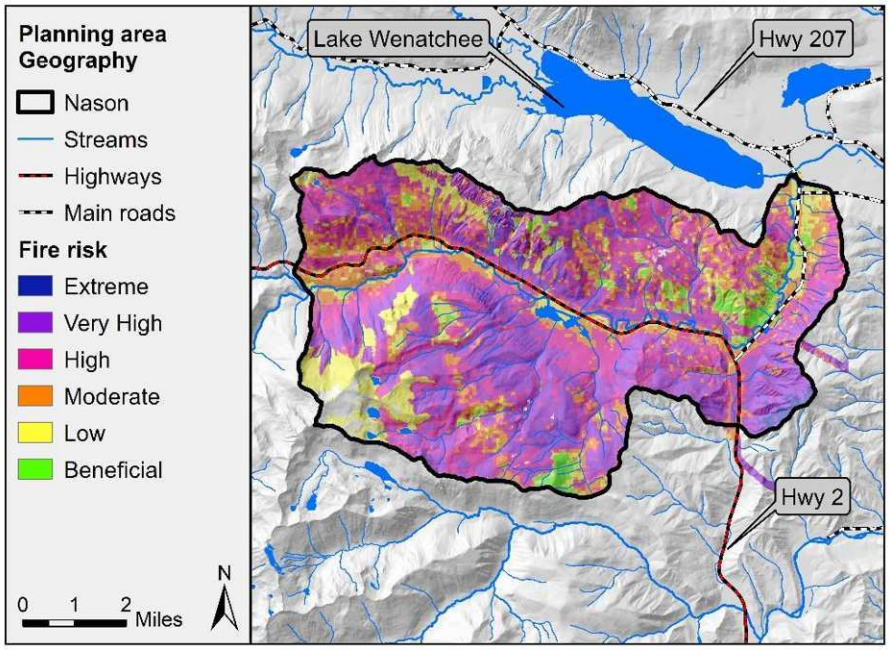
Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires that are allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

NASON CREEK PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
31,679	29,243	6,750 - 11,500





Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- This planning area is east of Steven's Pass and south and west of the DNR Upper Wenatchee 2018 planning area.
- This planning area is mostly dense, moist and cold mixed-conifer forests, with some dry forest in the eastern portion. Much of the area is highly productive and suitable for long-term timber production on all lands.
- Land ownership is 61% USFS, 16% industrial forestland, 9% Nason Community Forest, 12% small private landowners, and 2% DNR Trustlands.
- Fire risk and treatment need are high for most of the small private landowner parcels along Highways 2 and 207.
- Treating 23-39% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- High priority areas for potential treatments that maximize forest health and wildfire response benefit include locations north and east of Highway 2 in the eastern portion of the planning area.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high to very high in most of the planning area due to high fuel loading and moderate to high fire probability (Fig. 2). Risk is very high for the private parcels along Highways 2 and 207. In the northeastern portion, past fuels treatments on USFS land and fires and timber harvest on private land have reduced fire risk. Additional fuels treatments in this area are needed to flip the south-facing slope north of Highway 2 to mostly open forest with large trees of fire resistant species. Treatments in the south-central portion are also needed to break up the large, contiguous patches of dense forest and risk of a large crown fire. Finally, the wildland-urban interface needs extensive treatment.

Increase resilience and prepare for climate change

By mid-century, almost all the north central and eastern portions are projected to have moisture stress levels currently associated with dry forest or woodland (Fig. 3). Dense forests in these areas will be vulnerable to drought. The western half of the planning area, which is mostly moist and cold forest, is projected to maintain low to moderate moisture deficit levels and thus should support dense forest, especially on north-facing slopes. However, dense forests dominated by silver, grand, sub-alpine fir may be susceptible to drought mortality, especially at their lower elevation limits. Treatments, as well as managed wildfires in roadless and other inaccessible areas, that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

A very small amount (~2%) of the landscape is currently habitat for large tree, open canopy species (e.g. White Headed Woodpecker), although the patch sizes are adequate. The total amount and range of patch sizes of habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is within desired ranges. However, approximately 1/3rd of this habitat has high fire risk and drought vulnerability. In high fire risk locations, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability while helping maintain habitat in the most sustainable locations (Fig. 7). Habitat for species that depend on cold, closed canopy forest with large trees (e.g. American Marten) is within but at the lower end of desired ranges for total amount and patch size.

Enhance rural economic development

Much of this planning area is highly productive forestland and is projected to remain so into the future. Most of the higher priority areas for commercial treatments have road access and are capable of producing significant timber volume. Reducing overall fire risk will reduce potential losses to private and public forestlands and help sustain the high level of recreational use and tourism in and around the planning area.

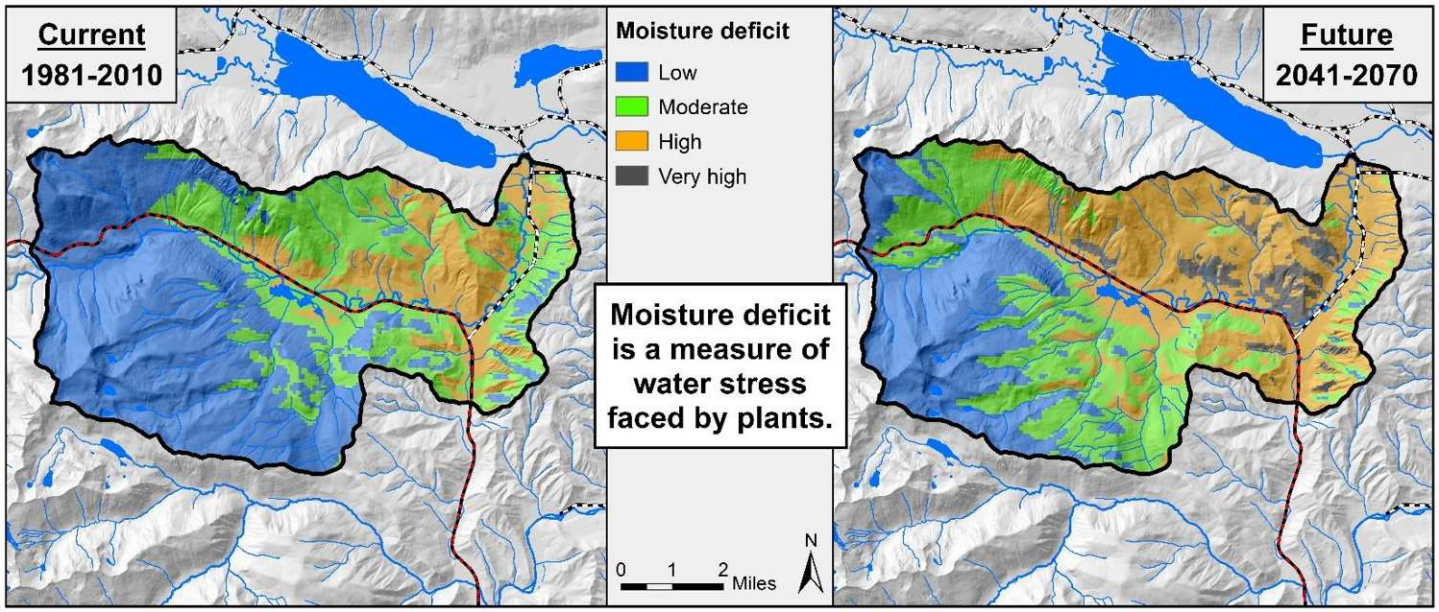


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

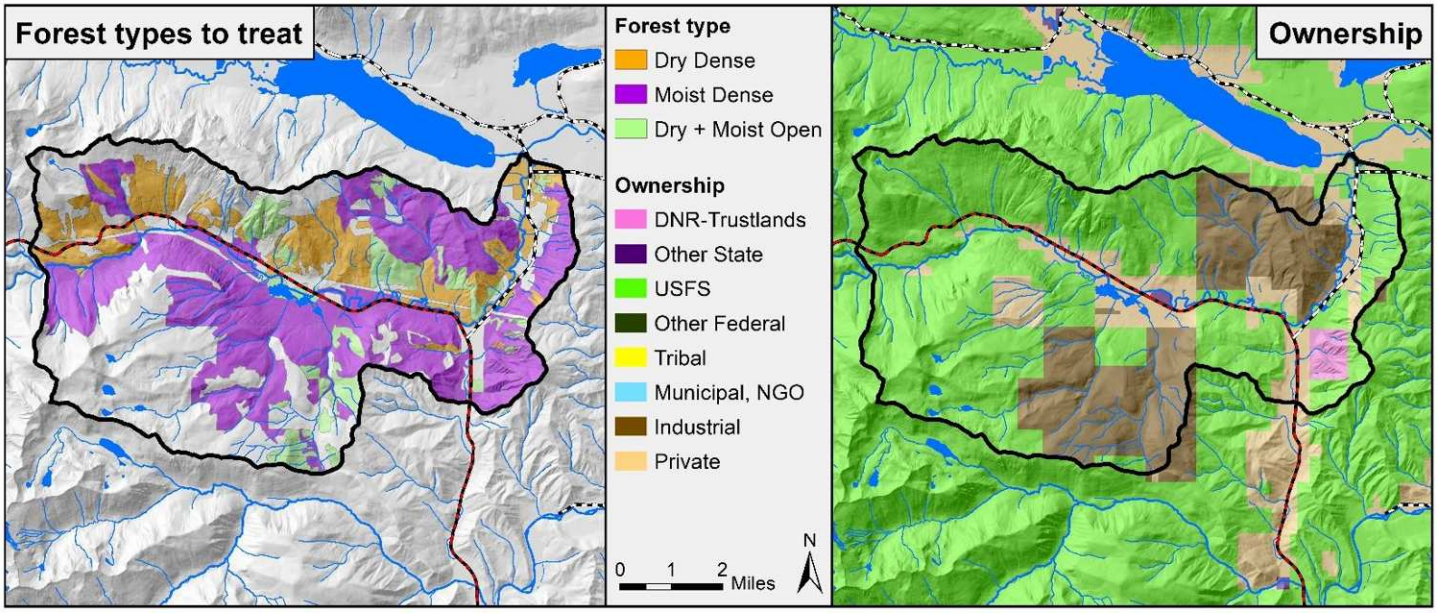
Forest Health Treatment Needs

Treating 6,750 to 11,500 acres is recommended to move the landscape into a resilient condition (23-39% of forested acres; Table 1). This total includes an estimated 5,750-10,000 acres to shift dense to open forest and 1,000-1,500 acres of maintenance treatments in existing open forest, based on current condition data from 2017 aerial photos. The majority of the treatment need and opportunity is on USFS land, although substantial need exists on other ownership types, including small private landowners and the Nason Community Forest.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in less accessible locations. Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**USFS**	**Industrial**	**Community**	**Private**	**DNR**
Dry Dense	Small	250 - 500	20	159	726	114	0
	Medium-Large	3,500 - 4,000	3,419	191	175	979	177
Moist Dense	Small	500 - 1,500	239	801	795	264	0
	Medium-Large	1,500 - 4,000	4,672	524	78	671	249
Dry + Moist Open	Medium-Large	1,000 - 1,500	626	846	611	300	30
Total		**6,750 - 11,500**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Dry dense forest treatment need

Currently, dense, multistory forest structure dominated by Douglas-fir is over-represented on dry sites. Large, contiguous patches of this forest type create high susceptibility to defoliating insects and crown fire. Treating 3,750-4,500 acres of this type (Table 1) is recommended to create large patches (~100-1000 acres) of open forest with large trees (Fig. 4). This will shift dry forests to open forest (Fig. 6), which is more resistant to fire and drought. Shifting composition toward ponderosa pine and reducing grand fir and Douglas-fir is also recommended.

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or up to 10% cover of conifers.

Forest structure

Large tree: Overstory diameter > 20 inches; **Medium tree:** Overstory diameter 10-20 inches; **Small tree:** Overstory diameter < 10 inches; **Dense canopy:** Greater than 40% tree canopy; **Open canopy:** Less than 40% tree canopy.

***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels Treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fire is allowed to burn under safe conditions to achieve management goals; can be suppressed if conditions change.

Moist and cold dense forest treatment need

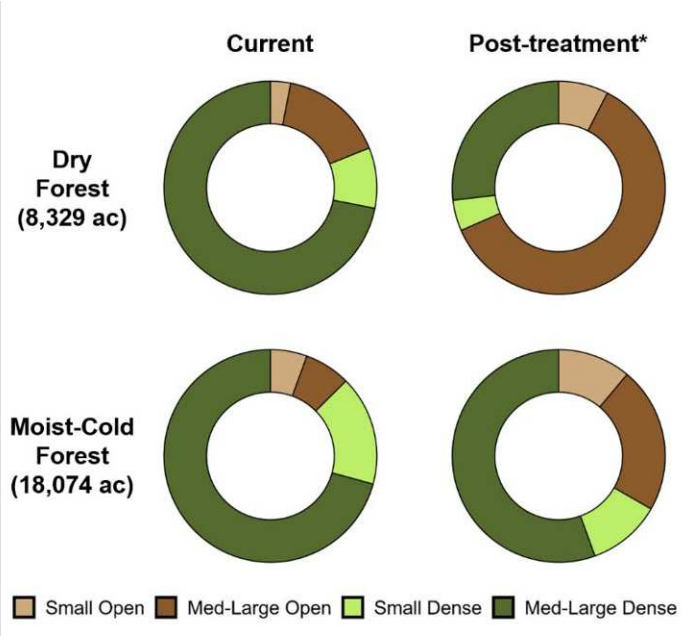
Dense, multistory forest is also over-represented in the moist forest portion of the planning area, and patch sizes are too large. Treating 2,000-5,500 acres of this forest type (Table 1, Fig. 4) is recommended to create a mosaic of open and dense forest that will reduce risks of a large crown fire and insect outbreaks. Increasing the relative composition of ponderosa pine and western larch is also needed to help these sites adapt to a warming climate. Following treatments, over 60% of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

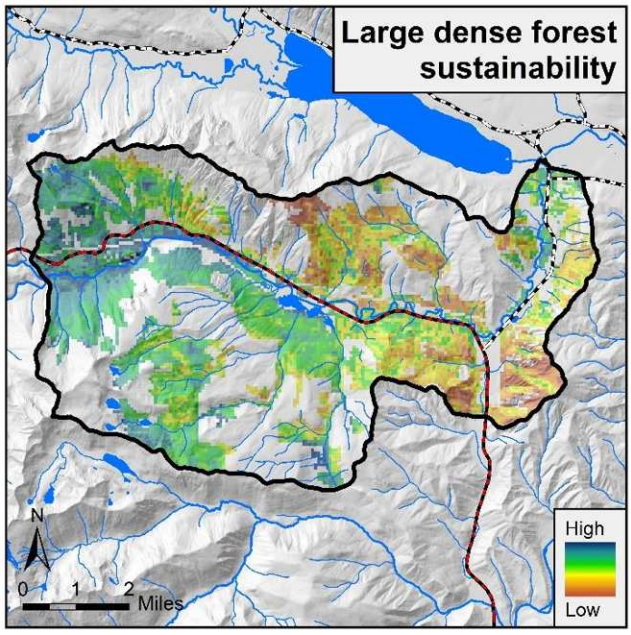
Open forest maintenance treatment need

Over the next 15 years, an estimated 1,000-1,500 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. Specific maintenance strategies depend on landowner objectives and time since prior treatments.

Sustainable locations for large tree, dense forest

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this habitat type and associated ecosystem functions. Sustainable locations include the western end of the planning area, north-facing slopes in the central portion, and the valley bottom area along Highway 207 (Fig. 7).





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). We also recommend incorporating the large dense forest sustainability layer (Fig. 7) as an overlay when selecting treatment locations. Wildfire transmission is high across most of the planning area, indicating that wildfires starting in these locations are expected to expose homes near Highway 2, Highway 207, and the Wenatchee River.

Treatment priorities

Landscape treatment priority is high throughout most of the planning area, with the exception of the southwestern portion (Fig. 9). North-facing slopes are particularly high priority due to fire risk and dense forest structure. Medium priority areas on roadless USFS lands in the northwestern portion indicate that managed wildfire may be appropriate under the right conditions. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues In addition, fuel reduction treatments, defensible space, and home hardening are needed to protect communities along Highways 2 and 207. High priority treatments that reduce fire risk in eastern portions of the planning area may help sustain large, dense forest habitat over time (Fig. 7).

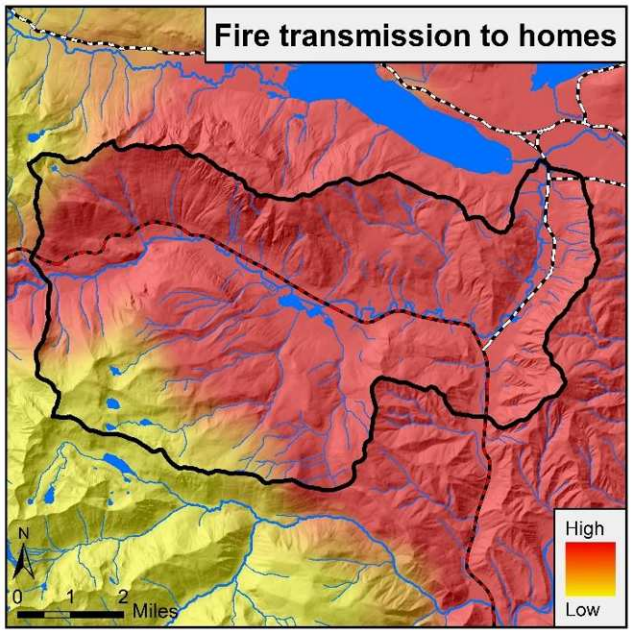


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

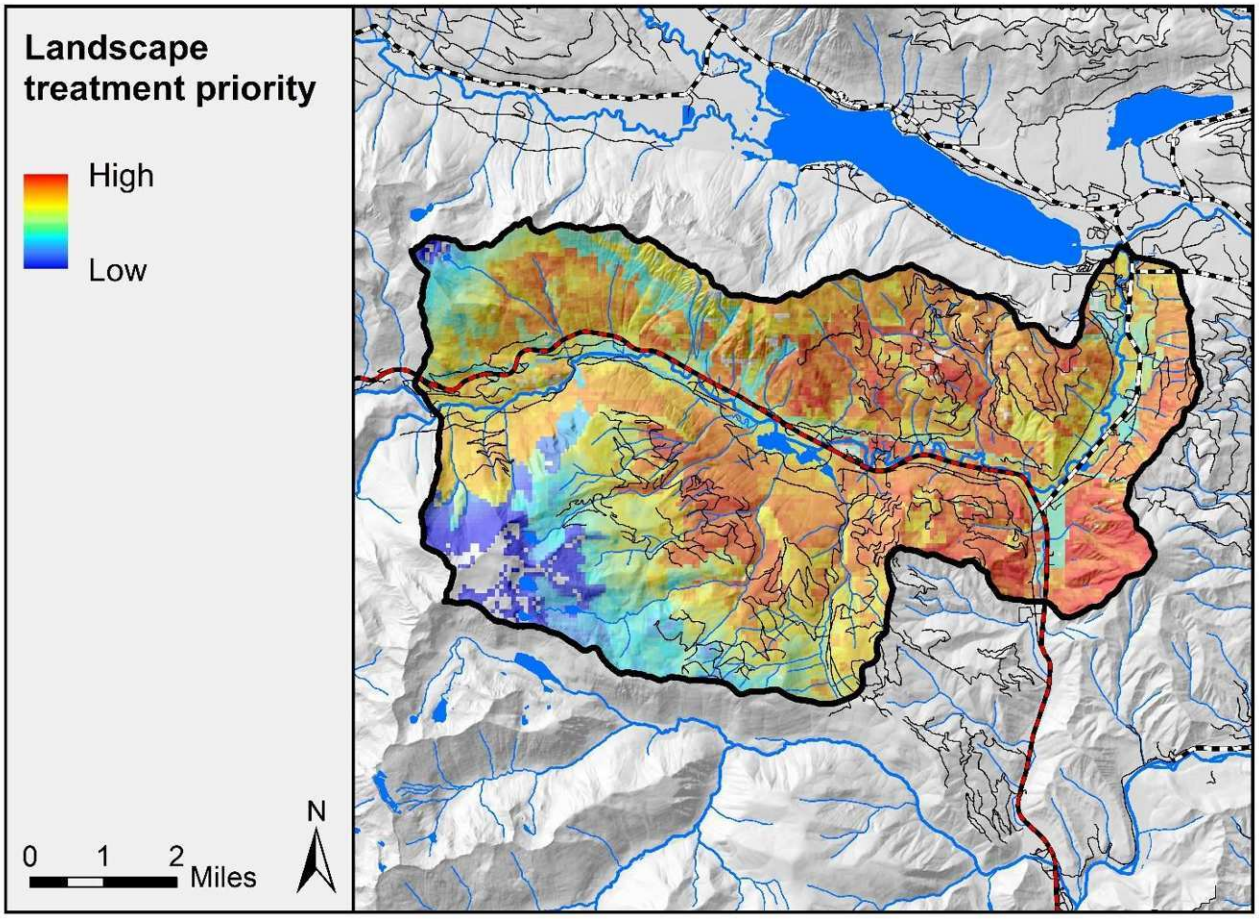


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Wildfire Response Benefit Prioritization

Dual benefits for forest health and wildfire response

It is necessary to conduct treatments to both improve forest health and reduce fire risk to communities as well as provide conditions where firefighters can safely and efficiently conduct fire operations (e.g. suppression, prescribed burning, and managed wildfire). The wildfire response benefit metric (WRB; Fig. 10) identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes, infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior. Because there are positive feedbacks between healthy, resilient forests and safe, effective fire operations, the WRB metric also integrates the landscape treatment priority map (Fig. 9).

Where WRB is highest, actions may be needed to create and maintain conditions that provide a tactical advantage for fire operations. These actions will vary with the local context and can include landscape-level forest health and fuel treatments, treatments along escape routes, resident and community fire mitigation activities (e.g. defensible space, home hardening), and improving signage and road conditions. The WRB metric provides a high-level prioritization, and additional work at the local level will be required to identify appropriate actions and assess their feasibility. WRB is useful for prioritizing Potential Control Lines (PCLs) for fire operations (Fig. 11). PCLs are a part of Potential Operational Delineations (PODs); see page 7.

In the Nason Creek planning area, wildfire response benefit is highest along Highways 2 and 207 (Fig. 2), which constitute the major concentrations of homes and infrastructure in this planning area. Risk to commercially managed lands is highest south and southeast of Highway 2, which also coincides with the highest transmission to homes (Fig. 8) and landscape treatment priority (Fig. 9).

Definitions (continued)

Wildfire response benefit: Any tactical advantage gained for wildfire response activities from actions on the landscape, including identifying and consolidating existing anchor points and control lines and reducing potential fire behavior. Wildfire response benefit is not restricted to any specific fire management strategy; it is centered on conditions that improve fire operations safety and efficacy during suppression, prescribed fire, or managed wildfire.

Potential Control Lines (PCLs): Boundaries of Potential Operational Delineations (PODs) relevant to fire control operations (e.g. roads, ridgetops, and water bodies).

Potential Operational Delineations (PODs) for wildland fire: Landscape containers whose boundaries are potential control lines (PCLs). PODs are useful for planning strategic response to unplanned ignitions, strategic fuel planning, and prioritizing fuel treatments within PODs.

Commercially managed lands: Commercially managed forestlands include: DNR Trustlands, tribal forests, industrial forests, non-industrial private forests, and US Forest Service forests where timber is a primary management objective.

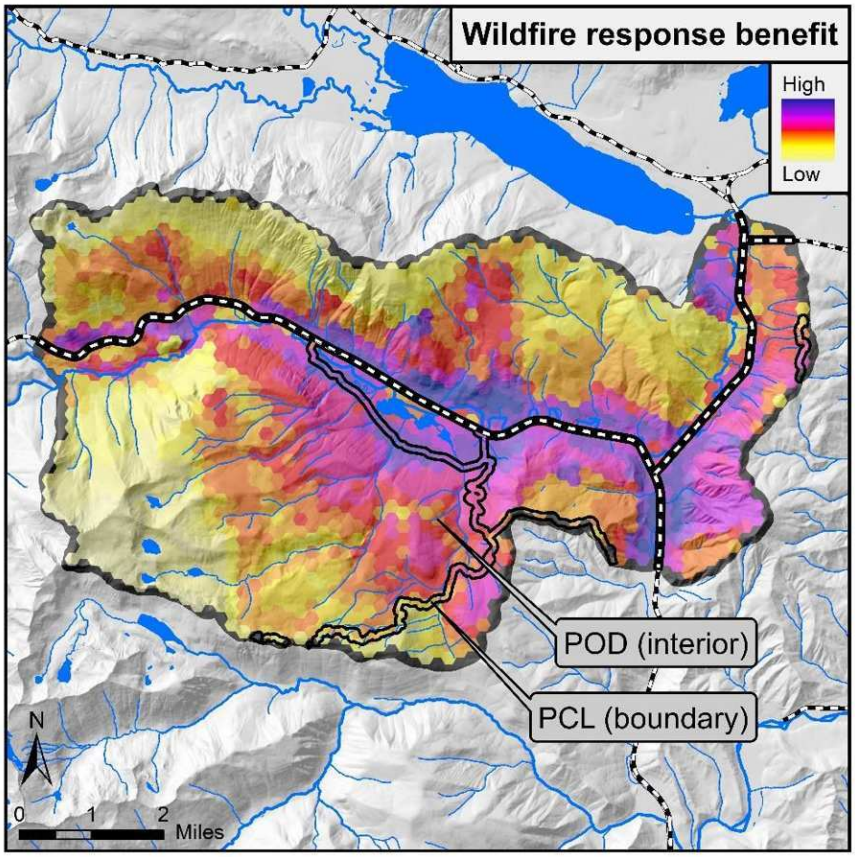


Figure 10. Wildfire response benefit (WRB) integrates multiple fire risk and forest health components. It includes four fire risk metrics representing highly valued resources – risk to homes, infrastructure, drinking water, commercially managed lands – as well as crown fire potential and wildfire transmission to homes (Fig. 8). Combined, these account for 75% of the wildfire response benefit. Landscape treatment priority (Fig. 9) accounts for the remaining 25%. Also shown are PODs: units bounded by PCLs (open black lines). One use of the WRB metric is to prioritize Potential Control Lines (PCLs) for fire operations (Fig. 11).

Prioritizing Landscape Treatments for Dual Benefits

Integration of forest health and wildfire response benefit using PODs

Potential Operational Delineations (PODs) provide a powerful spatial framework to communicate and identify locations that will deliver dual benefits for forest health and wildfire response at the landscape scale. PODs are large landscape areas delimited by Potential Control Lines (PCLs) for fire operations (suppression, prescribed fire, and managed wildfire) delineated by fire operations personnel. PCLs can be roads, ridgelines, or any artificial or natural fuelbreak that provides a strategic opportunity for fire operations. Summarizing landscape treatment priorities (Fig. 9) within PODs and wildfire response benefit priorities (Fig. 10) within PCLs enables planners and managers to identify, at a high level, locations where forest health or fuels treatments can be connected to a high-priority PCL that will support firefighter operations (e.g. ingress/egress route or opportunity for engagement).

Achieving forest health and wildfire response goals will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs.

There is important work to do in all Nason Creek PODs to achieve the forest health treatment targets in Table 1. Multiple opportunities for treatments that provide dual benefit occur in the first priority PODs north of Highways 2 and 207. First priority PCLs correspond to Highway 2 running E-W and include a forest road connecting the highway to McCue Ridge to the south. Further work is needed to assess PCLs locally for their condition and detailed treatment needs, which will depend on management goals and values at risk. Ideally, landscape treatments will be implemented adjacent to priority PCLs where feasible to maximize both forest health and wildfire response goals.

Achieving forest health and wildfire response dual benefits will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs. These two approaches combined will contribute to restoring and maintaining large portions of the landscape in a resilient condition while providing safe and effective areas for firefighter engagement during suppression, prescribed fire, or managed wildfire operations.

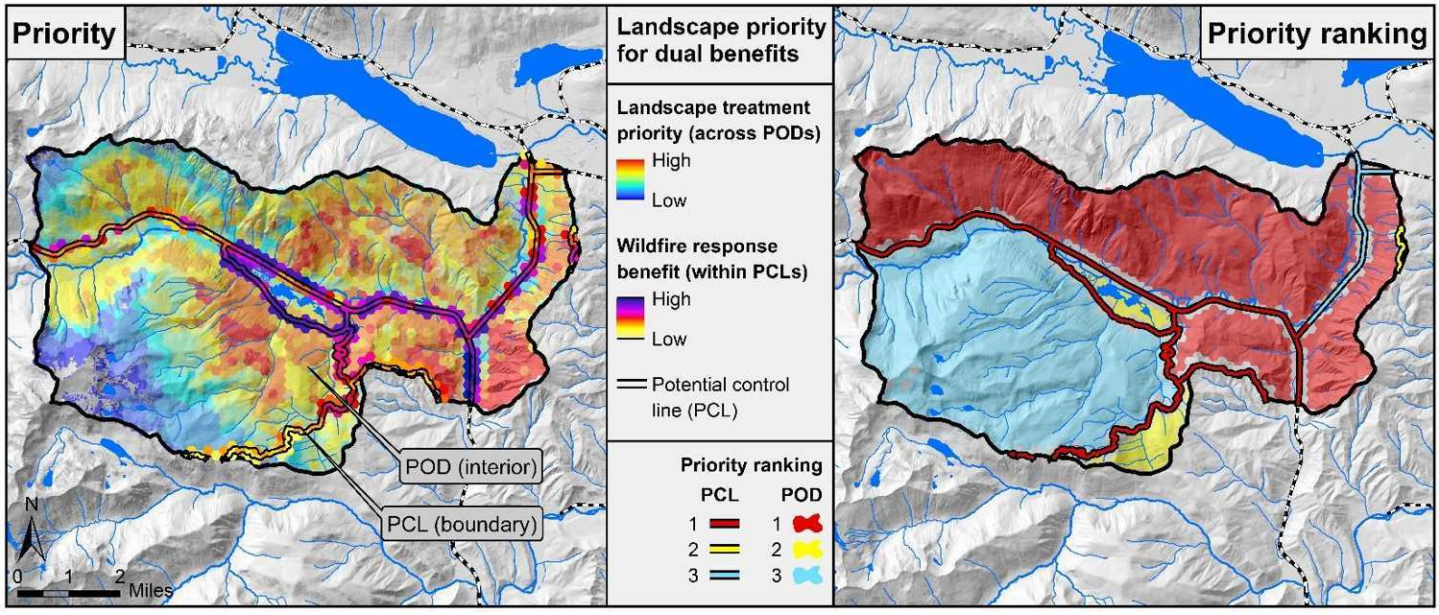
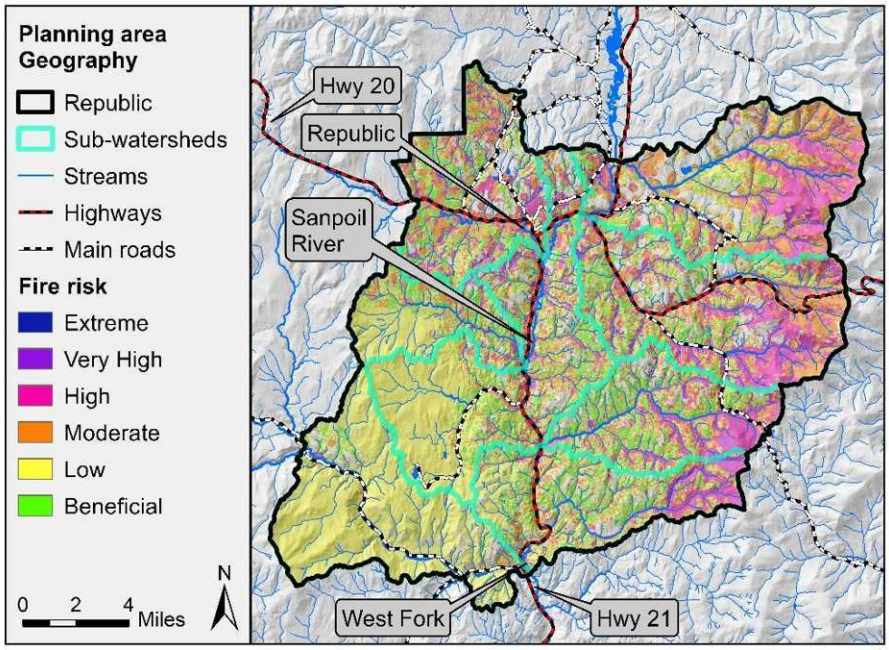


Figure 11. Landscape prioritization of dual benefits using PODs as a spatial framework to summarize treatment priorities. Both maps display landscape treatment priority within PODs and wildfire response benefit within PCLs. The map on the left shows the datasets at the raster level, while the map on the right shows the same information summarized and ranked within PODs and PCLs. PCL width is inflated to display spatial patterns. *PODs shown here are part of an ongoing process towards an all-lands delineation; POD boundaries are subject to change following on-the-ground vetting and continued dialogue among wildfire agencies and stakeholders.*

REPUBLIC PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
180,553	144,350	46,500 - 64,000



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- Land ownership is split among the Colville National Forest (58%), private (30%), the Colville Nation (7%) and DNR (4%).
- Treating 32-44% of forested acres is recommended to increase resilience and reduce fire risk to communities. This total includes 13,500-20,500 acres of maintenance treatments in currently open areas.
- A combination of mechanical treatments and prescribed fire will be needed. Managed wildfire can also be utilized under the right fire weather and fuel moisture conditions to reduce fuels and tree densities, especially in roadless and other inaccessible areas. It is also a cost effective tool to maintain areas over time once they have been treated.
- Landscape treatment priority is highest around the town of Republic. This area is private land and will require a mix of fuel reduction and defensible space treatments, as well as home hardening, to protect homes and restore resilient forests
- Blocks of medium and some high priority are scattered throughout most of the rest of the planning area
- The Colville National Forest is currently planning the Sanpoil project, which is a large forest restoration project in the southeastern portion. Planning for another project in the western portion is slated to begin in the next several years.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Predicted fire risk is variable across the planning area (Fig. 2). The southwest portion has low risk due to the 2015 Northstar Fire that consumed surface fuels and which will limit fire spread until fuels grow back 10-15 years following fire. Mid to upper elevations in the eastern portion have high to moderate risk due to high fuel loading and moderate predicted burn probability, which is based on patterns of large fires from 1992-2015. The central and northern portions around Republic have intermixed patches of high, moderate and low risk, plus large patches of grassland and open forest where fires are predicted to burn as low-intensity fires with beneficial effects on surface fuels. Landscape treatments will help reduce the risk of uncharacteristically large patches of high-severity fire, especially as burn probability increases with projected climate warming. Over time, a restored landscape will provide managers more flexibility to utilize managed wildfire. In addition, implementing fuel reduction treatments around homes and establishing potential control lines will increase firefighter safety and help protect communities.

Increase resilience and prepare for climate change

By mid-century, low to mid elevations in the planning area are projected to become drier, with south-facing slopes experiencing moisture stress levels that may not support forest (Fig. 3). Treatments that reduce density and favor drought-tolerant species will enhance future forest persistence. At high elevations, moisture stress is projected to increase due to earlier snow melt, less summer precipitation, and warmer spring and summer temperatures.

Climate models, however, predict that some mid-elevation areas will have somewhat lower moisture stress levels. Lower moisture stress is due to warmer and more rain-dominated winter and spring conditions, offsetting mild decreases in summer precipitation.

Sustain wildlife habitat

The amount of habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is somewhat abundant across the planning area. Thinning and/or fire-based treatments to create or expand moderate to large patches (100-500+ acres) of open forest dominated by ponderosa pine will expand this habitat type. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Goshawk) is also somewhat abundant with a wide range of patch sizes. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is somewhat well represented in the cold and moist forest along the eastern edge of the planning area.

Enhance rural economic development

The majority of the high and medium priority areas for treatment have road access, gentle terrain, and are commercially viable, except for rugged roadless areas in the eastern portion and southeast corner. Meeting restoration needs will provide a significant amount of forest products and related economic activity. Over time, however, warming trends will necessitate managing for more drought-tolerant species and lower densities across much of the planning area. At mid to upper elevations, forest productivity should remain moderate and potentially increase.

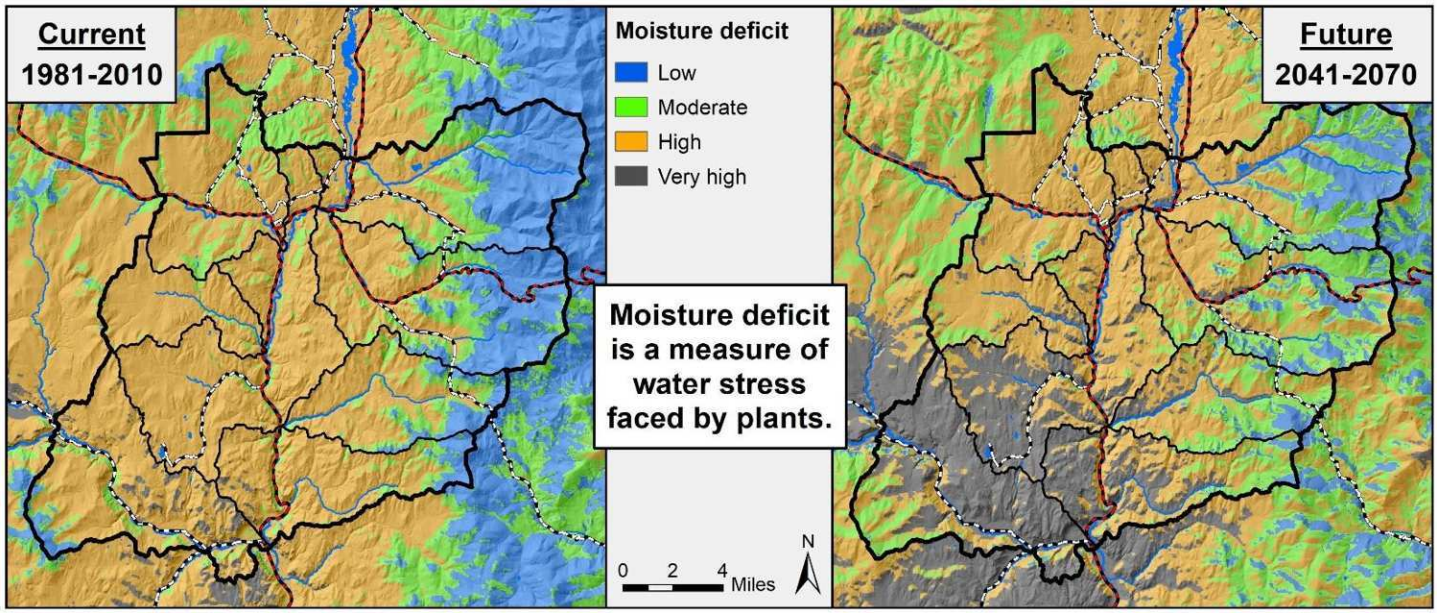


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

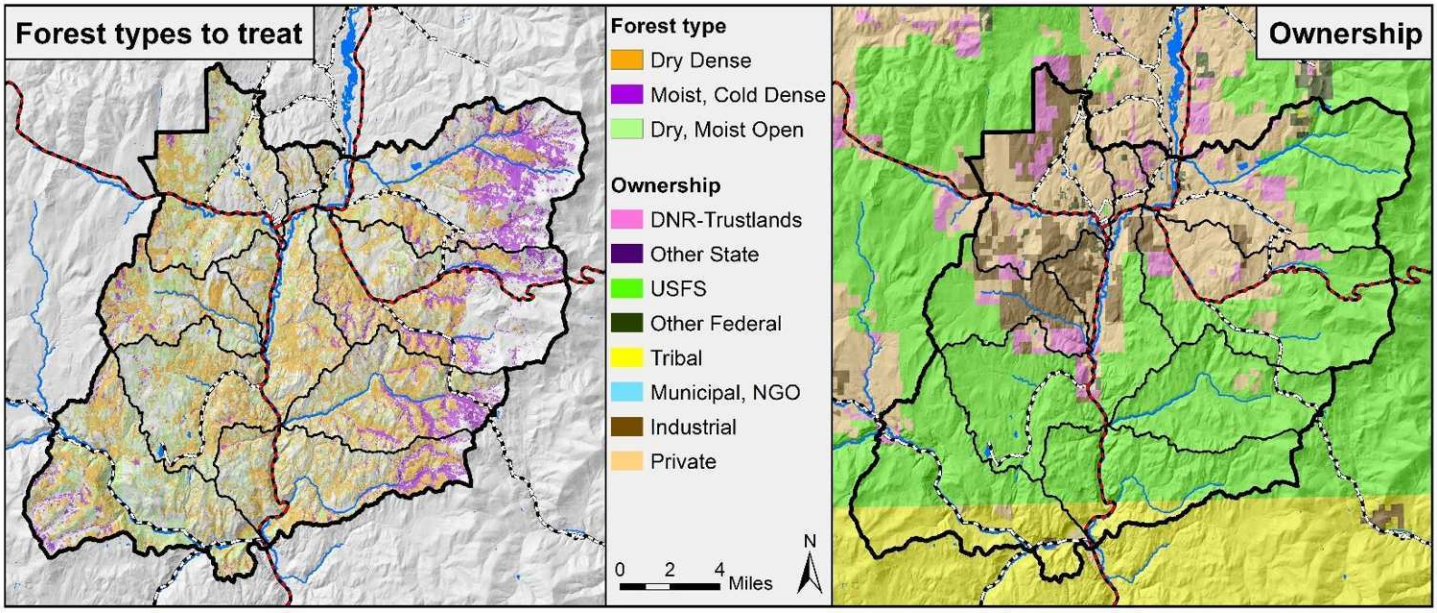
Forest Health Treatment Needs

Treating 46,500 to 64,000 acres is recommended to move the landscape into a resilient condition (32-44% of forested acres; Table 1). This total includes an estimated 33,000-43,500 acres to shift dense to open forest and 13,500-20,500 acres of maintenance treatments in existing open forest, based on current condition data from 2017 LiDAR and GNN. The USFS has the majority of the potential treatment need. The Colville National Forest is currently planning the Sanpoil forest restoration project, which will address treatment needs in the southeastern portion. There is also significant need on small private, industrial, Tribal, and DNR lands.

Meeting restoration goals will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed for initial and maintenance treatments over time, especially in the multiple Inventoried Roadless Areas along the Kettle Range and in the Southeast corner. Based on tree size class, many areas are commercially viable, although treatment type will depend on access, logging systems, markets, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**USFS**	**Private**	**Industrial**	**Tribal**	**DNR Trust**
Dry Dense	Medium-Large	30,000 - 39,000	31,673	11,768	4,125	3,885	2,170
Moist + Cold Dense	Medium-Large	3,000 - 4,500	13,137	973	220	548	217
Dry + Moist Open	Medium-Large	13,500 - 20,500	14,316	5,954	2,569	2,943	2,044
Total		**46,500 - 64,000**	**These are current acres, not targets*				
Anticipated treatment type		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, medium and large tree, dense forest structure is over-represented on dry sites. While the central portion has large, contiguous patches of dense forest, most of the dense forest patches are small to moderately sized and are broken up by open canopy or young forest, as well as non-forest patches on south-facing slopes. Much of the dry forest is also dominated by Douglas-fir. These forests are vulnerable to uncharacteristically large patches of high-severity fire that will reduce existing medium and large tree structure, as occurred in parts of the Northstar Fire. Treating 30,000-39,000 acres of dry dense forest (Table 1) is recommended to shift the majority of dry sites to open forest dominated by large patches (~500-1000+ ac) (Fig. 6). As the retained trees grow over time, much of the dry forest will shift to large tree, open forest, which is currently only at 4% of the dry forest. Shifting composition toward ponderosa pine is also needed.

Moist and cold dense forest treatment need

Dense, medium tree forest on moist and cold sites is over represented relative to desired ranges. On moist forests, large tree dense and open forest are below desired ranges and patch sizes are small. On cold forest sites, open forest with small trees and shrubs is low. Treating 3,000-4,500 acres of moist and cold forest type (Table 1, Fig. 4) is recommended. Patch sizes of treatments should be moderate to large (~100-1000 acres) and tailored to the topography and soil types that support these forest types.

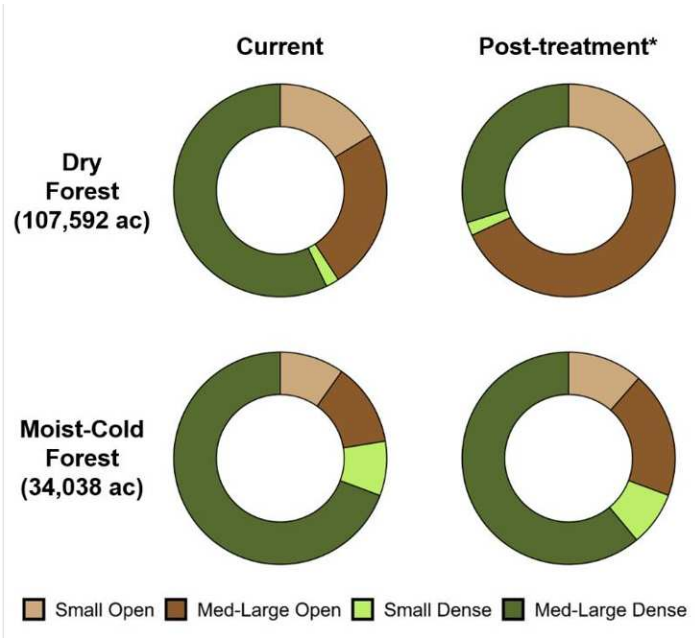
A range of treatment types will be needed including thinning, regeneration treatments, and managed wildfire. Increasing the relative composition of ponderosa pine and western larch will help these sites adapt to a warming climate. Following treatments, over 60% of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

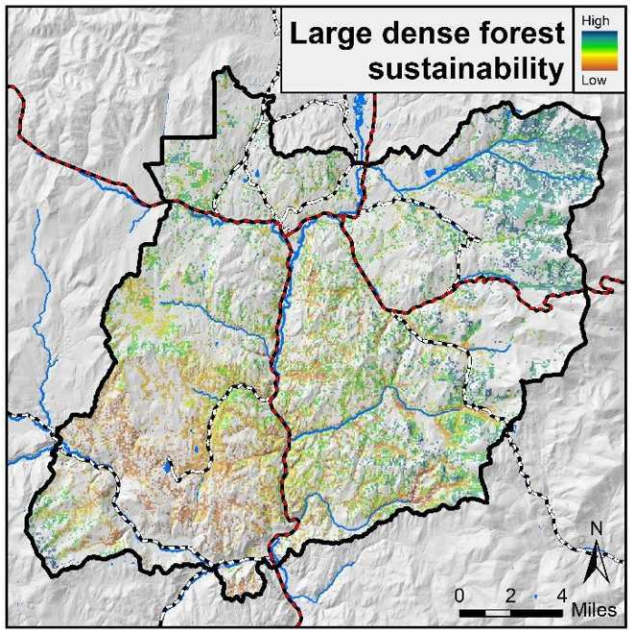
Open forest maintenance treatment need

Over the next 15 years, an estimated 13,500-20,500 acres of currently open forests on dry and moist sites will require prescribed fire, managed wildfire, or mechanical methods to maintain open conditions and low fuel levels. These sites include mechanically treated areas that may or may not have received fuel treatments, as well as parts of the Northstar Fire where additional fuel reduction is needed. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type. More sustainable locations are well distributed throughout the planning area, especially in the northeast corner (Fig. 7). This map can be used in conjunction with treatment priority (Fig. 9) to select areas to maintain and build this type of forest structure.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is high in the north central portion, indicating that wildfires starting in these locations are expected to expose homes in the area around the town of Republic.

Treatment priorities

Landscape treatment priority is highest around the town of Republic (Fig. 9). This area is private land and will require a mix of fuel reduction and defensible space treatments, as well as home hardening, to protect homes and restore resilient forest conditions. Blocks of medium and some high priority are scattered throughout most of the rest of the planning area, except for the footprints of 1988 White Mountain Fire south of Sherman Pass and the 2015 Northstar Fire. Some low priority areas may need treatment to address species composition, risk to large trees, insect and disease risk, or other issues.

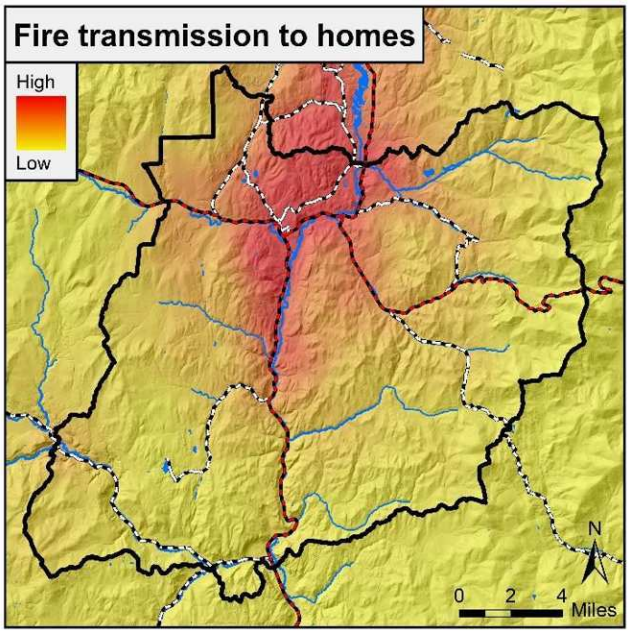


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

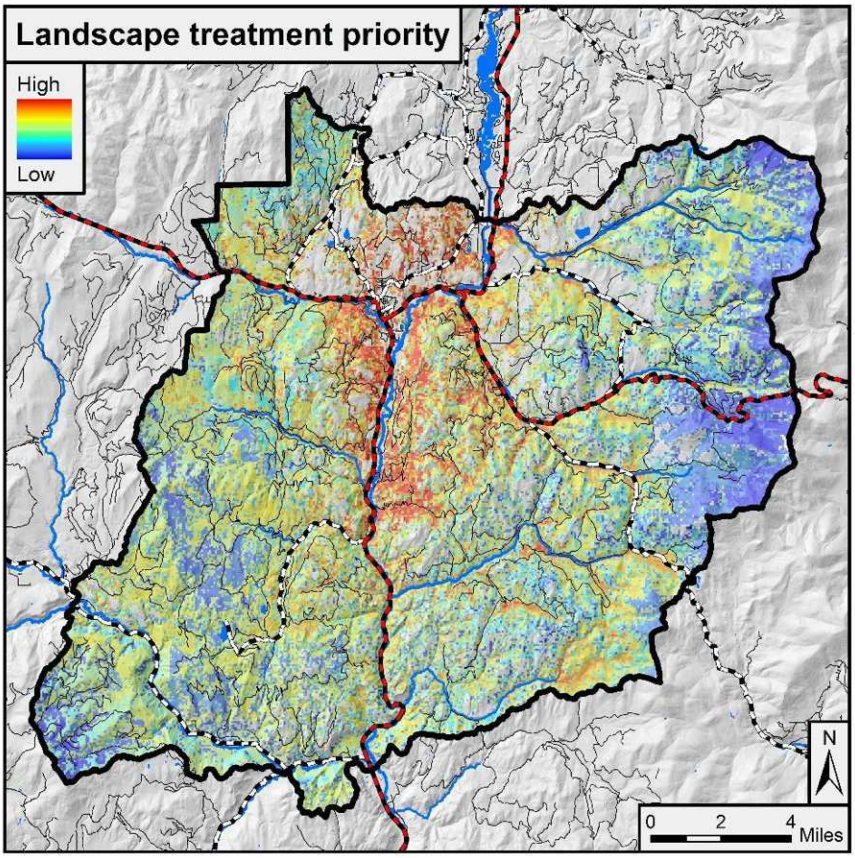


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

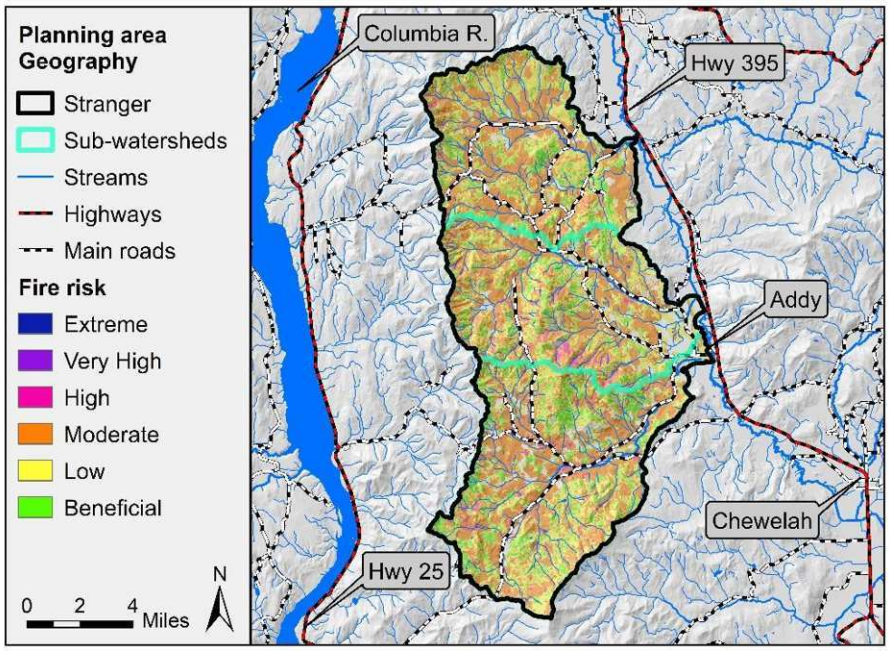
***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires is allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

STRANGER PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
89,904	72,061	30,000 - 38,000



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- Ownership is 56% small private non-industrial, 22% industrial, and 22% DNR.
- 73% of the planning area is dry forest, 6% is moist forest, 1% is cold forest, 11% is shrub-steppe, and 9% is agriculture and developed areas.
- Fire risk is currently moderate to low due to low burn probability. If a fire does occur, the risk of a large crown fire that threatens the many homes in and around the planning area is significant due to high fuel loading in many areas.
- Substantial area at lower elevations in the southern and eastern portions are projected to shift to non-forest over time.
- Treating 42-53% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical treatments, prescribed fire, and maintenance treatments in currently open areas.
- Landscape treatment priority is highest in the far northern portion on private and DNR land. Other medium and high priority treatment areas are scattered through the planning area.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Predicted fire risk is variable across the planning area, with intermixed patches of moderate and low risk (Fig. 2), along with patches of open forest where fires are predicted to burn as low-intensity surface fires, which will have beneficial effects by consuming fuels and small trees. Moderate risk areas generally have high predicted fire intensity and tree mortality but low burn probability, which is based on patterns of large fires from 1992-2015. Low risk area generally have low to moderate predicted fire intensity along with low burn probability. Landscape treatments will help reduce the risk of large, high-severity fire, especially as burn probability increases with projected climate warming. Risk to homes is a major concern given that homes are scattered through this planning area, as to the north in Kettle Falls and east along Highway 395. Implementing fuel reduction treatments around homes and establishing potential control lines will increase firefighter safety and protection efforts.

Increase resilience and prepare for climate change

By mid-century, the majority of the planning area is projected to have moisture stress levels that are currently associated with dry forest (Fig. 3). Substantial area at lower elevations in the southern and eastern portions are projected to shift to non-forest. Moderate and low moisture stress levels are projected to only remain on a few north-facing slopes at higher elevations. Treatments that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is somewhat abundant, but patches are generally moderate to small in size. Thinning and/or fire-based treatments to create or expand moderate to large patches (100-500+ acres) of open forest dominated by ponderosa pine will expand this habitat type. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Goshawk) is limited and occurs only on DNR land. Patch sizes are generally small to moderate. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is well represented in the relatively small amount of cold and moist forest within the planning area.

Enhance rural economic development

Almost all of the high and medium priority areas for treatment have road access, gentle terrain, and are commercially viable. Landscape scale treatments to shift this area into a more resilient condition will produce a significant amount of forest products and related economic activity. Over time, warming trends and increasing burn probability will likely make it difficult to sustain timber production at lower elevations (Fig. 3). In the remainder of the planning area, long-term timber production will likely be possible if proactive strategies to shift species composition and manage for lower tree densities and fuel loads are adopted over time.

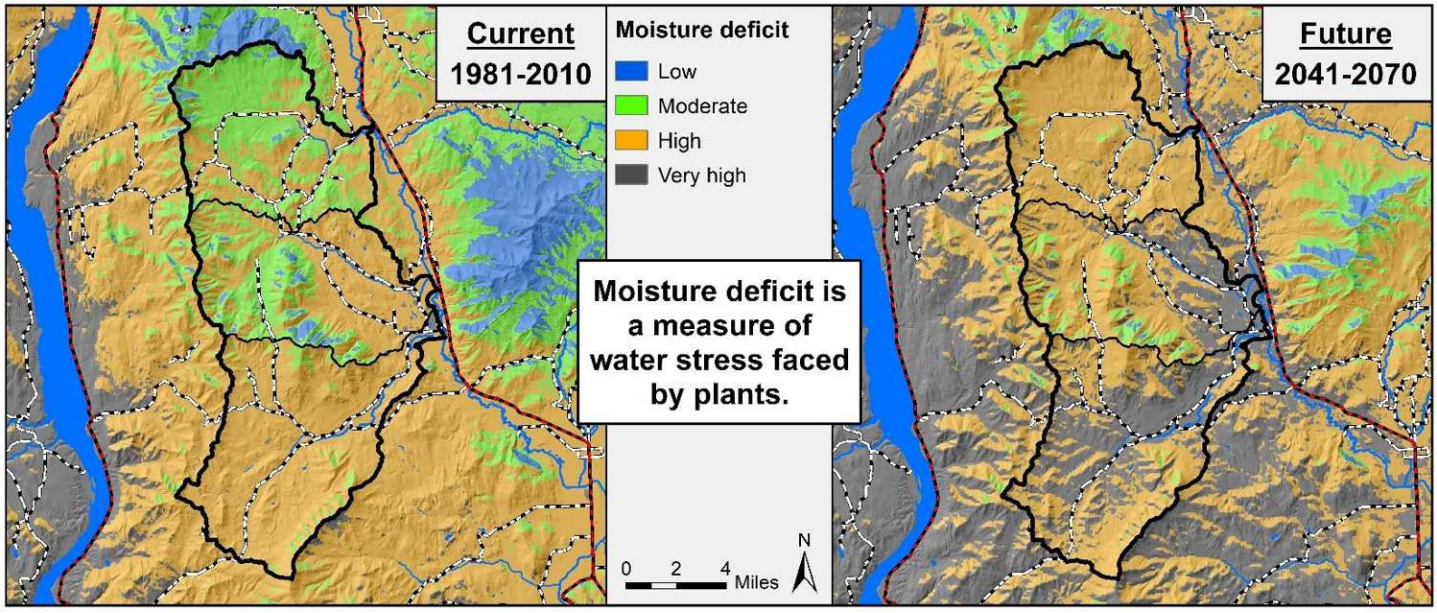


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

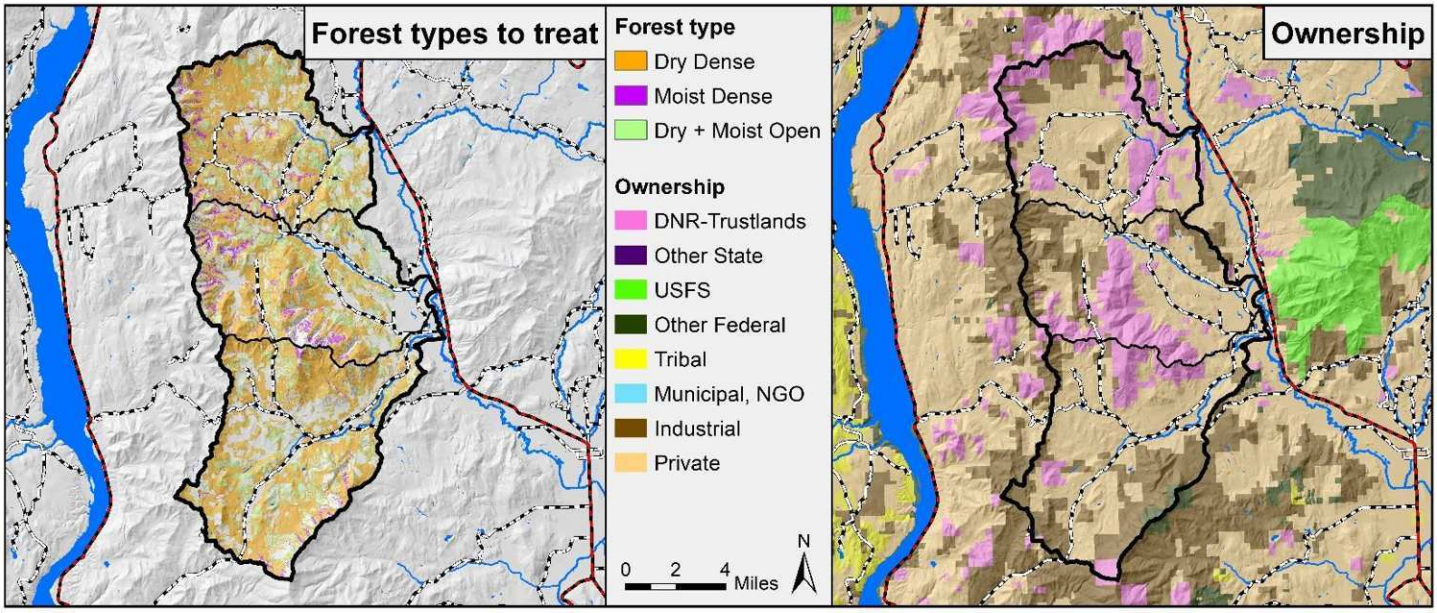
Forest Health Treatment Needs

Treating 30,000 to 38,000 acres is recommended to move the landscape into a resilient condition (42-53% of forested acres; Table 1). This total includes an estimated 24,000-29,000 acres to shift dense to open forest and 6,000-9,000 acres of maintenance treatments in existing open forest, based on current condition data from 2017 aerial photos. Treatment need is split between small non-industrial, industrial, and DNR State lands.

Meeting this target range will require multiple treatment strategies (Table 1). Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, markets, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need)*.

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*			
Type	**Size class**		**Private**	**Industrial**	**DNR Trust**	**Federal**
Dry Dense	Small	500 - 1,000	717	811	284	3
	Medium-Large	23,000 - 27,000	21,684	9,135	11,035	396
Moist Dense	Medium-Large	500 - 1,000	1,015	798	916	106
Dry + Moist Open	Medium-Large	6,000 - 9,000	6,333	3,519	2,776	9
Total		**30,000 - 38,000**	*These are current acres, not targets*			
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).				
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.				
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*				



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, medium and large tree, dense forest structure is over-represented on dry sites. Large patches of dense forest exist throughout the planning area, but are interspersed with open or young forest, as well as agricultural land. These forests are vulnerable to uncharacteristically large patches of high-severity fire, as well as a combination of drought stress, root disease, and Douglas-fir beetle. These disturbances will reduce existing medium and large tree structure. Treating 23,500-28,000 acres of dry dense forest (Table 1) is recommended to shift the majority of dry sites to open forest with low fuel loads (Fig. 6). When consistent with landowner objectives, retaining a component of large, fire resistant trees will increase resilience. Shifting composition toward ponderosa pine and western larch is also recommended to reduce vulnerability to large disturbances.

Moist and cold dense forest treatment need

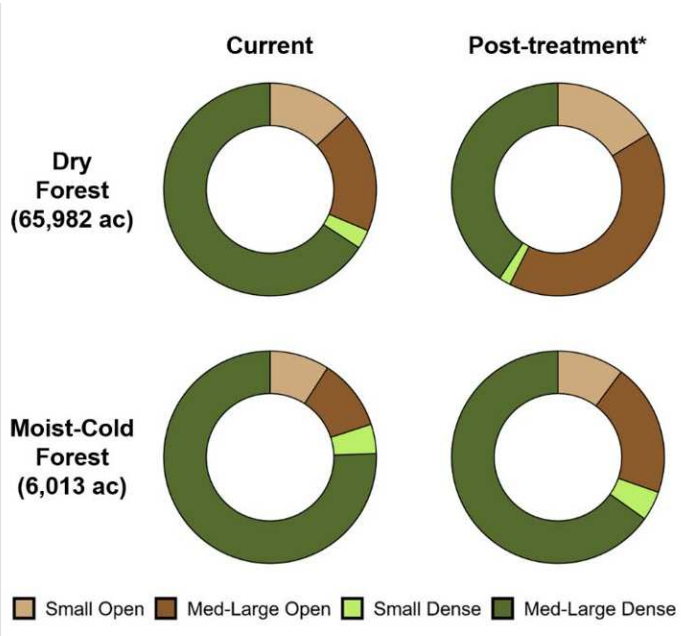
Although the planning area contains a small amount of moist forest (6% of the total acres) and very little cold forest (1%), dense, medium tree forest on moist sites exceeds the upper end of desired ranges. In contrast, large tree dense and large tree open forest are below desired ranges and patch sizes are small. Treating 500-1,000 acres of this forest type (Table 1, Fig. 4) is recommended to reduce density and increase resistance to high-severity fire. Where consistent with landowner objectives, retaining and growing a large tree component will increase resilience. Following treatments, over 70% of the total amount of moist forest would remain dense (Fig. 6) to meet wood production, habitat, and other objectives.

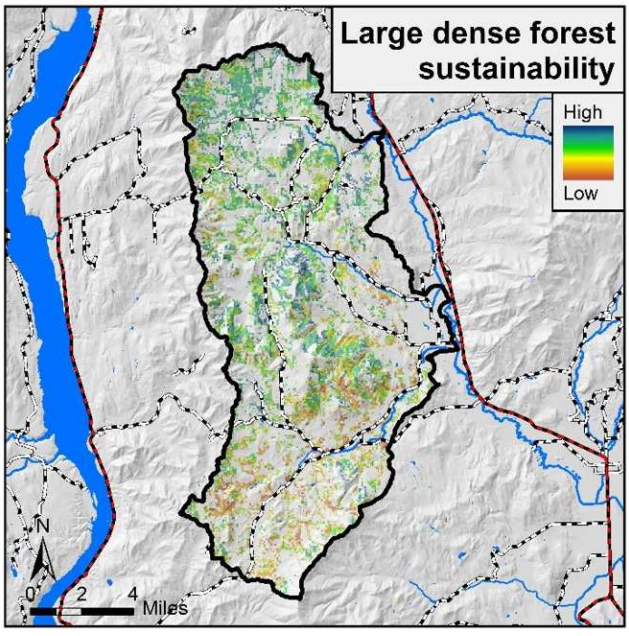
Open forest maintenance treatment need

Over the next 15 years, an estimated 6,000-9,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Sustainable locations include north- and east-facing slopes in the central portion, as well as areas in the northern section (Fig. 7). This map can be used in conjunction with treatment priority (Fig. 9) to select areas to maintain and build this type of forest structure as well as areas better suited to shift towards open canopy structure.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is moderate to high in the northern half of the planning area, indicating that wildfires starting in these locations are expected to expose homes in Kettle Falls, as well as in the planning area itself.

Treatment priorities

Landscape treatment priority is highest in the far northern portion on private and DNR land (Fig. 9). Other medium and high priority treatment areas are scattered through the planning area on private and DNR land. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are recommended on private parcels to protect homes throughout the planning area.

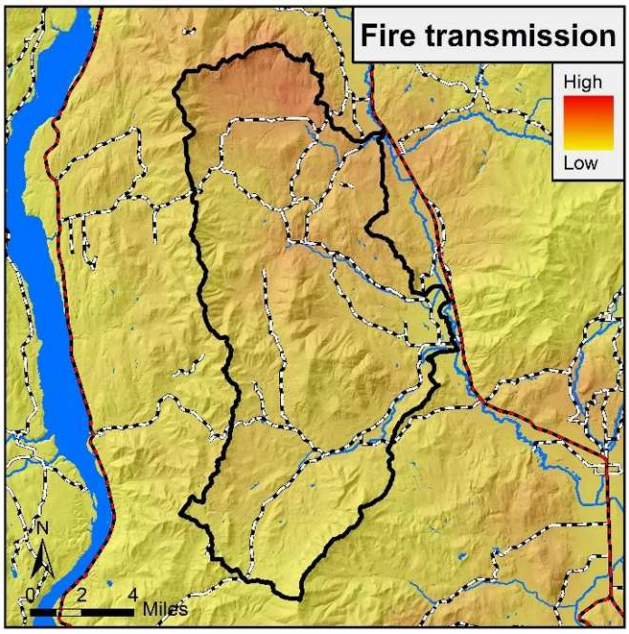


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

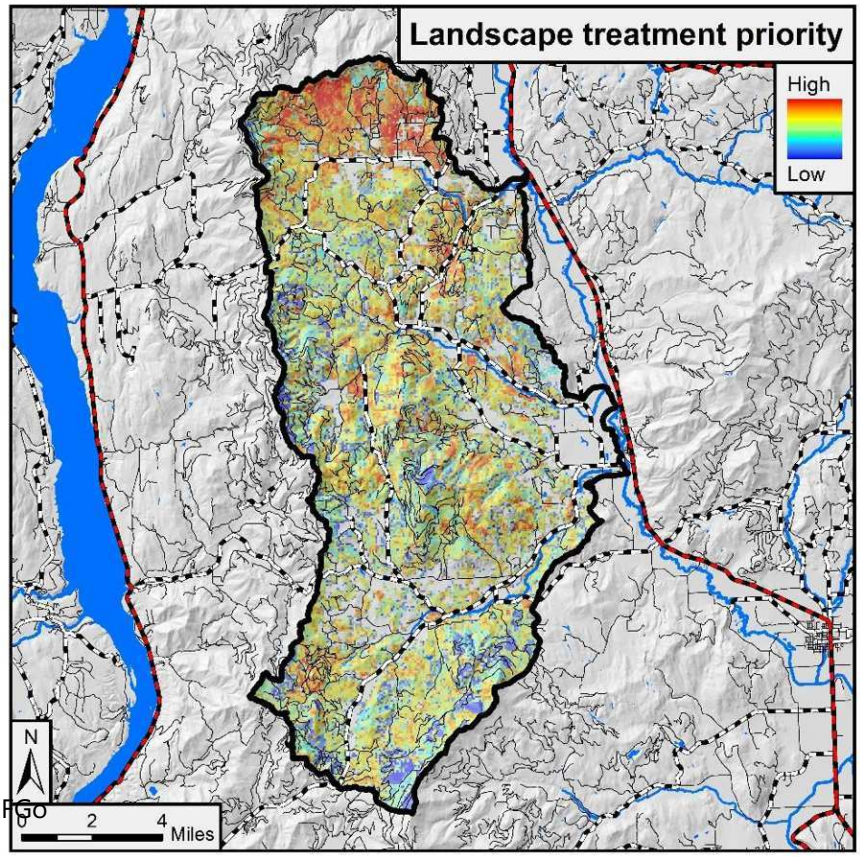


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

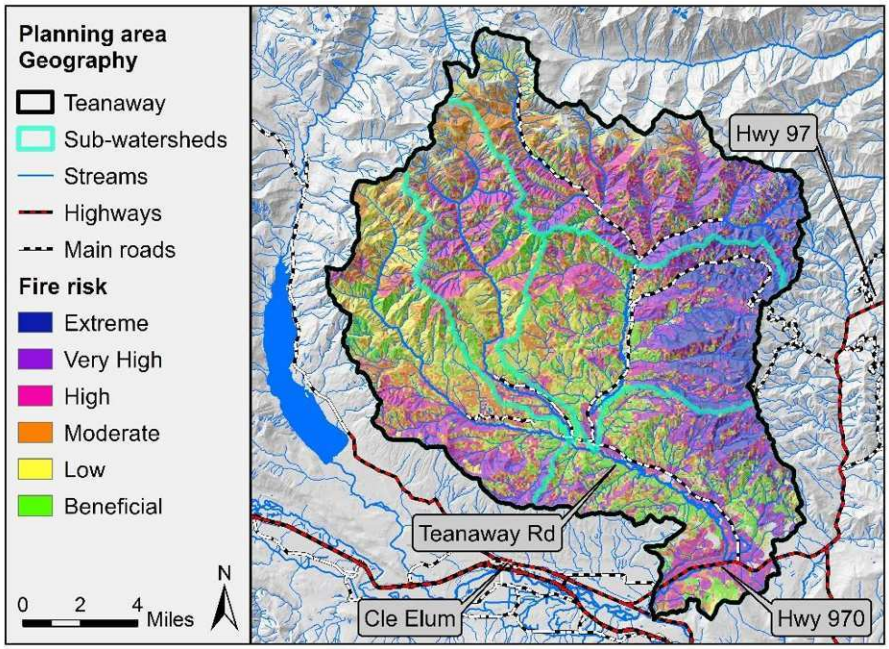
***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires that are allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

TEANAWAY PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
132,120	111,696	38,500 - 60,000



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- This planning area is 87% public land, split between the DNR Teanaway Community Forest (39%) in the center and US Forest Service land (48%) to the north and east. The majority of USFS land is designated as inventoried roadless area and Late Successional Reserve.
- Fire risk is highest in the eastern portion of the planning area, representing some of the highest risk areas in eastern WA (Fig. 2). The north side of Cle Elum Ridge and private land along Highway 970 and Teanaway road are also high risk.
- Projected warming over the next 20-40 years will likely shift climate conditions suitable for moist and cold forest towards conditions suitable for dry forest. The southeastern portion may no longer support forest.
- Treating 34-54% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- High priority areas for potential treatments that maximize forest health and wildfire response benefit include the Teanaway Community Forest and the southern boundary of the planning area.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high to extreme throughout the eastern, northern, and southern portions of the planning area due to high fuel loads and burn probability (Fig. 2). The eastern portion represents some of the highest fire risk in eastern WA. High risk areas on the southern edge are adjacent to the Cle Elum planning area and include private property. Fuels treatments are needed to break up the large patches of dense forest to reduce the likelihood of large crown fire and to facilitate protection of private property along Highway 970 and Teanaway Road. In much of the central portion and within the 2017 Jolly Mountain Fire perimeter, fire is predicted to have low risk or beneficial effects due to reduced fuels and lower burn probability from extensive harvesting and fire effects.

Increase resilience and prepare for climate change

By mid-century, the majority of the planning area is projected to have moisture stress levels that are currently associated with dry forest (Fig. 3). Substantial area in the southern end is projected to shift to non-forest over time. Moderate and low moisture stress levels are projected to remain on north-facing slopes and valley bottoms, primarily in the northern half. Treatments, as well as managed wildfires in roadless and other inaccessible areas, that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is well represented in the planning area, although it is concentrated in large patches in the east and south. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is in the middle or upper end of desired ranges, though it is overly abundant in eastern and central portions. In high fire risk locations, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability, help maintain habitat in the most sustainable locations (Fig. 7), and broaden the spatial distribution of open canopy habitat. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is well represented but concentrated in large patches along the central part of the northern edge.

Enhance rural economic development

Most of the higher priority areas for commercial treatments have road access and will produce significant timber volume. Extensive harvesting by past owners in the Teanaway Community Forest has reduced wood production potential for the next 2-3 decades. Although warming trends and high burn probability will necessitate managing for lower densities and fuel loads, long-term timber production will likely be possible in much of the community forest and adjacent USFS land. Reducing fire risk will help sustain recreation and tourism while reducing the potential of smoke affecting nearby communities.

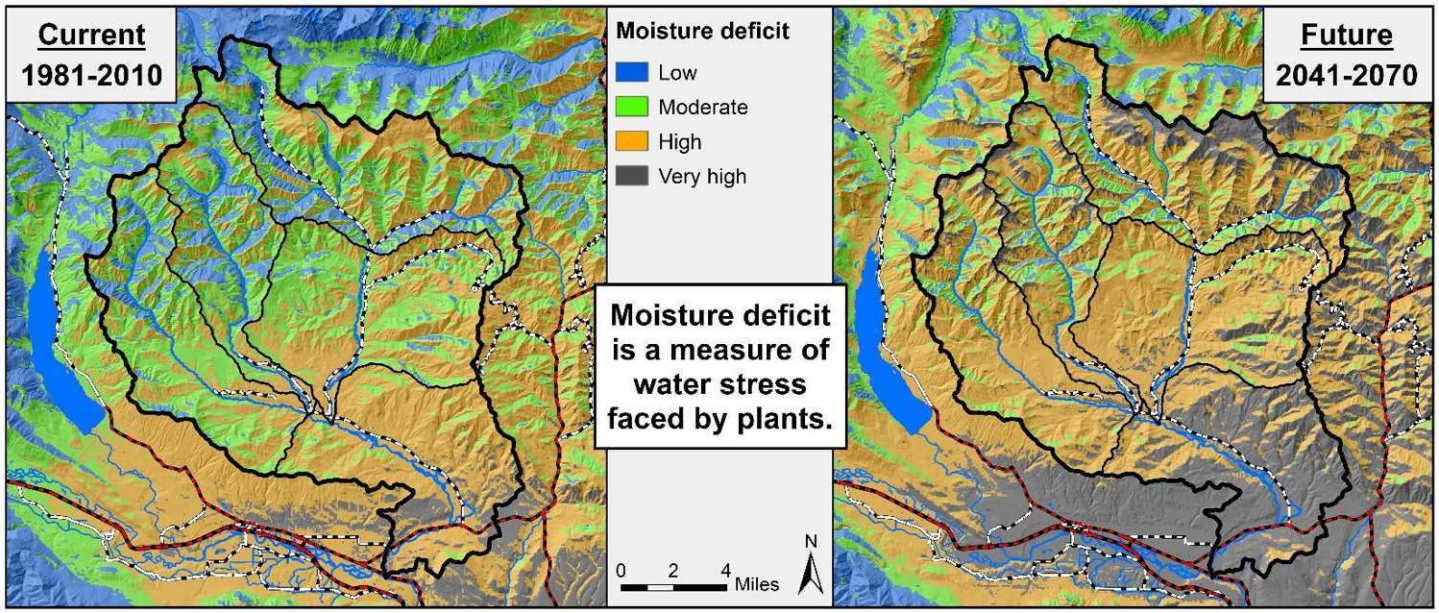


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

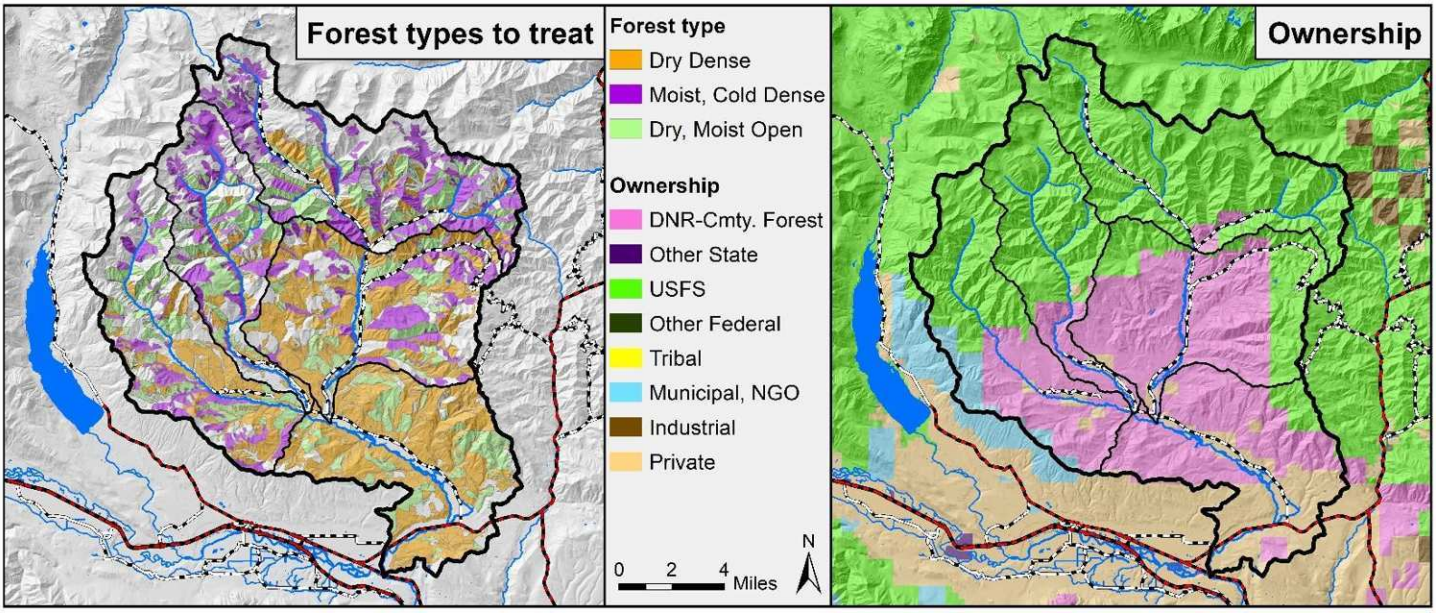
Forest Health Treatment Needs

Treating 38,500 to 60,000 acres is recommended to move the landscape into a resilient condition (34-54% of forested acres; Table 1). This total includes an estimated 27,500-43,000 acres to shift dense to open forest and 11,000-17,000 acres of maintenance treatments in existing open forest, based on current condition data from 2017 aerial photos. Most of the treatment need is located within the Teanaway Community Forest and USFS land, although substantial need exists on private land in the southern tip.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in the large roadless area in the northern third and for maintenance treatments over time. Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*			
Type	**Size class**		**USFS**	**DNR Community**	**Private**	**TNC**
Dry Dense	Small	1,500 - 3,000	56	4,034	108	236
	Medium-Large	23,000 - 32,000	11,129	21,344	5,713	498
Moist + Cold Dense	Medium-Large	3,000 - 8,000	19,627	6,684	345	480
Dry + Moist Open	Medium-Large	11,000 - 17,000	11,992	10,333	1,238	530
Total		**38,500 - 60,000**	**These are current acres, not targets*			
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).				
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.				
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*				



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites, especially sites dominated by Douglas-fir. The large, contiguous patches of this forest type create high susceptibility to defoliating insects and crown fire. Treating 24,500-35,000 acres of this type (Table 1) is recommended to create large patches (~100-1000 ac) of open forest with a component of large trees (Fig. 4), flipping the majority of dry sites from closed to open forest (Fig. 6). Shifting composition toward ponderosa pine and reducing grand fir and Douglas-fir is also recommended.

Moist and cold dense forest treatment need

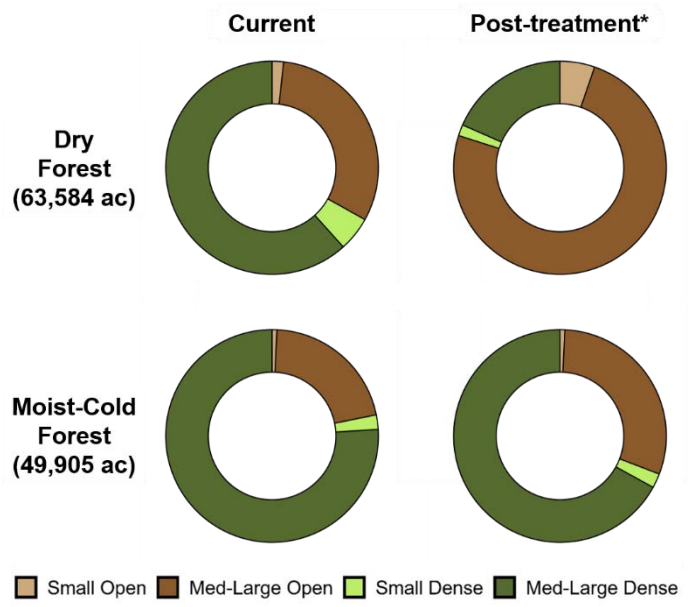
Dense, multistory forest on moist and cold sites exceeds or is at the upper end of desired ranges across the planning area. In contrast, open canopy forest with medium to large trees, as well as open forest with small trees and shrubs, are at the low end of desired ranges, except where the Jolly Mountain Fire burned. Treating 3,000-8,000 acres of this forest type (Table 1, Fig. 4) is recommended to create a mosaic of open and dense forest that will reduce risks of large crown fire and insect outbreaks. A range of treatment types will be needed, including thinning, regeneration treatments, and managed wildfire. Increasing the relative composition of ponderosa pine and western larch is also needed to help these sites adapt to a warming climate. Following treatments, over 60% of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

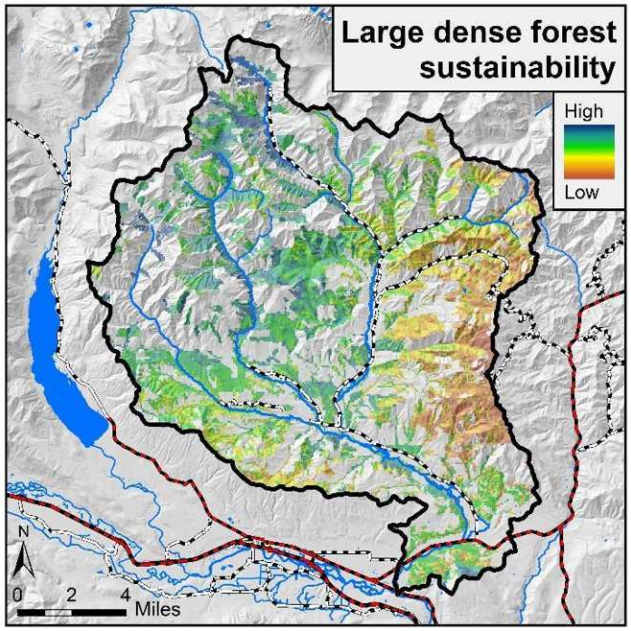
Open forest maintenance treatment need

Over the next 15 years, an estimated 11,000-17,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments, as well as parts of the Jolly Mountain Fire where additional fuel reduction is needed. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Sustainable locations include the western end of the planning area, as well as north-facing slopes in the central portion and valley bottoms in the northeastern corner (Fig. 7). The large tree, dense forest sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is high across most of the planning area, indicating that wildfires starting in these locations are expected to expose homes in Roslyn, Cle Elum, and along Teanaway Road (Fig. 2).

Treatment priorities

Landscape treatment priority is highest in the eastern portion on the Teanaway Community Forest and USFS land (Fig. 9). The southern edge along the north side of Cle Elum Ridge is also high priority. Medium and high priority areas on roadless USFS lands in the northeastern portion indicate that managed wildfire will be needed to restore this landscape. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes along Highway 970 and Teanaway Road.

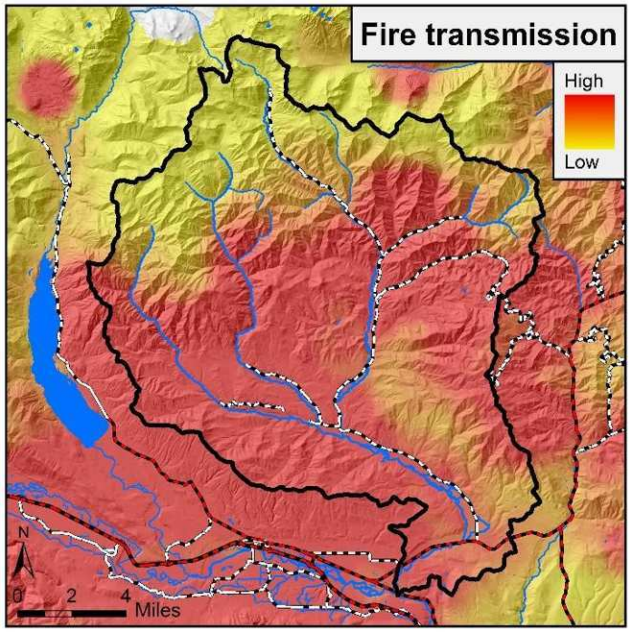


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

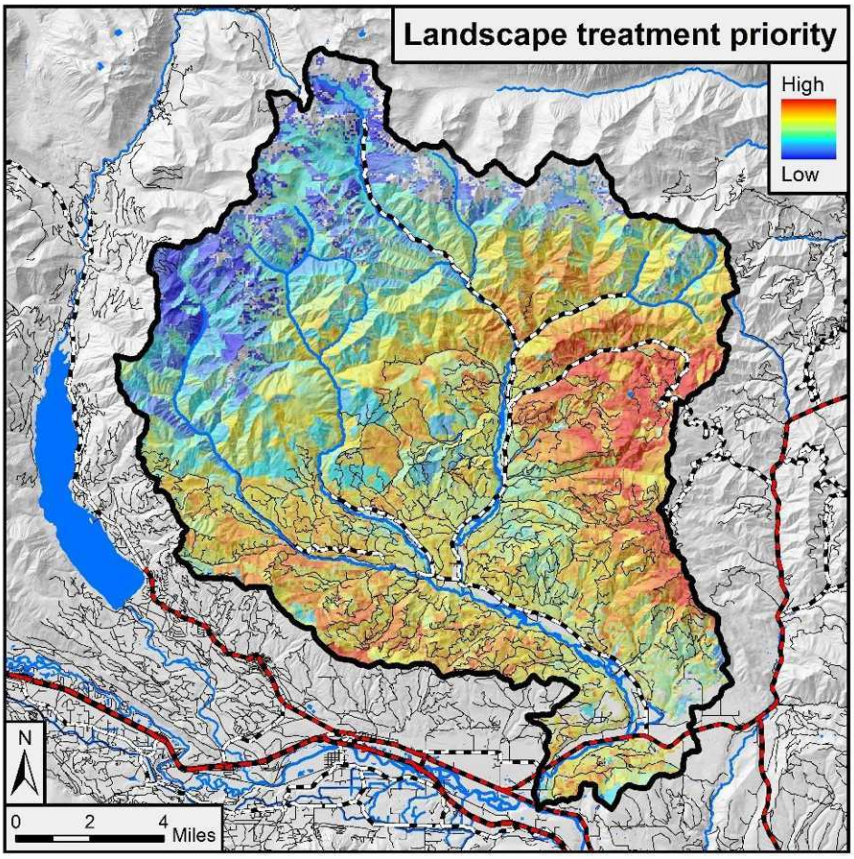


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires that are allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

Wildfire Response Benefit Prioritization

Dual benefits for forest health and wildfire response

It is necessary to conduct treatments to both improve forest health and reduce fire risk to communities as well as provide conditions where firefighters can safely and efficiently conduct fire operations (e.g. suppression, prescribed burning, and managed wildfire). The wildfire response benefit metric (WRB; Fig. 10) identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes, infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior. Because there are positive feedbacks between healthy, resilient forests and safe, effective fire operations, the WRB metric also integrates the landscape treatment priority map (Fig. 9).

Where WRB is highest, actions may be needed to create and maintain conditions that provide a tactical advantage for fire operations. These actions will vary with the local context and can include landscape-level forest health and fuel treatments, treatments along escape routes, resident and community fire mitigation activities (e.g. defensible space, home hardening), and improving signage and road conditions. The WRB metric provides a high-level prioritization, and additional work at the local level will be required to identify appropriate actions and assess their feasibility. WRB is useful for prioritizing Potential Control Lines (PCLs) for fire operations (Fig. 11). PCLs are a part of Potential Operational Delineations (PODs); see page 7.

In the Teanaway planning area, wildfire response benefit is highest along the Teanaway Road and Highway 970, reflecting risk to communities along these road corridors. Wildfire transmission to homes is high throughout the southern and central portions of the planning area (Fig. 8), indicating that ignitions in those locations will expose houses in communities along Interstate 90. Crown fire potential (not shown) is high throughout the planning area with the exception of a few patches with lower crown fire potential in the Jolly Mountain burned area.

Definitions (continued)

Wildfire response benefit: Any tactical advantage gained for wildfire response activities from actions on the landscape, including identifying and consolidating existing anchor points and control lines and reducing potential fire behavior. Wildfire response benefit is not restricted to any specific fire management strategy; it is centered on conditions that improve fire operations safety and efficacy during suppression, prescribed fire, or managed wildfire.

Potential Control Lines (PCLs): Boundaries of Potential Operational Delineations (PODs) relevant to fire control operations (e.g. roads, ridgetops, and water bodies).

Potential Operational Delineations (PODs) for wildland fire: Landscape containers whose boundaries are potential control lines (PCLs). PODs are useful for planning strategic response to unplanned ignitions, strategic fuel planning, and prioritizing fuel treatments within PODs.

Commercially managed lands: Commercially managed forestlands include: DNR Trustlands, tribal forests, industrial forests, non-industrial private forests, and US Forest Service forests where timber is a primary management objective.

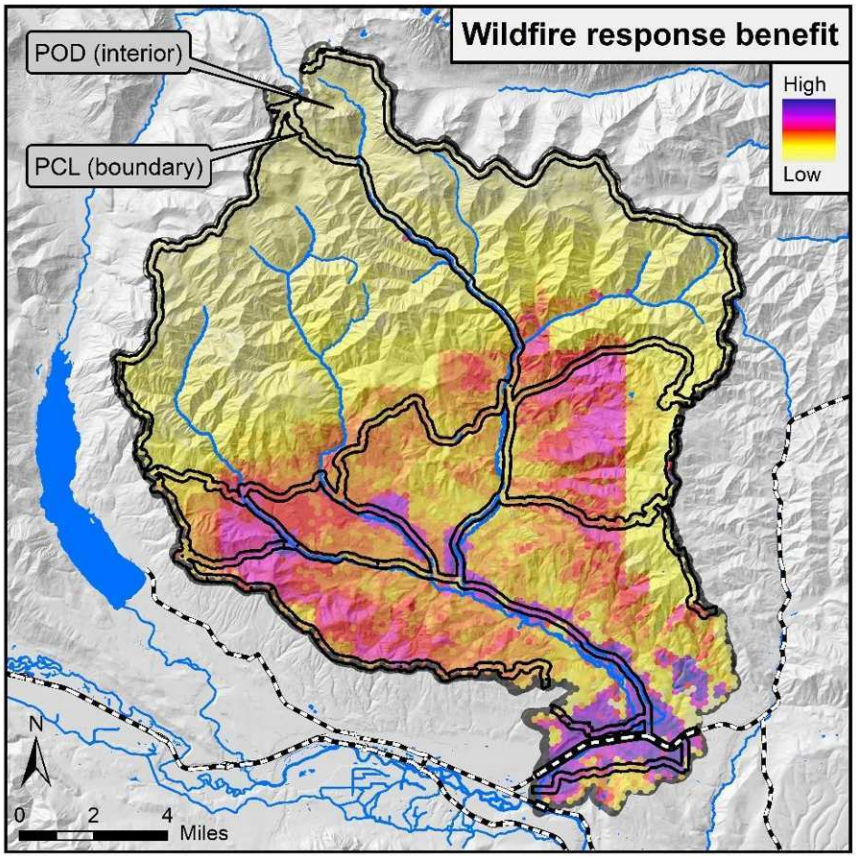


Figure 10. Wildfire response benefit (WRB) integrates multiple fire risk and forest health components. It includes four fire risk metrics representing highly valued resources – risk to homes, infrastructure, drinking water, commercially managed lands – as well as crown fire potential and wildfire transmission to homes (Fig. 8). Combined, these account for 75% of the wildfire response benefit. Landscape treatment priority (Fig. 9) accounts for the remaining 25%. Also shown are PODs: units bounded by PCLs (open black lines). One use of the WRB metric is to prioritize Potential Control Lines (PCLs) for fire operations (Fig. 11).

Prioritizing Landscape Treatments for Dual Benefits

Integration of forest health and wildfire response benefit using PODs

Potential Operational Delineations (PODs) provide a powerful spatial framework to communicate and identify locations that will deliver dual benefits for forest health and wildfire response at the landscape scale. PODs are large landscape areas delimited by Potential Control Lines (PCLs) for fire operations (suppression, prescribed fire, and managed wildfire) delineated by fire operations personnel. PCLs can be roads, ridgelines, or any artificial or natural fuelbreak that provides a strategic opportunity for fire operations. Summarizing landscape treatment priorities (Fig. 9) within PODs and wildfire response benefit priorities (Fig. 10) within PCLs enables planners and managers to identify, at a high level, locations where forest health or fuels treatments can be connected to a high-priority PCL that will support firefighter operations (e.g. ingress/egress route or opportunity for engagement).

Achieving forest health and wildfire response goals will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs.

There is important work to do in all Teanaway PODs to achieve the forest health treatment targets in Table 1. First and second priority PODs include the Teanaway Community Forest and PODs along the southern boundary of the planning area bordering the Cle Elum planning area. PCLs vary in priority, reflecting variability in values at risk along POD boundaries (Fig. 10). Further work is needed to assess PCLs locally for their condition and detailed treatment needs, which will depend on management goals and values at risk. Ideally, landscape treatments will be implemented adjacent to priority PCLs where feasible to maximize both forest health and wildfire response goals.

Achieving forest health and wildfire response dual benefits will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs. These two approaches combined will contribute to restoring and maintaining large portions of the landscape in a resilient condition while providing safe and effective areas for firefighter engagement during suppression, prescribed fire, or managed wildfire operations.

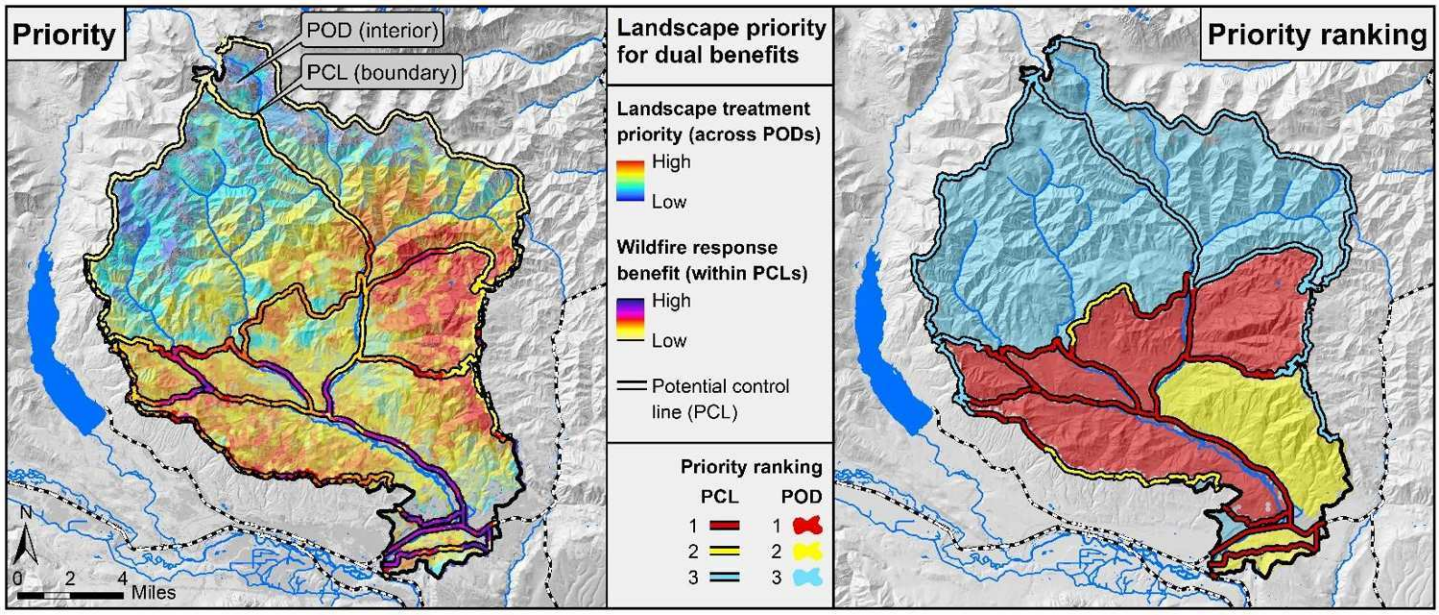
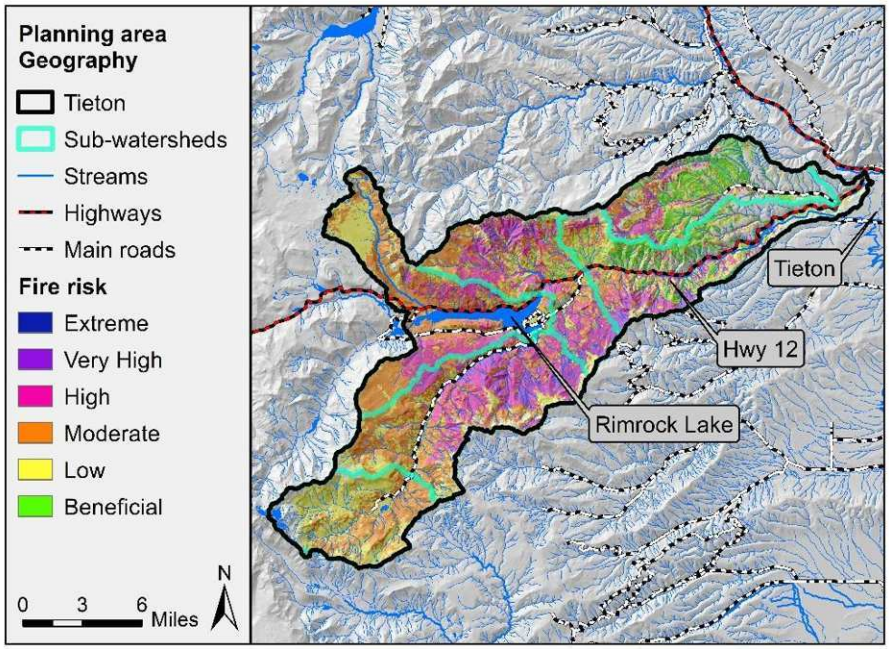


Figure 11. Landscape prioritization of dual benefits using PODs as a spatial framework to summarize treatment priorities. Both maps display landscape treatment priority within PODs and wildfire response benefit within PCLs. The map on the left shows the datasets at the raster level, while the map on the right shows the same information summarized and ranked within PODs and PCLs. PCL width is inflated to display spatial patterns. *PODs shown here are part of an ongoing process towards an all-lands delineation; POD boundaries are subject to change following on-the-ground vetting and continued dialogue among wildfire agencies and stakeholders.*

TIETON PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
148,634	117,781	38,000 - 60,500



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- This planning area spans a broad gradient of forest composition, from cold forests near the Cascade Crest to moist and dry forests at lower elevations and oak woodlands and non-forest vegetation to the east.
- Ownership is 95% public land, including USFS (80%), WA Department of Fish and Wildlife (11%) and WA Department of Natural Resources (4%).
- Fire risk is highest in the center of the planning area to the north and south of Rimrock Lake (Fig. 2). Several small to medium wildfires (500-5,000 acres) have occurred in and around the planning area, including the 2020 Cold Creek Fire.
- Projected warming over the next 20-40 years will likely shift climate conditions suitable for moist and cold forest towards conditions suitable for dry forest. South-facing slopes in the eastern portion may no longer support forest (Fig. 3).
- Treating 32-51% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- Treatment priority is highest in the center of the planning area based on fire risk, drought vulnerability, current forest structure, and fire transmission to communities, particularly to the south of Rimrock Lake.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is moderate to high throughout the central portions of the planning area due to high fuel loads and moderate burn probability (Fig. 2). The slopes north and south of Rimrock Lake exhibit high and very high fire risk. Fuels treatments are needed to break up the large patches of dense forest where they exist to reduce the likelihood of large crown fire and to facilitate protection of private property around Rimrock Lake and along Highway 12. Fire is predicted to have beneficial effects in the eastern portion of the planning area due to reduced fuels from treatments in dry forests and woodlands, particularly in the Oak Creek area

Increase resilience and prepare for climate change

By mid-century, most of the planning area is projected to have moisture stress levels that are currently associated with dry forest (Fig. 3). Substantial area in the eastern portion is projected shift to non-forest over time, particularly at lower elevations. Moderate and low moisture stress levels are projected to remain at higher elevations, on north-facing slopes, and in valley bottoms. Treatments, as well as managed wildfires in roadless and other inaccessible areas, that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is concentrated in dry forest patches in the east. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is in the middle or upper end of desired ranges, although it is overly abundant in the central and northwestern portion. In high fire risk locations, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability, help maintain habitat in the most sustainable locations (Fig. 7), and broaden the spatial distribution of open canopy habitat. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is abundant but concentrated in large patches at higher elevations in the western part of the planning area.

Enhance rural economic development

Most of the higher priority areas for commercial treatments have road access and are capable of producing significant timber volume. Although warming trends and high fire risk will necessitate managing for lower densities and drought-tolerant species such as ponderosa pine and Douglas-fir, long-term timber production will likely be possible. Reducing fire risk will help sustain recreation and tourism while reducing the potential of smoke affecting nearby communities.

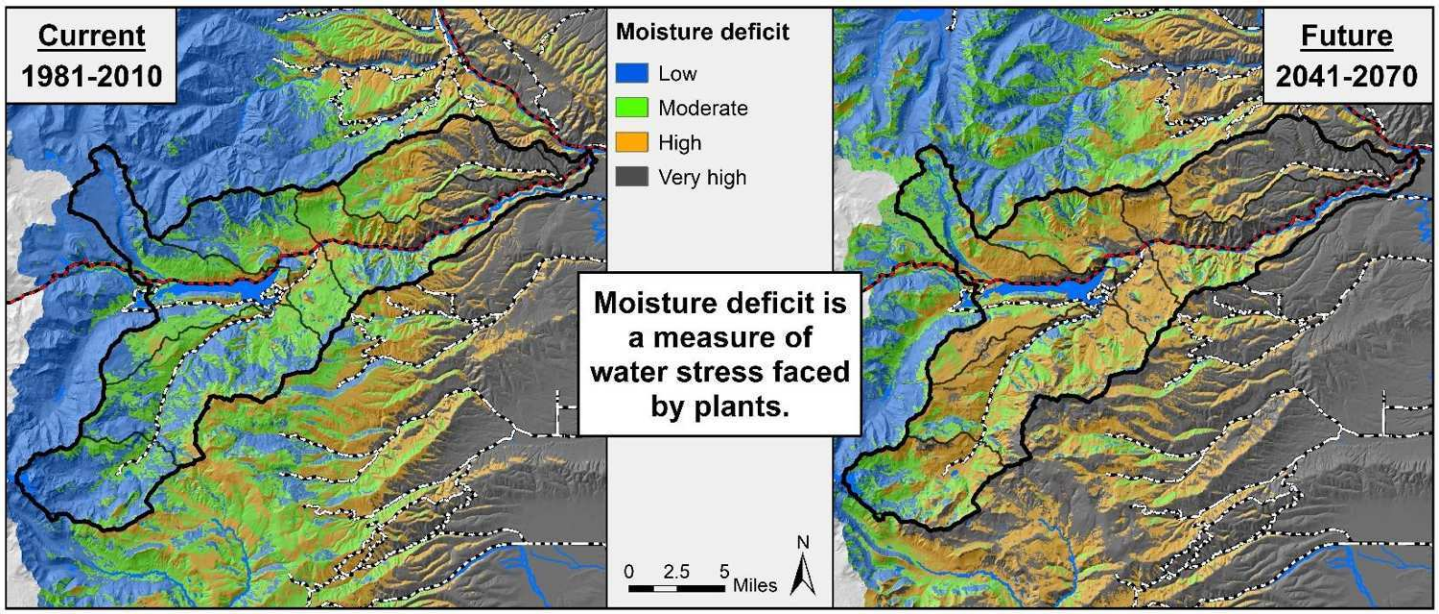


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

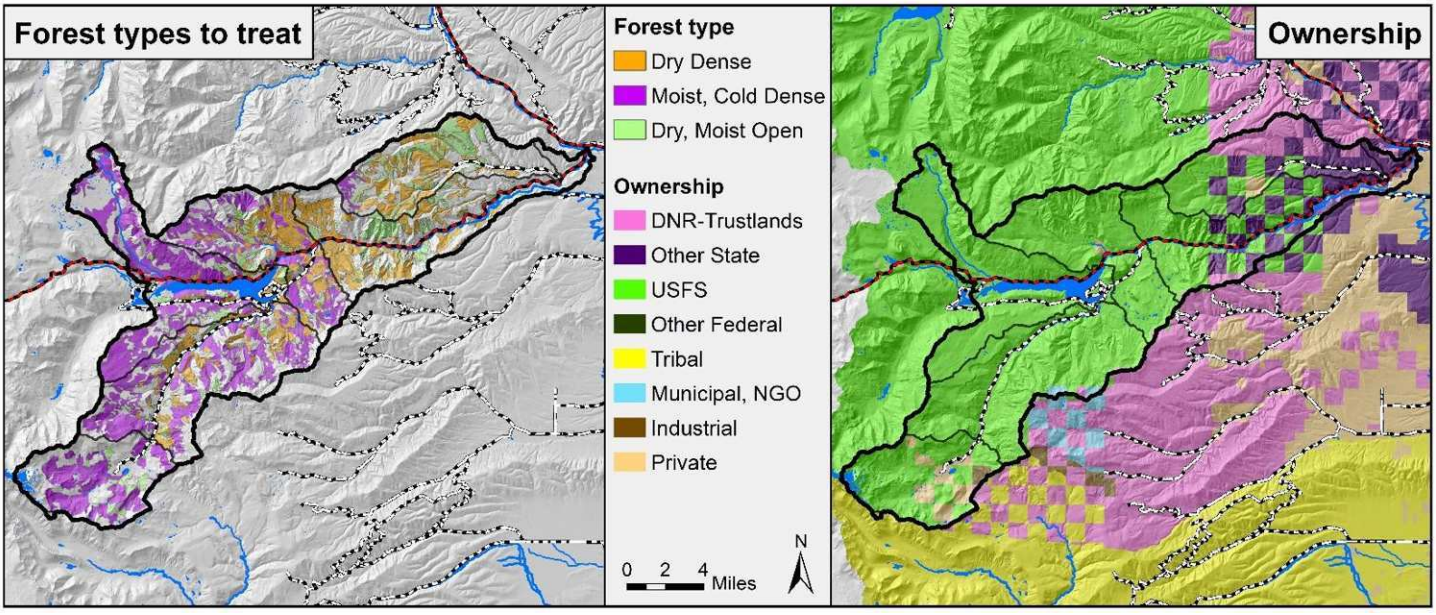
Forest Health Treatment Needs

Treating 38,000 to 60,500 acres is recommended to move the landscape into a resilient condition (32-51% of forested acres; Table 1). This total includes an estimated 31,250-49,500 acres to shift dense to open forest and 6,750-11,000 acres of maintenance treatments in existing open forest, based on current condition data from 2017 aerial photos. Most of the treatment need is located within USFS ownership.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in roadless and wilderness areas. Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**USFS**	**DFW**	**DNR Trust**	**Private**	**Other**
Dry Dense	Medium-Large	18,250 - 22,500	25,153	4,388	2,197	520	0
Moist + Cold Dense	Medium-Large	13,000 - 27,000	43,526	237	176	1,101	461
Dry + Moist Open	Medium-Large	6,750 - 11,000	9,239	3,095	1,989	943	63
Total		**38,000 - 60,500**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites, especially sites dominated by Douglas-fir. The large, numerous patches of this forest type create high susceptibility to defoliating insects, bark beetles, and crown fire. Treating 18,250-22,500 acres of this type (Table 1) is recommended to create large patches (~100-1000 ac) of open forest with a component of large trees (Fig. 4), flipping the majority of dry sites from closed to open forest (Fig. 6). Shifting composition toward ponderosa pine and reducing grand fir and Douglas-fir is also recommended.

Moist and cold dense forest treatment need

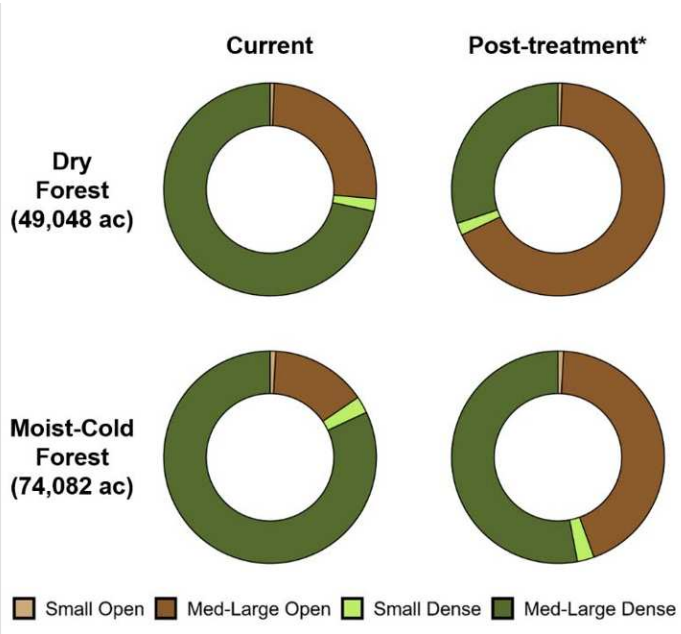
Dense, multistory mixed-conifer forest on moist and cold sites exceeds or is at the upper end of desired ranges throughout the western portion of the planning area. In contrast, open canopy forest with medium to large trees are at the low end of desired ranges. Treating 13,000-27,000 (Table 1, Fig. 4) is recommended to create a mosaic of open and dense forest that will reduce the risk of large crown fire and insect outbreaks. A range of treatment types will be needed, including thinning, regeneration treatments, and managed wildfire in roadless areas. Increasing the relative composition of ponderosa pine and western larch is also recommended to help these sites adapt to a warming climate. Following treatments, over half of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

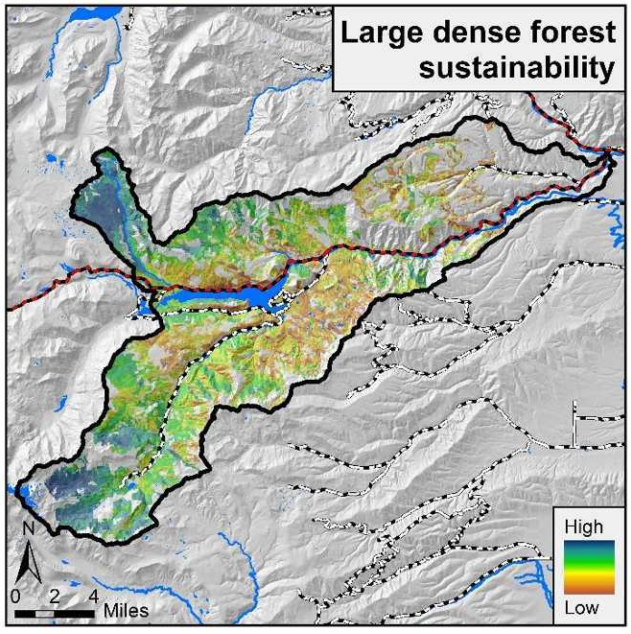
Open forest maintenance treatment need

Over the next 15 years, an estimated 6,750-11,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments, especially in the Oak Creek area. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Sustainable locations include the western end of the planning area, as well as upper slopes in the central portion (Fig. 7). The large tree, dense forest sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). We also recommend incorporating the large dense forest sustainability layer (Fig. 7) as an overlay when selecting treatment locations. Wildfire transmission is relatively low across most of the planning area, although high transmission in the eastern end represents substantial fire exposure to the communities of Tieton and Naches (Fig. 2).

Treatment priorities

Landscape treatment priority is high throughout the central portion (Fig. 9). Relatively gentle, north-facing slopes south of Rimrock Lake are particularly high priority due to fire risk and dense forest structure. Medium priority areas in wilderness and roadless areas in the northwest and southwest portions indicate that managed wildfire could be beneficial under the right conditions. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes and businesses around Rimrock Lake and along Highway 12.

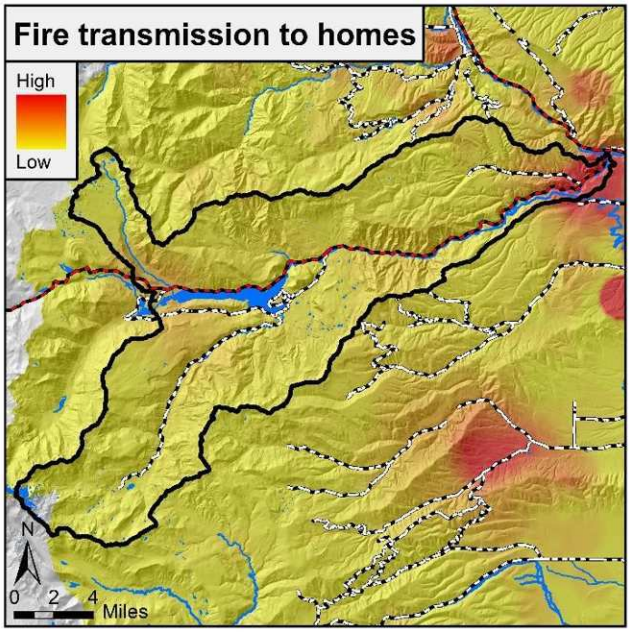


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

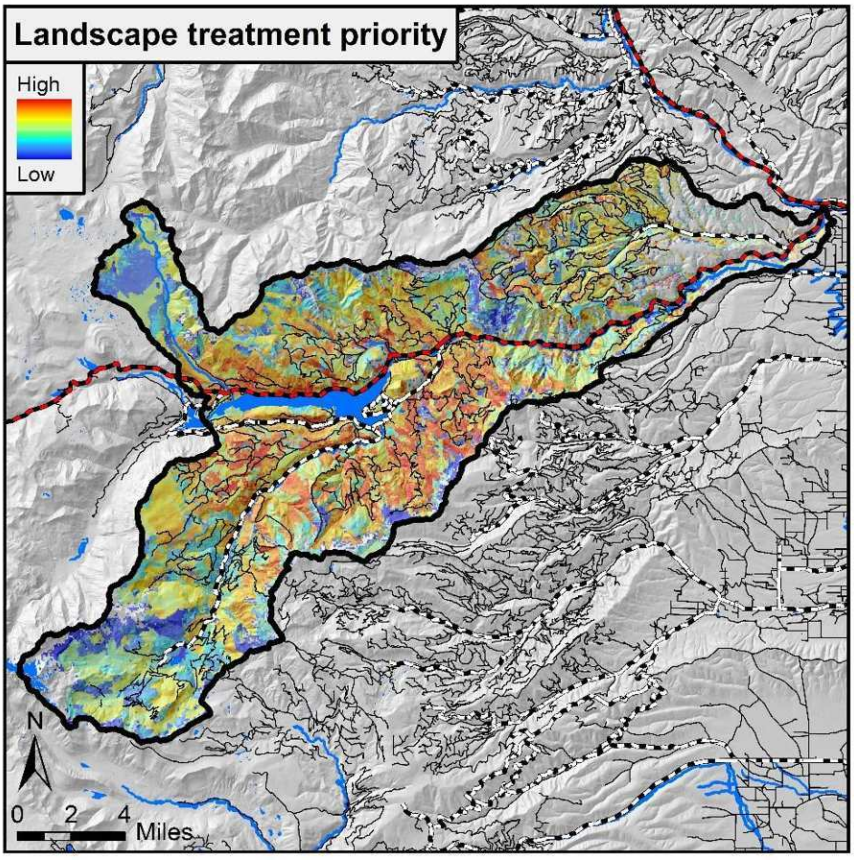


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

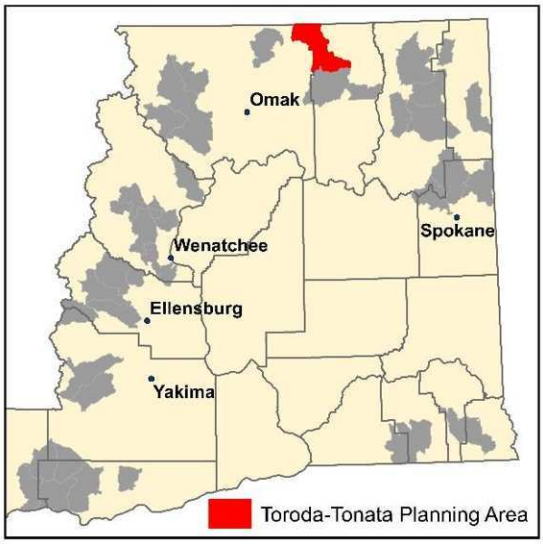
***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

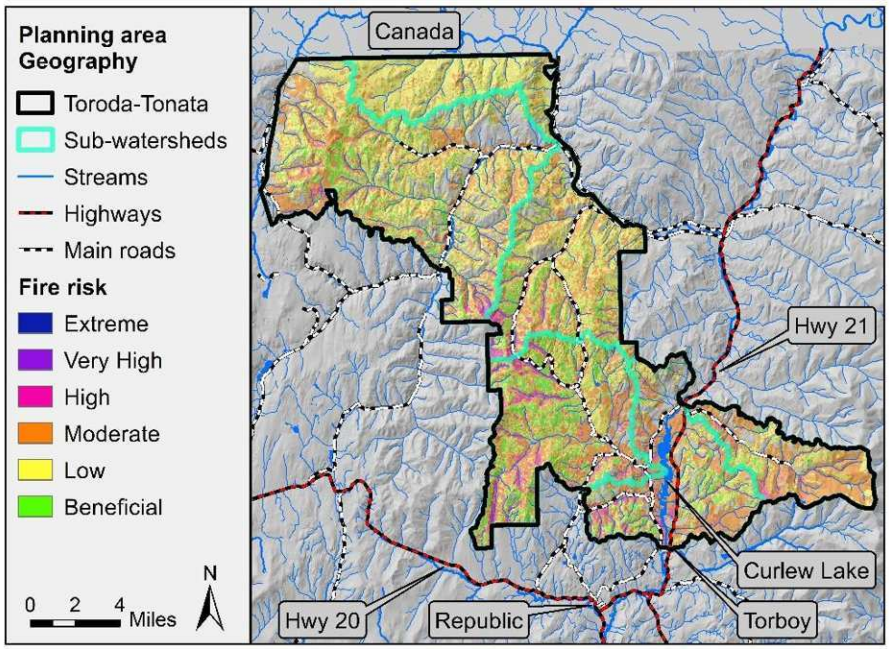
Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fire is allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

TORODA-TONATA PLANNING AREA LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
153,611	117,345	51,000 - 66,000





Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- Land ownership is split among the Colville National Forest (59%), private (31%), and DNR (7%) and BLM (3%).
- Treating 43-56% of forested acres is recommended to move the landscape into a resilient condition. This includes 7,500-12,000 acres of maintenance treatments in currently open areas.
- Landscape treatment priority is highest just north of Republic and west and east of Curlew Lake. This area is private land and will require a mix of fuel reduction and defensible space treatments, as well as home hardening, to protect homes and restore resilient forest conditions.
- Other high and medium priority treatment areas include large patches of dense, medium-sized forest in the central and northern portions.
- A combination of mechanical treatments and prescribed fire will be needed. Managed wildfire can also be utilized under the right fire weather and fuel moisture conditions, especially in roadless and other inaccessible areas.
- The Colville National Forest is currently planning the Tonata-Trout project, which is a large forest restoration project in the central portion. Planning for another project in the northern portion is slated to begin in the next several years.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Predicted fire risk is variable across the planning area with intermixed patches of moderate and low risk, with some high risk areas in valley bottoms and north-facing slopes (Fig. 2). Moderate risk areas generally have high predicted fire intensity and tree mortality but low burn probability, which is based on patterns of large fires from 1992-2015. There are also significant patches of grassland and open forest where fires are predicted to burn as low-intensity surface fires, which will have beneficial effects by consuming fuels and small trees. Without treatments, fire risk is predicted to increase as burn probability increases with projected climate warming Landscape treatments will help restore conditions conducive to a more characteristic balance of low- and mixed-severity fire, with some high-severity patches. Over time, a restored landscape will provide managers more flexibility to utilize managed wildfire to maintain these fire-dependent ecosystems and thus harness the predicted increase in burn probability. In addition, implementing fuel reduction treatments around homes and establishing potential control line will increase firefighter safety and help protect communities.

Increase resilience and prepare for climate change

By mid-century, low to mid elevations in the planning area are projected to become drier, with south-facing slopes experiencing moisture stress levels that may not support forest (Fig. 3). Treatments that reduce density and favor drought-tolerant species will enhance forest persistence. At high elevations, moisture stress is projected to increase due to earlier snow melt, less summer precipitation, and warmer spring and summer temperatures. Climate models, however, predict that some mid-elevation areas will have somewhat lower moisture stress levels. Lower moisture stress is due to warmer and more rain-dominated winter and spring conditions, offsetting mild decreases in summer precipitation.

Sustain wildlife habitat

The amount of habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is somewhat abundant across the planning area. Thinning and/or fire-based treatments to create or expand moderate to large patches (100-500+ acres) of open forest dominated by ponderosa pine will expand this habitat type. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Goshawk) is also somewhat abundant with a wide range of patch sizes. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is well represented in the relatively small amount of cold and moist forest within the planning area.

Enhance rural economic development

Most of the high and medium priority areas for treatments have road access, gentle terrain, and are commercially viable in the central and southern 2/3^{rds}. The northern 1/3rd has steeper terrain and less access. Meeting restoration treatment needs will provide a significant amount of forest products and related economic activity. Although warming trends will necessitate managing for more drought-tolerant species and lower densities and fuel loads on dry sites, forest productivity should remain moderate at mid to upper elevations and potentially increase.

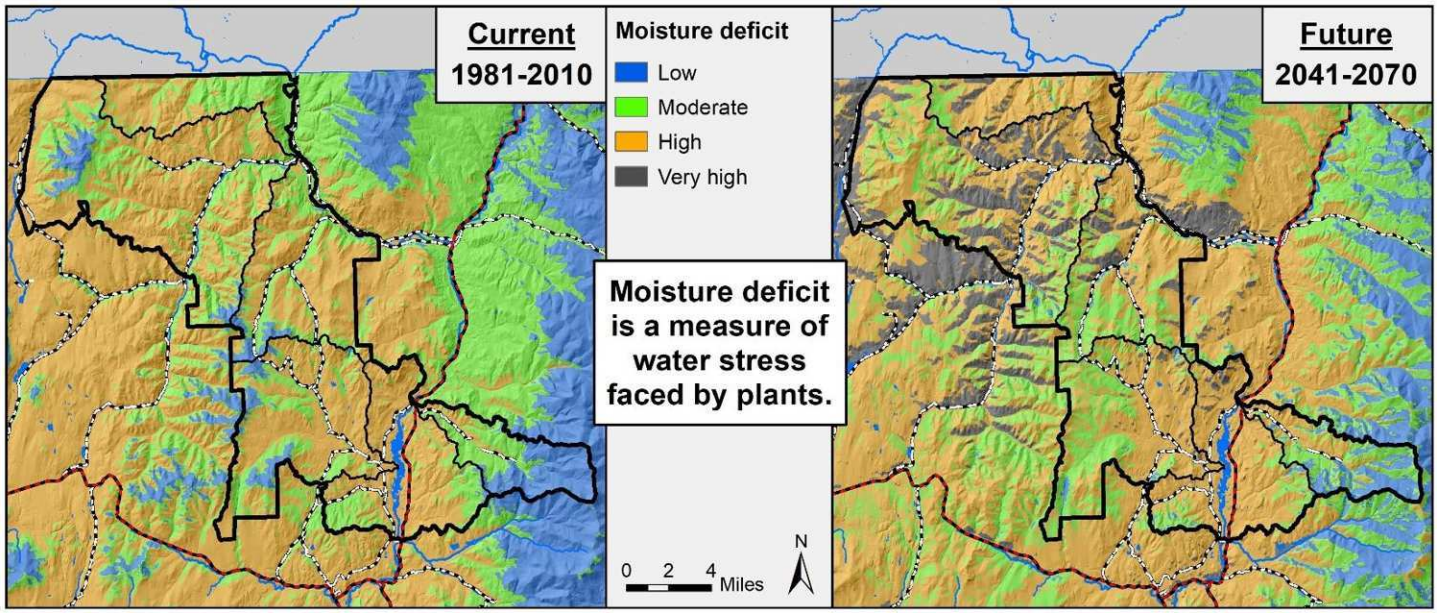


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

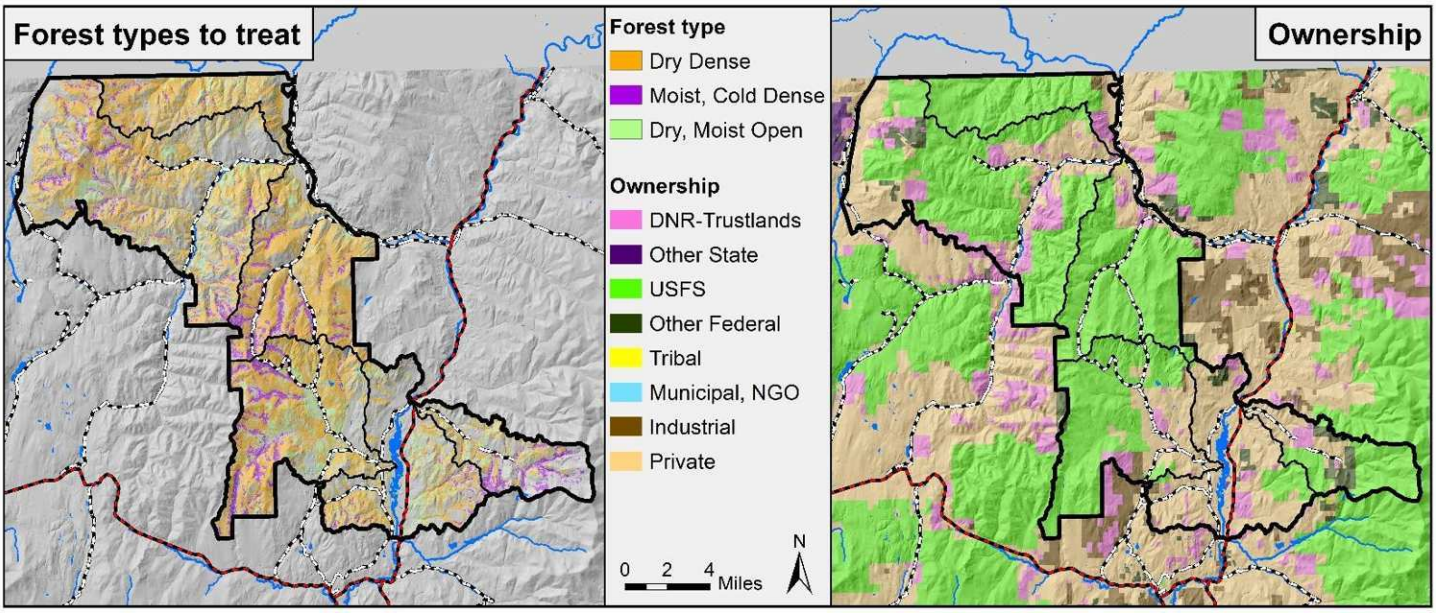
Forest Health Treatment Needs

Treating 51,000 to 66,000 acres is recommended to move the landscape into a resilient condition (43-56% of forested acres; Table 1). This total includes an estimated 43,500-54,000 acres to shift dense to open forest and 7,500-12,000 acres of maintenance treatments in existing open forest, based on current condition data from 2017 LiDAR. The majority of the treatment is on USFS land, although substantial need exists on private land in the southern portion. The Colville National Forest is currently planning a large restoration project in the middle portion of the planning area. There is also a small amount of need on DNR and BLM land.

Meeting restoration goals will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed for initial and maintenance treatments over time, especially in the Jackson Creek and Bodie Mountain Inventoried Roadless Areas. Based on tree size class, many areas are commercially viable, although treatment type will depend on access, logging systems, markets, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**USFS**	**Private**	**DNR Trust**	**Other Fed**	**Industrial**
Dry Dense	Medium-Large	41,000 - 50,000	46,707	13,509	2,784	1,350	239
Moist + Cold Dense	Medium-Large	2,500 - 4,000	9,603	790	230	386	20
Dry + Moist Open	Medium-Large	7,500 - 12,000	7,151	6,091	2,394	337	278
Total		**51,000 - 66,000**	*These are current acres, not targets				
Anticipated treatment type		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, medium and large tree, dense forest structure is over-represented on dry sites. The far north and central portions have large, contiguous patches of dense forest. Other parts of the planning area are more broken up with open canopy or young forest, or non-forest patches on south-facing slopes. Much of the dry forest is also dominated by Douglas-fir. These forests are vulnerable to uncharacteristically large patches of high-severity fire, as well as a combination of drought stress, root disease, and Douglas-fir beetle. These disturbances will reduce existing medium and large tree structure. Treating 41,000-50,000 acres of dry dense forest (Table 1) is recommended to shift the majority of dry sites to open forest dominated by medium and large patches (~100-1000 ac) (Fig. 6). As the retained trees grow over time, much of the dry forest will shift to large tree, open forest, which is currently only at 8% of the dry forest area. Shifting composition toward ponderosa pine and western larch is also needed.

Moist and cold dense forest treatment need

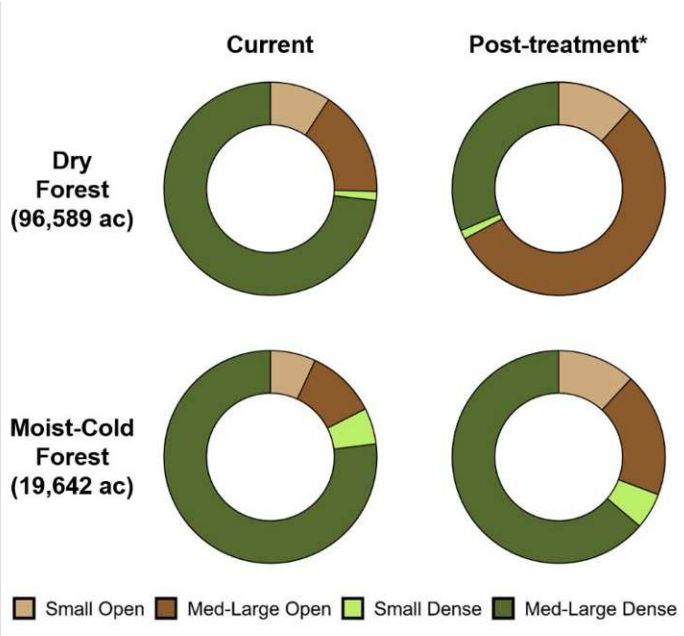
Dense, medium tree forest on moist and cold sites exceeds the upper end of desired ranges. In contrast, open canopy forest with medium to large trees, as well as open forest with small trees and shrubs, are at the low end of desired ranges. Large tree dense forest is also low on moist forest sites. Treating 2,500-4,000 acres of this forest type (Table 1, Fig. 4) is recommended. Patch. Patch sizes of treatments should be tailored to the topography and soil types that support moist forests. A range of treatment types will be needed, including thinning, regeneration treatments, and managed wildfire, especially in inaccessible and roadless areas. Increasing the amount of ponderosa pine and western larch will help these sites adapt to a warming climate. Following treatments, over 60% of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

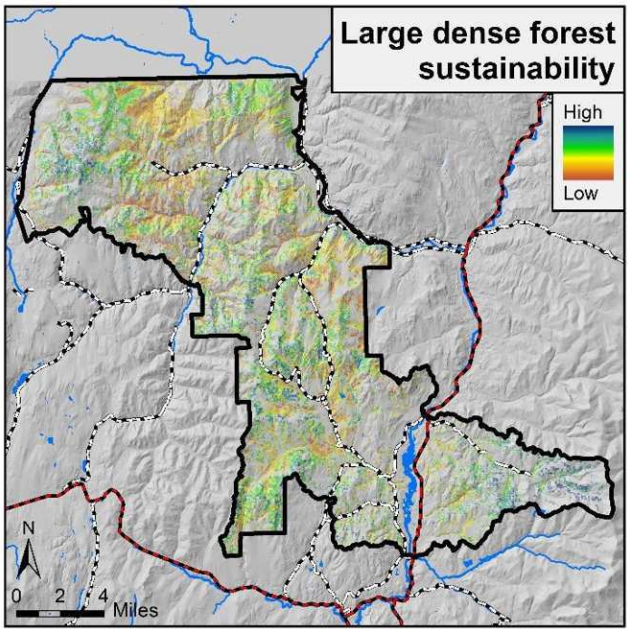
Open forest maintenance treatment need

Over the next 15 years, an estimated 7,500-12,000 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. Specific maintenance strategies depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. More sustainable locations are generally located on north-facing slopes at mid elevations, as well as at higher elevations (Fig. 7). This sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to promote open forest vs. where to maintain and build large tree, closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is high in the southern end of the planning area, indicating that wildfires starting in these locations are expected to expose homes in the area around Republic (Fig. 2).

Treatment priorities

Landscape treatment priority is highest in the southern portion, north of Republic and west and east of Curlew Lake (Fig. 9). This area is private land and will require a mix of fuel reduction and defensible space treatments, as well as home hardening, to protect homes and restore resilient forest conditions. The central portion of the planning area, which is mostly USFS land, has large patches of high and medium priority areas. Blocks of medium priority are also present in the north portion, mostly on south-facing slopes. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues.

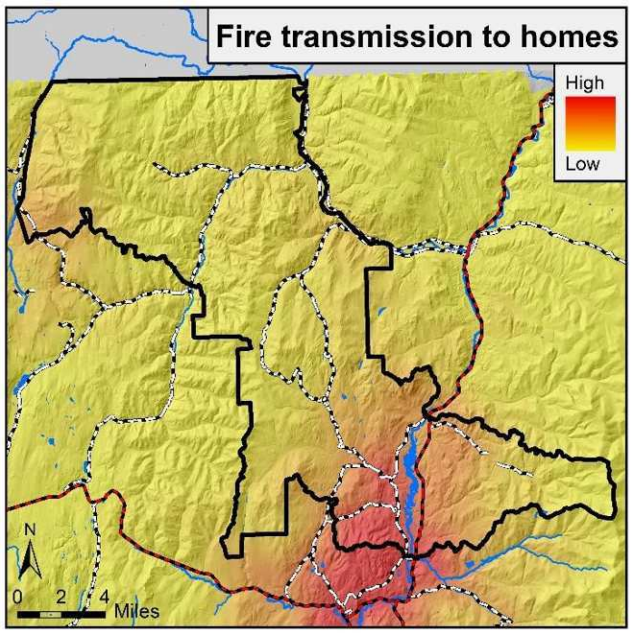


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

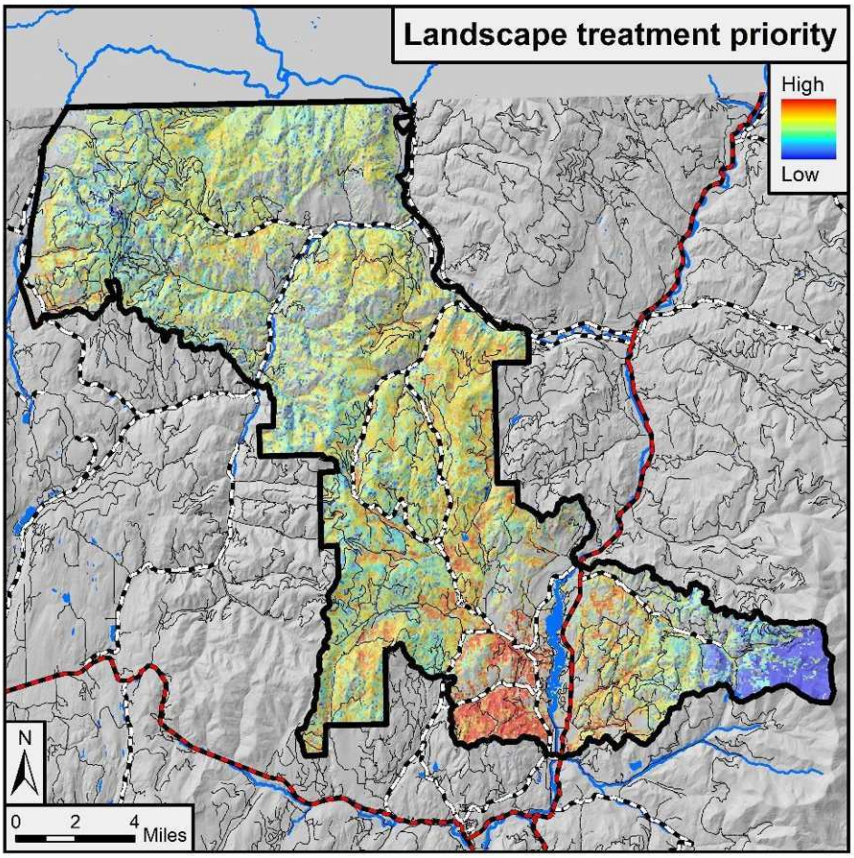


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

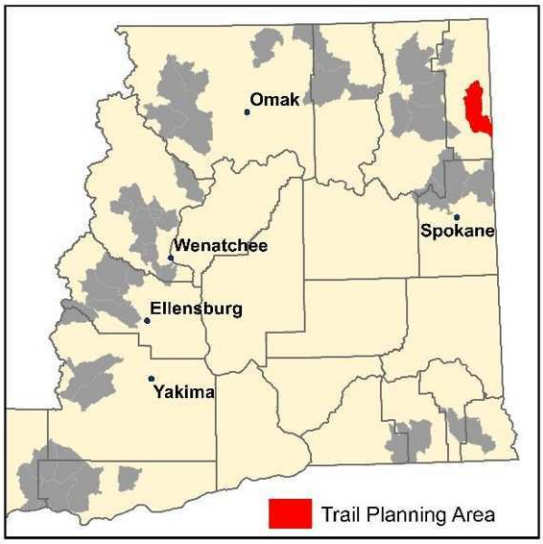
***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

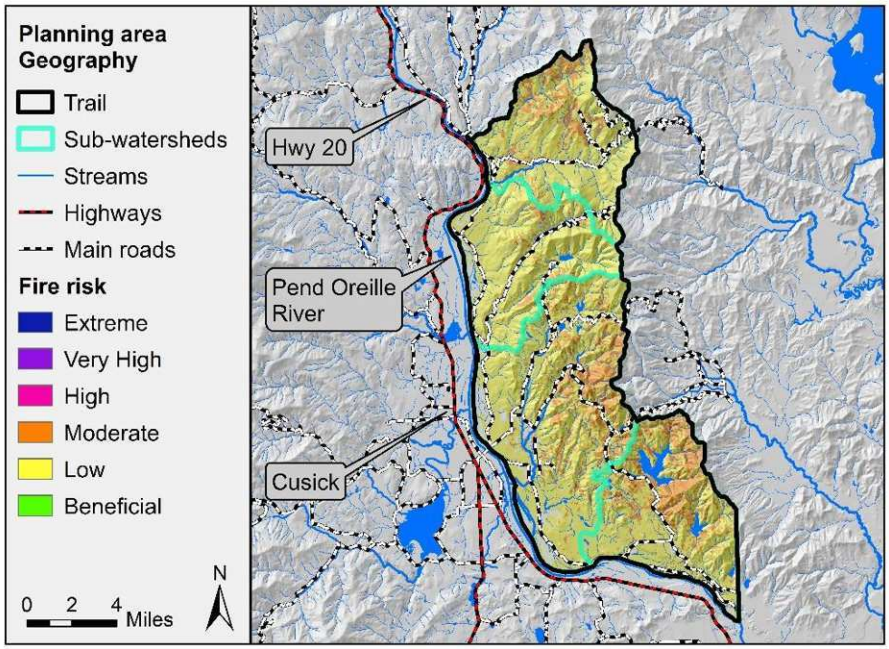
Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fires is allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

TRAIL PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
105,242	94,948	32,500 - 44,000





Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- Land ownership is split between the Colville National Forest (40%), private (28%), industrial forestland (18%), DNR (8%), and the Kalispel Tribe (5%).
- Fire risk is highest around Bead and Marshall Lakes, as well as in the central eastern portion and in the far north (Fig. 2). Although fuel loads are high in these areas, burn probability is low, resulting in moderate risk.
- Projected warming over the next 20-40 years will likely shift climate conditions suitable for moist and cold forest towards conditions suitable for dry forest. North-facing slopes should continue to support moist forest into the future.
- Treating 34-46% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- Treatment priority is generally highest on south-facing slopes in the southern 2/3^{rds} of the planning area. Much of the private land east of the Pend Oreille River is also medium to high priority.
- The Kalispel Tribe requested initiation of a forest restoration project on the Colville National Forest (CNF) under the Tribal Forest Protection Act. This restoration project, known as Sw^{x}uytn-Kaniksu Connections 'Trail', is a joint planning effort of the CNF, Tribe, and DNR, which will address much of the restoration need on the CNF within the planning area.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Although fuel loads are moderate to high, fire risk to forests and homes is moderate to low across the planning area (Fig. 2) due to low burn probability, which is based on large fires from 1992-2015. If a fire does occur, however, predicted fire intensity is moderate to high in much of the planning area. The Tower Fire that burned 24,194 acres in 2015 is a prominent example. Without treatments, fire risk is predicted to increase as burn probability increases with projected climate warming. Landscape treatments will help reduce the risk of large, high-severity fire and restore conditions conducive to a more characteristic balance of low- and mixed-severity fire, with some high-severity patches. Over time, a restored landscape will provide managers more flexibility to utilize managed wildfire to maintain these fire-dependent ecosystems and thus harness the predicted increase in burn probability. In addition, implementing fuel reduction treatments around homes and establishing potential control line will increase firefighter safety and help protect communities.

Increase resilience and prepare for climate change

By mid-century, the majority of the planning area is projected to have moisture stress levels that are currently associated with dry forest (Fig. 3). Dense forests with drought-intolerant species on dry sites will be increasingly susceptible to drought stress, root diseases, and insects. Moderate and low moisture stress levels are projected to remain on north-facing slopes at mid to high elevations. Treatments that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is somewhat abundant in the planning area. Patch sizes are generally small but are well distributed across the dry forest in the planning area. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Goshawk) is abundant in the middle to southern 2/3^{rds} of the planning area. Patch sizes are moderate to large and aggregated. In high fire risk locations, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability, help maintain habitat in the most sustainable locations (Fig. 7), and broaden the spatial distribution of open canopy habitat. In the northern 1/3rd, large tree dense forest habitat is low and patch sizes are small. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is well represented in the moist and cold forest portions.

Enhance rural economic development

Most of the higher priority areas for commercial treatments have road access and will produce significant timber volume. Although warming trends will necessitate managing for more drought-tolerant species and lower densities and fuel loads on current and future dry sites, long-term timber production should be possible. Productivity should remain moderate to high and may even increase at mid to upper elevations. Reducing fire risk will reduce the potential for smoke to affect communities.

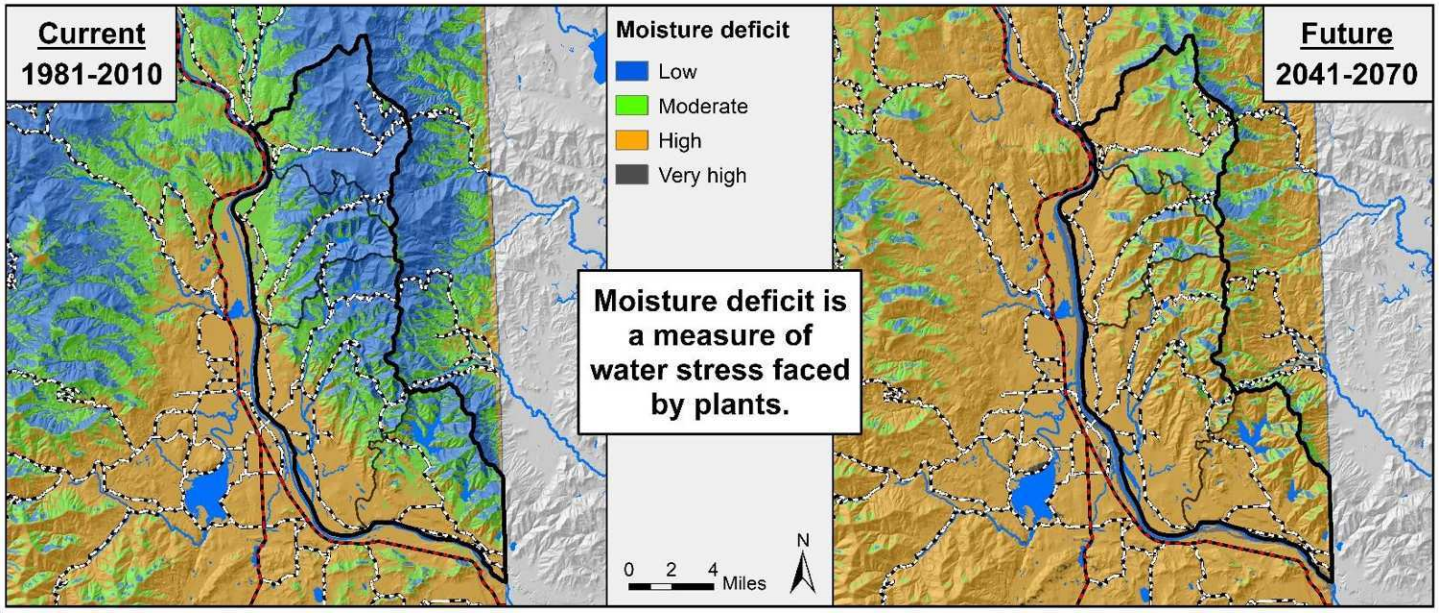


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

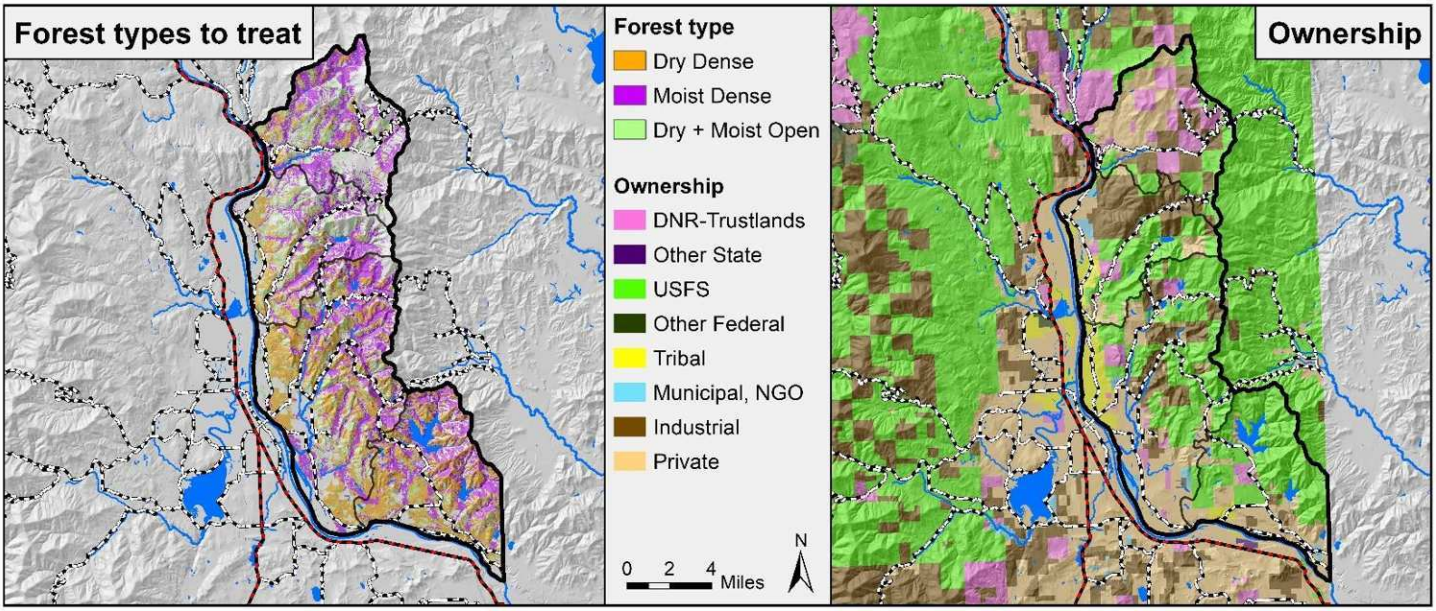
Forest Health Treatment Needs

Treating 32,500 to 44,000 acres is recommended to move the landscape into a resilient condition (34-46% of forested acres; Table 1). This total includes an estimated 27,000-34,500 acres to shift dense to open forest and 5,500-9,500 acres of maintenance treatments in existing open forest, based on current condition data from 2016 LiDAR. The majority of the treatment need is located on USFS land, although substantial need exists on other ownerships as well (Table 1).

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in less accessible locations. Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*				
Type	**Size class**		**USFS**	**Private**	**Industrial**	**DNR**	**Tribal**
Dry Dense	Small	250 - 500	313	444	279	108	35
	Medium-Large	16,250 - 20,000	12,582	7,130	2,323	1,505	1,820
Moist Dense	Small	500 - 1,000	770	358	852	144	19
	Medium-Large	10,000 - 13,000	14,430	6,693	4,661	1,985	237
Dry + Moist Open	Large	5,500 - 9,500	3,603	4,670	3,377	1,701	641
Total		**32,500 - 44,000**	**These are current acres, not targets*				
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).					
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.					
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*					



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense forest structure of all size classes is over-represented on dry sites. In addition, mortality and past harvest of large ponderosa pine and western larch has resulted in much of the dry forest being dominated by Douglas-fir. This has set the stage for significant potential mortality from a combination of drought stress, root disease, and Douglas-fir beetle. Treating 16,500-20,500 acres of this type (Table 1) is recommended to create large patches (~100-1000 ac) of open forest with a component of large, fire-tolerant trees and to shift the majority of dry sites to open forest (Fig. 6). Shifting composition toward ponderosa pine and western larch is also needed. In places where these species are poorly represented, planting will be required after gap creation, variable retention harvests, or open patches created by high-severity fire.

Moist and cold dense forest treatment need

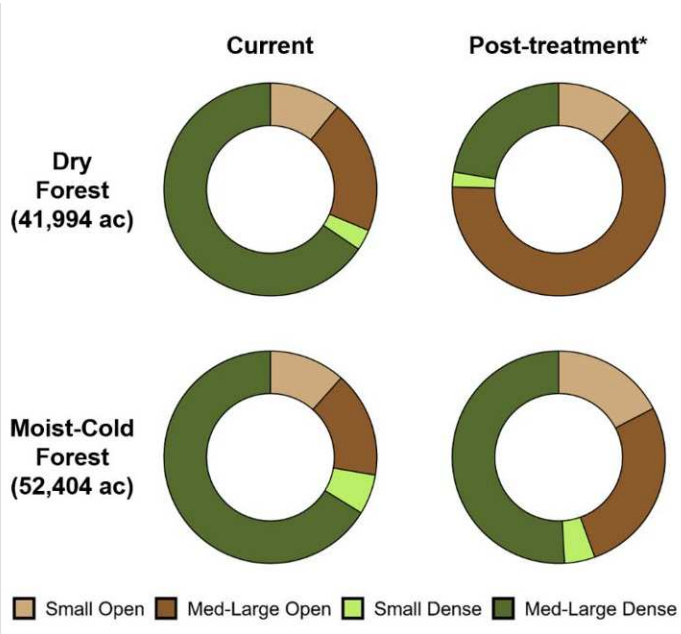
Dense, medium tree forest on moist sites exceeds desired ranges across the planning area, especially in the southern 2/3^{rds}. Patch sizes are large and aggregated. Both open and dense large tree structure is below desired ranges. Treating 10,500-14,000 acres of this type (Table 1, Fig. 4) is recommended to accelerate the development of large tree structure and create a mosaic of open, moderate, and dense patches that will reduce risks of large crown fire and insect outbreaks. Increasing the relative composition of western larch and ponderosa pine while decreasing grand fir and western red cedar is also needed, especially on sites projected to shift to dry forest (Fig. 3). Following treatments, over half of the moist forest area would remain dense (Fig. 6) to meet habitat, wood production, carbon, and other objectives. Cold forest structure is within desired ranges and thus not included in Table 1. However, there may be other forest health reasons to treat cold forests based on field evaluation.

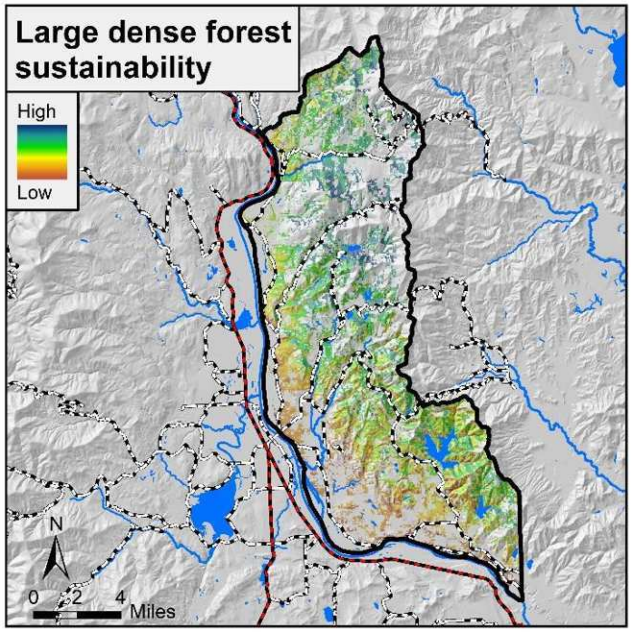
Open forest maintenance treatment need

Over the next 15 years, an estimated 5,500-9,500 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. These sites include mechanically treated areas that may or may not have received fuel treatments, as well as parts of the Tower Fire where additional fuel reduction is needed. Specific maintenance strategies will depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain and build sufficient area and patch sizes of this habitat type and associated ecosystem functions. Sustainable locations include north-facing slopes at mid to higher elevations in the southern 2/3^{rds} and much of the northern 1/3rd (Fig. 7). This sustainability map can be used in conjunction with treatment priority (Fig. 9) to select areas to shift to open forest vs. where to manage for large tree closed canopy patches.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Transmission potential is low in this planning area compared to areas with higher fire probability. However, treatments close to Cusik and the western side of Bead and Marshall Lakes (Fig. 2) will assist firefighters in protecting structures if a fire occurs.

Landscape treatment priorities

Landscape treatment priority is generally highest on south-facing slopes in the southern 2/3rd, although some north-facing slopes and valley bottoms are also medium or high priority (Fig. 9). Much of the flat area to the east of Pend Oreille River is also medium to high priority. While most of the medium and high priority areas are on USFS land, there is significant need on non-industrial private land. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels across the planning area.

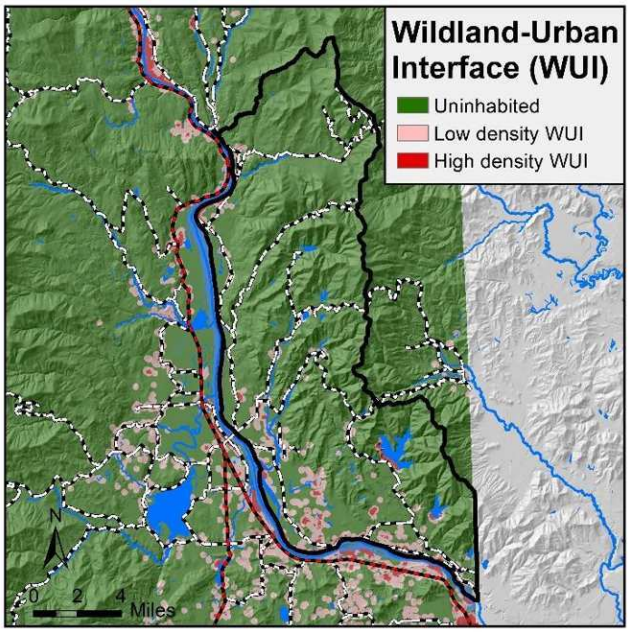


Figure 8. Wildland-Urban Interface (WUI) based on locations of private property with structures.

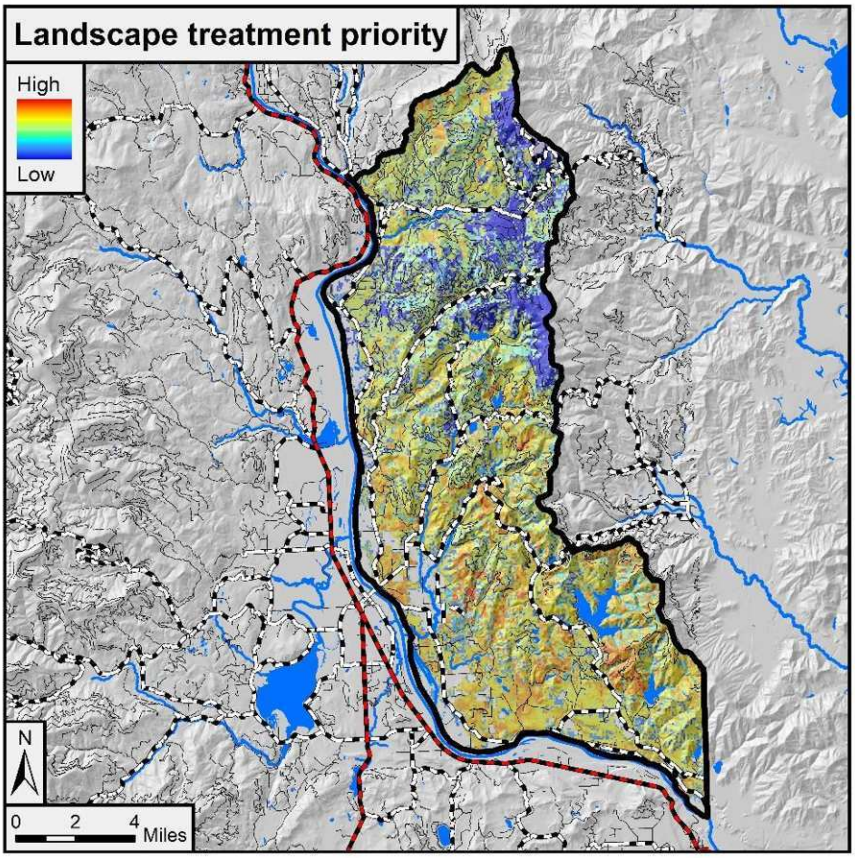


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or ≤ 10% conifer cover.

Forest structure

Large tree: Overstory diameter > 20 inches.

Medium tree: Overstory diameter 10-20 inches.

Small tree: Overstory diameter < 10 inches.

Dense canopy: Greater than 40% tree canopy.

Open canopy: Less than 40% tree canopy.

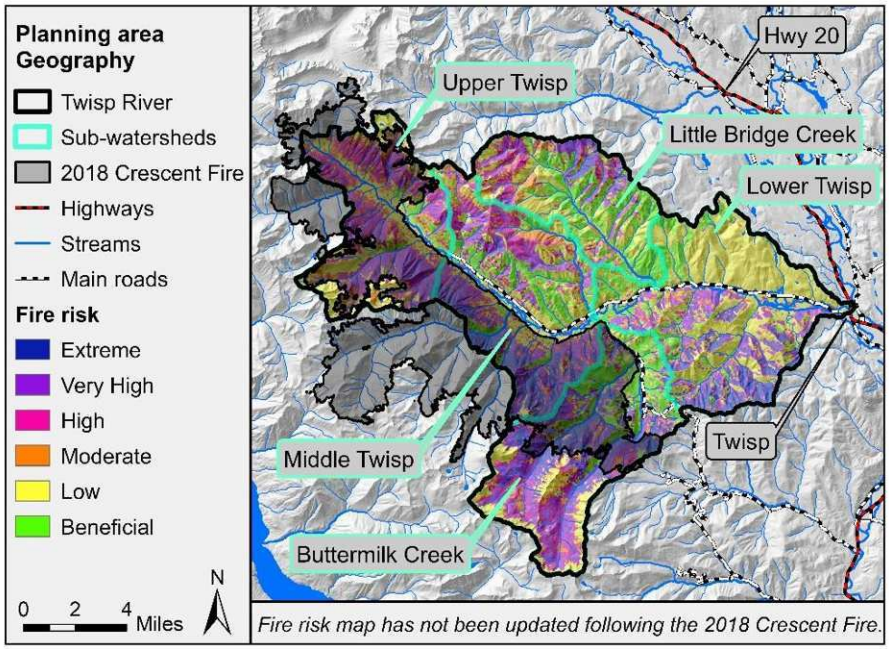
***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fire is allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

TWISP RIVER PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
111,918	82,349	26,000 - 36,500



Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- Land ownership is 91% Okanogan-Wenatchee National Forest, 5% private, 2% DNR, and 2% WDFW. USFS management allocation is split between Matrix, Late Successional Reserve, and Wilderness areas.
- 45% of the planning area is dry forest, 25% is cold forest, 3% is moist forest, 19% is shrub-steppe, and 8% is other.
- Fire risk is very high across much of the planning area (Fig. 2), but large patches of open canopy forest exist where wildfires will be beneficial by consuming surface fuels. Burn probability is among the highest in eastern Washington.
- Treating 32-44% of forested acres is recommended to move the landscape into a resilient condition using a combination of mechanical, prescribe fire, and managed wildfire treatments. The Okanogan-Wenatchee National Forest is currently planning a large restoration project in this area.
- Priority areas for potential treatments that maximize forest health and wildfire response benefit include high priority locations south of the Twisp River in the Lower Twisp sub-watershed and in the north-central portion north of Little Bridge Creek, as well as moderate priority locations throughout the Buttermilk Creek sub-watershed.
- In 2018, the Crescent Mountain Fire burned ~52,000 acres (32,000 acres within the planning area). Although the fire did some good restoration work, there is still a need for thinning and fuel reduction treatments in some low- and moderate-severity areas, as well as a need to monitor and possibly plant trees in some high-severity areas.

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

CONTACT

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high to extreme across much of the planning area (Fig. 2). However, large patches of open canopy forest are predicted burn with low-intensity surface fires, which will have beneficial effects by consuming fuels. Recently burned acres within the 2018 Crescent Mountain fire will have low risk until fuels grow back 10-15 years following fire. Burn probability across most of the planning area, which is based on patterns of large fires from 1992-2015, is among the highest in eastern Washington. Landscape treatments will help reduce the risk of uncharacteristically large patches of high-severity fire, especially as burn probability further increases with projected climate warming. Over time, a restored landscape will provide managers more flexibility to utilize managed wildfire to maintain these fire-dependent ecosystems. In addition, implementing fuel reduction treatments around homes and establishing potential control lines will increase firefighter safety and help protect communities, which is covered in the last two pages of this summary.

Increase resilience and prepare for climate change

By mid-century, the majority of the planning area is projected to have moisture stress levels that are currently associated with dry forest (Fig. 3). Substantial area in the eastern end is projected to shift to non-forest over time. Moderate and low moisture stress levels are projected to remain at higher elevations, north-facing slopes and valley bottoms, primarily in the western half. Treatments, as well as managed wildfires, that reduce density and favor drought-tolerant species will support forest persistence into the future.

Sustain wildlife habitat

The total amount habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is within desired ranges in the planning area, but habitat is fragmented with patch sizes that are too small. Similarly, habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is somewhat fragmented and within desired ranges for most areas, but it is overabundant in the Middle Twisp sub-watershed. To address these habitat needs, patches of open canopy, large tree forest can be expanded in high fire and drought risk locations, while large-tree, closed canopy patches can be expanded in more sustainable locations (Fig. 7). Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is within desired ranges for most of the planning area, but overly abundant in the Buttermilk sub-watershed.

Enhance rural economic development

Reducing fire risk will help sustain recreation and tourism. While much of the high and medium priority treatment has access and will provide a significant amount of forest products, steep terrain will limit what is commercially viable. Over time, warming trends and high probability will necessitate managing for more drought-tolerant species and lower densities across much of the planning area limiting wood production. North-facing slopes and higher elevation will remain more productive.

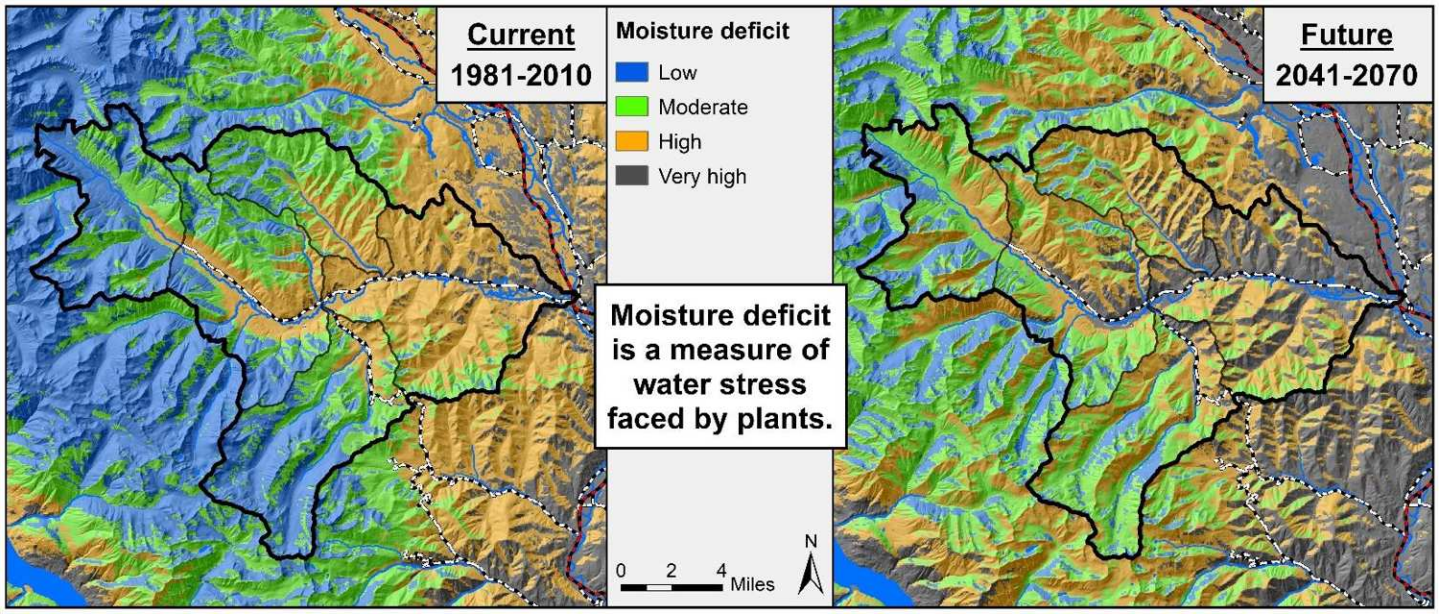


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

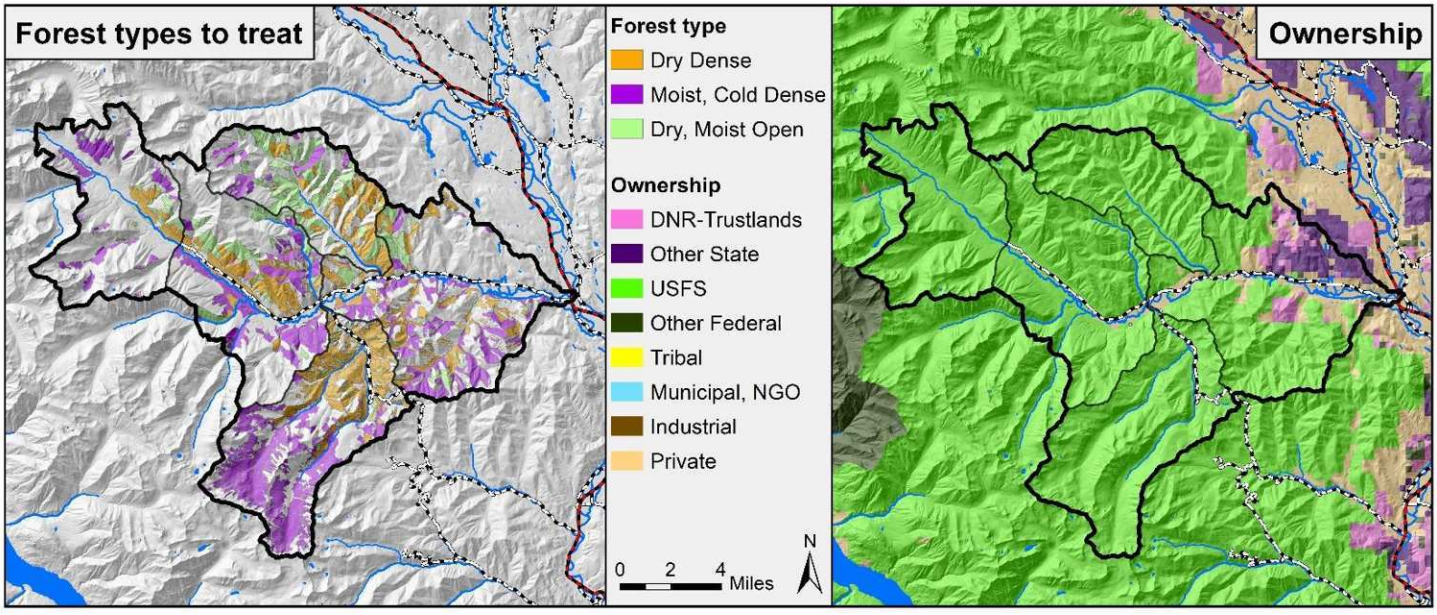
Forest Health Treatment Needs

Treating 26,000 to 36,500 acres is recommended to move the landscape into a resilient condition (32-44% of forested acres; Table 1). This total includes an estimated 22,250-30,000 acres to shift dense to open forest, and 3,750-6,500 acres of maintenance treatments based on current condition data from 2017 aerial photos, which was updated after the 2018 Crescent Fire. In the large patches of high-severity burn in this fire, we recommend monitoring natural regeneration and planting drought- and fire-tolerant species where tree cover is desired and seed sources for future climate-adapted species are limited.

Meeting this target range will require multiple treatment strategies (Table 1), including managed wildfire in Wilderness, roadless, and other locations. Many areas are commercially viable based on tree size, although treatment type will depend on access, logging systems, markets, and other factors. Individual landowners will conduct their own planning processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*			
Type	**Size class**		**USFS**	**Private**	**DNR Trustlands**	**DFW**
Dry Dense	Small	250 - 500	1,246	0	0	0
	Medium-Large	11,000 - 13,500	16,658	868	159	0
Moist Dense	Medium-Large	11,000 - 16,000	28,039	488	64	28
Dry + Moist Open	Medium-Large	3,750 - 6,500	9,538	170	22	0
Total		**26,000 - 36,500**	**These are current acres, not targets*			
Anticipated treatment type		Noncommercial thin plus fuels treatment. May be fire only (prescribed or managed wildfire).				
		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.				
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*				



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites relative to resilient landscape conditions. Overly large patches of this forest type are found along the north side of the Twisp river valley, in the northern portion of the Buttermilk drainage, and on the north side of Little Bridge Creek. Treating 11,250-14,000 acres of this type (Table 1) is recommended to create large patches (~200-1000 ac) of open forest with a component of large trees (Fig. 4), flipping the majority of dry sites from closed to open forest (Fig. 6). As the retained trees grow over time, much of the dry forest will shift to large tree, open forest, which is currently low. Shifting composition toward ponderosa pine and reducing lodgepole pine and Douglas-fir is also recommended.

Moist and cold dense forest treatment need

Dense, multistory forest on moist and/or cold sites exceeds desired ranges in all of the sub-watersheds within the planning area. Shifting 11,000-16,000 acres of this forest type (Table 1, Fig. 4) to medium and large tree open forest, as well as some early open forest outside of the Crescent Fire area, is recommended. This will reduce risks of a large crown fire that could further reduce medium and large tree structure. Managed wildfire can be utilized in Wilderness and inaccessible areas, while mechanical treatments and prescribed fire can be used where access exists. Following treatments, approximately half of the total moist and cold forest area would remain dense (Fig. 6).

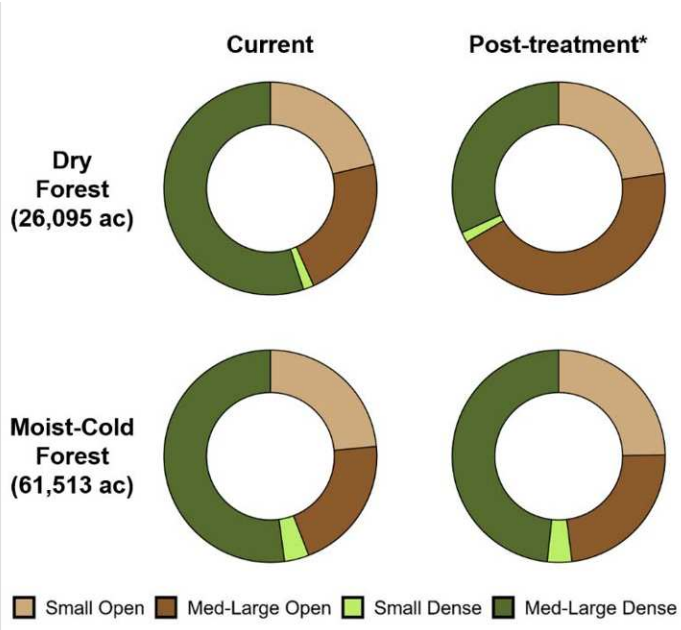
The large amount of high-severity fire in the 2018 Crescent Fire increased the amount of early-open (stand initiation) above desired ranges in the Upper and Middle Twisp sub-watersheds by 4,000-8,000 acres. Where future tree cover is desired, natural regeneration should be monitored and planting added where necessary. We recommend planting ponderosa pine and western larch on sites projected to shift to dry forest and where seed sources for these species are limited.

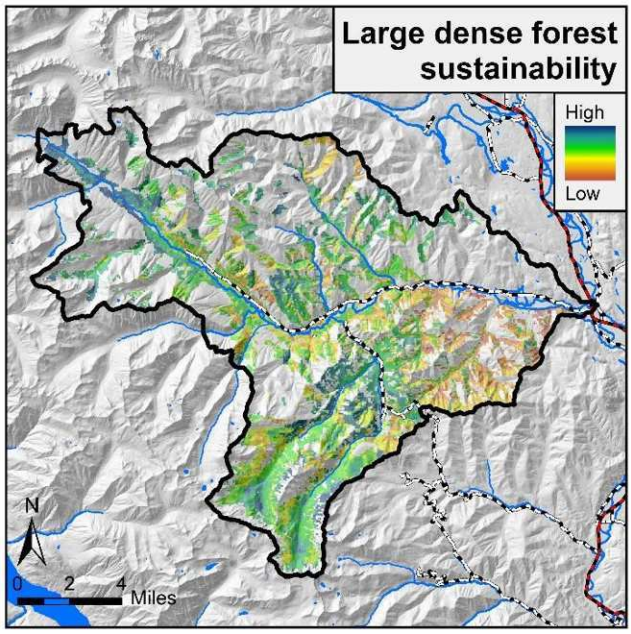
Open forest maintenance treatment need

Over the next 15 years, an estimated 3,750-6,500 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. This does not include areas within the Crescent Fire that may need additional fuel and green tree density reduction. Specific approaches will depend on landowner objectives and time since treatment.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig. 3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Sustainable locations include the valley floor of upper and middle Twisp River, draws, lower slopes and higher elevation areas in the Buttermilk sub-watershed (Fig. 7). Less sustainable locations represent opportunities to create large tree, open forest structure that is needed.





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). We also recommend incorporating the large dense forest sustainability layer (Fig. 7) as an overlay when selecting treatment locations. Wildfire transmission is high across the eastern half, indicating that wildfires starting in these locations are expected to expose homes within the Twisp River Valley as well as the Methow Valley.

Treatment priorities

Landscape treatment priority is highest in eastern portion on USFS and private land, especially in the Newby and Poorman Creek drainages within the Lower Twisp sub-watershed (Fig. 9). Other high and medium and high priority areas include the northern slope of Little Bridge Creek, north- and south-facing slopes within the Middle Twisp, and areas throughout the Buttermilk Creek sub-watershed. Some low priority areas may need treatment to address species composition, insect and disease issues, or other considerations. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes in the Lower Twisp and Buttermilk sub-watersheds.

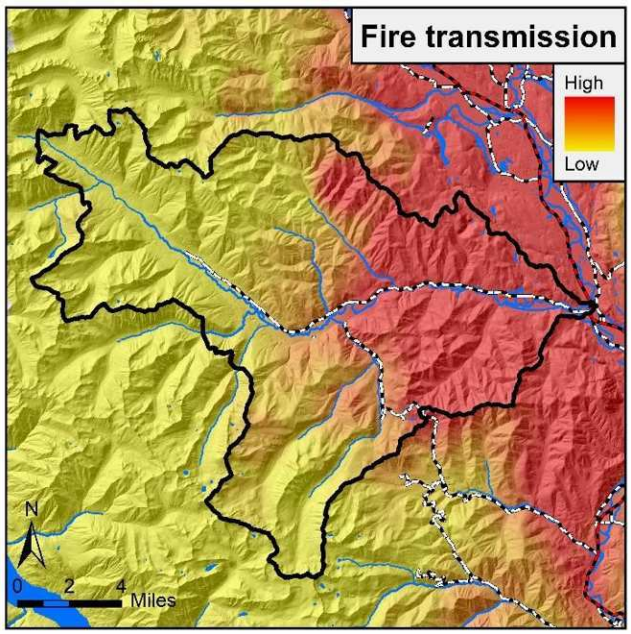
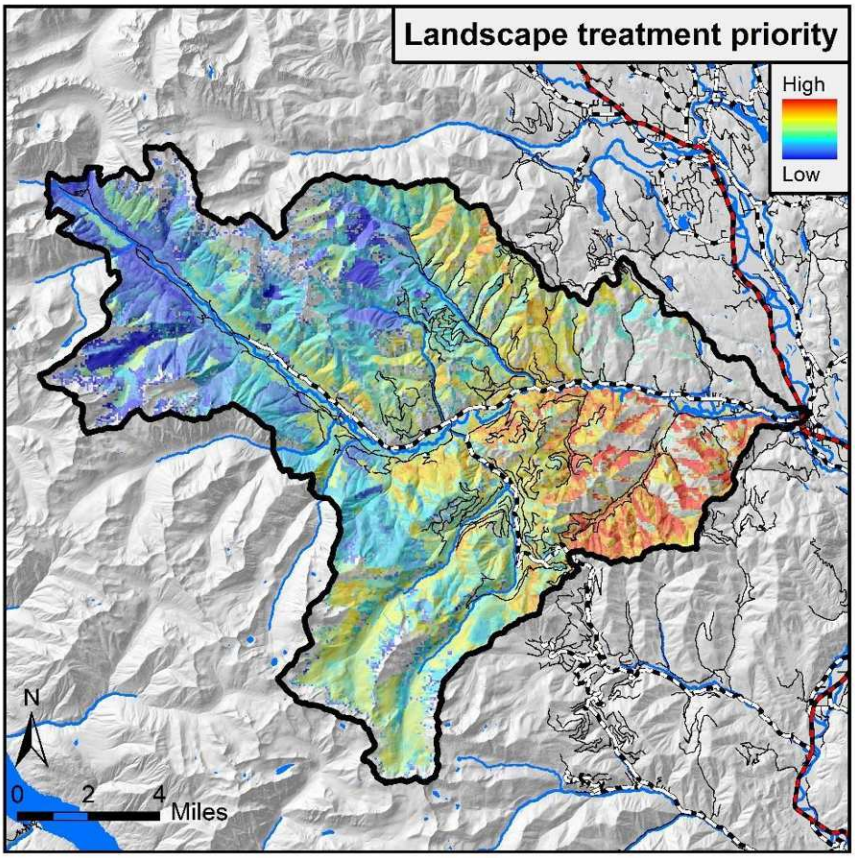


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.



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Managed wildfire: fires that are allowed to burn under safe conditions to achieve management goals but can be suppressed if conditions change.

Wildfire Response Benefit Prioritization

Dual benefits for forest health and wildfire response

It is necessary to conduct treatments to both improve forest health and reduce fire risk to communities as well as provide conditions where firefighters can safely and efficiently conduct fire operations (e.g. suppression, prescribed burning, and managed wildfire). The wildfire response benefit metric (WRB; Fig. 10) identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes, infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior. Because there are positive feedbacks between healthy, resilient forests and safe, effective fire operations, the WRB metric also integrates the landscape treatment priority map (Fig. 9).

Where WRB is highest, actions may be needed to create and maintain conditions that provide a tactical advantage for fire operations. These actions will vary with the local context and can include landscape-level forest health and fuel treatments, treatments along escape routes, resident and community fire mitigation activities (e.g. defensible space, home hardening), and improving signage and road conditions. The WRB metric provides a high-level prioritization, and additional work at the local level will be required to identify appropriate actions and assess their feasibility. WRB is useful for prioritizing Potential Control Lines (PCLs) for fire operations (Fig. 11). PCLs are a part of Potential Operational Delineations (PODs); see page 7.

In the Twisp River planning area, wildfire response benefit is highest along the eastern portion of Twisp River road leading to the town of Twisp (Fig. 2), encompassing the area of Newby Creek to Newby Ridge. This area includes the highest fire risk of homes and infrastructure as well as risk to commercially managed lands and transmission to homes in Twisp (Fig. 8). Crown fire potential is high throughout the planning area with the exception of the area burned by the tragic Twisp River Fire in 2016.

Definitions (continued)

Wildfire response benefit: Any tactical advantage gained for wildfire response activities from actions on the landscape, including identifying and consolidating existing anchor points and control lines and reducing potential fire behavior. Wildfire response benefit is not restricted to any specific fire management strategy; it is centered on conditions that improve fire operations safety and efficacy during suppression, prescribed fire, or managed wildfire.

Potential Control Lines (PCLs): Boundaries of Potential Operational Delineations (PODs) relevant to fire control operations (e.g. roads, ridgetops, and water bodies).

Potential Operational Delineations (PODs) for wildland fire: Landscape containers whose boundaries are potential control lines (PCLs). PODs are useful for planning strategic response to unplanned ignitions, strategic fuel planning, and prioritizing fuel treatments within PODs.

Commercially managed lands: Commercially managed forestlands include: DNR Trustlands, tribal forests, industrial forests, non-industrial private forests, and US Forest Service forests where timber is a primary management objective.

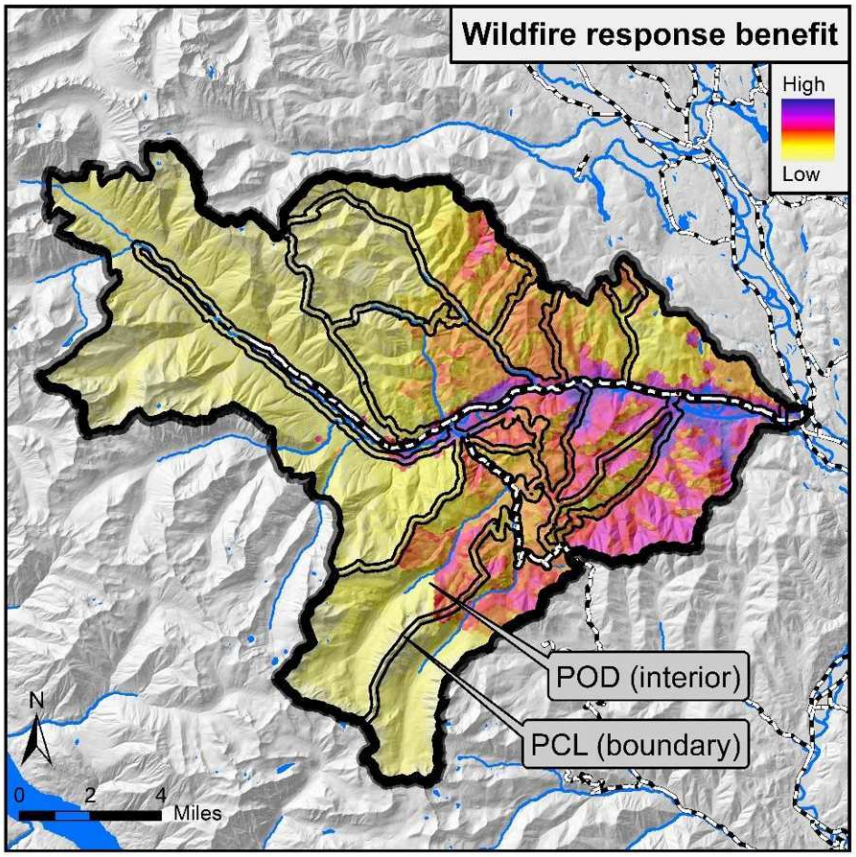


Figure 10. Wildfire response benefit (WRB) integrates multiple fire risk and forest health components. It includes four fire risk metrics representing highly valued resources – risk to homes, infrastructure, drinking water, commercially managed lands – as well as crown fire potential and wildfire transmission to homes (Fig. 8). Combined, these account for 75% of the wildfire response benefit. Landscape treatment priority (Fig. 9) accounts for the remaining 25%. Also shown are PODs: units bounded by PCLs (open black lines). One use of the WRB metric is to prioritize Potential Control Lines (PCLs) for fire operations (Fig. 11).

Prioritizing Landscape Treatments for Dual Benefits

Integration of forest health and wildfire response benefit using PODs

Potential Operational Delineations (PODs) provide a powerful spatial framework to communicate and identify locations that will deliver dual benefits for forest health and wildfire response at the landscape scale. PODs are large landscape areas delimited by Potential Control Lines (PCLs) for fire operations (suppression, prescribed fire, and managed wildfire) delineated by fire operations personnel. PCLs can be roads, ridgelines, or any artificial or natural fuelbreak that provides a strategic opportunity for fire operations. Summarizing landscape treatment priorities (Fig. 9) within PODs and wildfire response benefit priorities (Fig. 10) within PCLs enables planners and managers to identify, at a high level, locations where forest health or fuels treatments can be connected to a high-priority PCL that will support firefighter operations (e.g. ingress/egress route or opportunity for engagement).

Achieving forest health and wildfire response goals will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs.

There is important work to do in all PODs to achieve the forest health treatment targets in Table 1. First priority PODs include areas south of the Twisp River. These PODs are generally delimited by first priority PCLs, highlighting important opportunities for dual benefit. Additional first priority PODs occur in the north-central portion along Thompson Ridge. PODs in the western part of the planning area are mostly third priority but include pockets with moderate treatment need. Further work is needed to assess PCLs locally for their condition and detailed treatment needs, which will depend on management goals and values at risk. Ideally, landscape treatments will be implemented adjacent to priority PCLs where feasible to maximize both forest health and wildfire response goals.

Achieving forest health and wildfire response dual benefits will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs. These two approaches combined will contribute to restoring and maintaining large portions of the landscape in a resilient condition while providing safe and effective areas for firefighter engagement during suppression, prescribed fire, or managed wildfire operations.

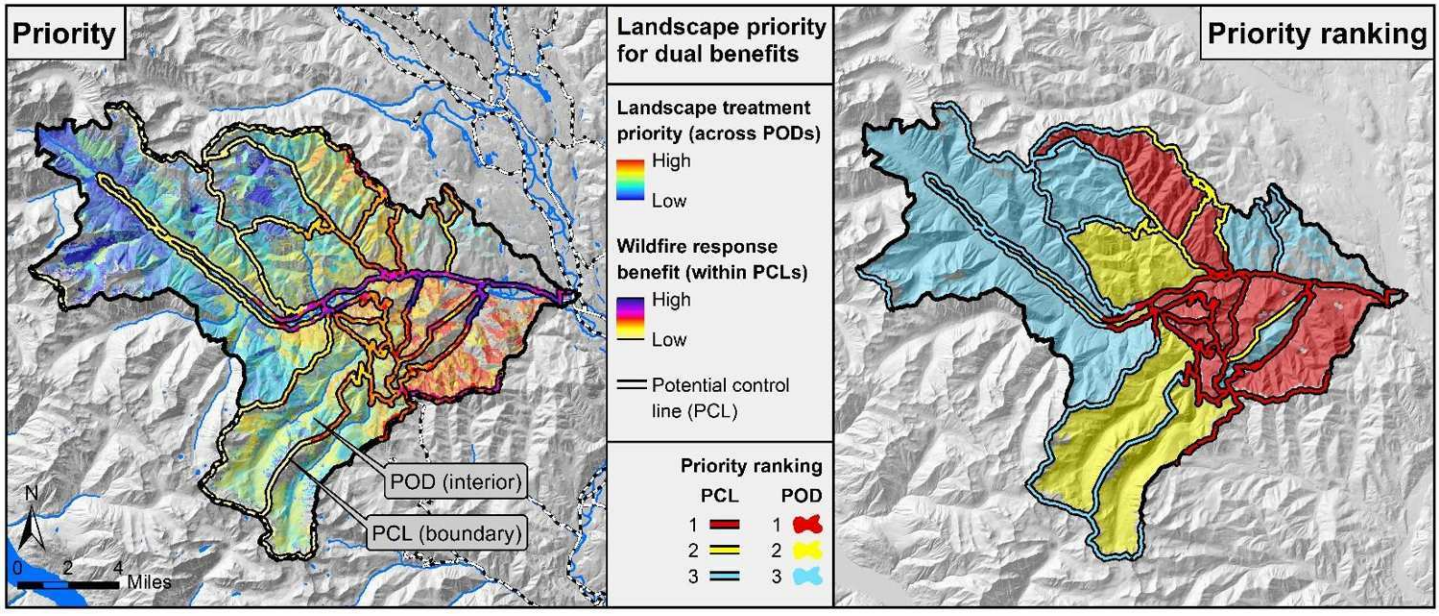
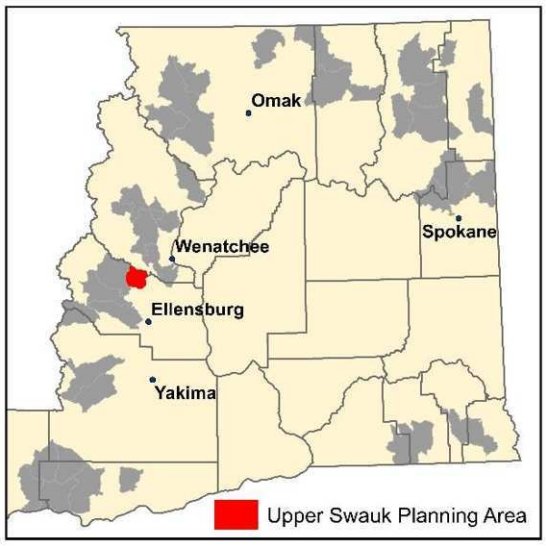
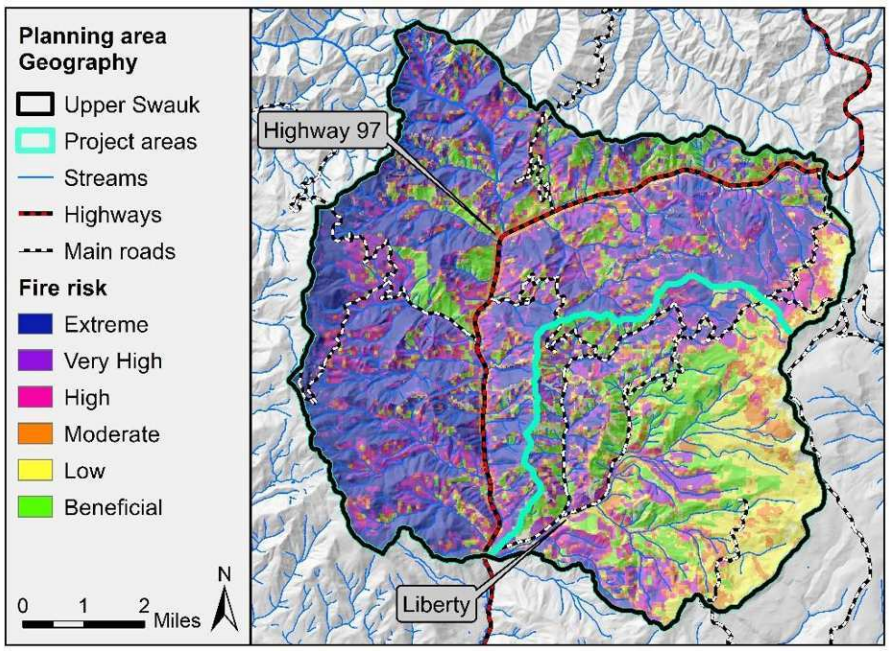


Figure 11. Landscape prioritization of dual benefits using PODs as a spatial framework to summarize treatment priorities. Both maps display landscape treatment priority within PODs and wildfire response benefit within PCLs. The map on the left shows the datasets at the raster level, while the map on the right shows the same information summarized and ranked within PODs and PCLs. Gray within planning area denotes locations without substantial forest cover. PCL width is inflated to display spatial patterns. *PODs shown here are part of an ongoing process towards an all-lands delineation; POD boundaries are subject to change following on-the-ground vetting and continued dialogue among wildfire agencies and stakeholders.*

UPPER SWAUK PLANNING AREA
LANDSCAPE EVALUATION SUMMARY (2020)

Total Acres	Forested Acres	Treatment Goal (Acres)
39,175	35,450	14,000 - 22,000





Above: Figure 1. Planning area location.
Right: Figure 2. Planning area geography and fire risk to forests, homes, and infrastructure.

Planning Area Highlights

- This planning area embodies many of the most pressing forest health issues in the eastern Cascades, including wildfire risk to communities and forests, endangered species, insects and disease, and climate change.
- Although ownership is primarily USDA Forest Service (97%), homes and private parcels in Liberty are vulnerable to fire.
- Projected warming over the next 20-40 years will likely shift climate conditions suitable for moist forest towards conditions suitable for dry forest. Some areas of current dry forest may no longer support forest.
- Treating 39-62% of forested acres is recommended to increase resilience and reduce fire risk to communities using a combination of mechanical, prescribe fire, and managed wildfire treatments.
- Treatment priority is high in western portions of the planning area based on forest fire risk, drought vulnerability, current forest structure, and fire transmission to communities.
- Swauk Pine in the southeastern portion and Wild Blew in the western portion are two project areas that have been assessed for USFS restoration projects (Fig. 2).

LEARN MORE

This landscape evaluation was completed in 2020.
More details about DNR's priority planning areas are available at: **https://www.dnr.wa.gov/ForestHealthPlan**
Data products are available at: **https://bit.ly/ForestHealthData**

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Overarching Goals

Reduce wildfire risk and protect communities

Fire risk is high to extreme in northern and western portions of the planning area due to high fuel loads and burn probability (Fig. 2). The western portion represents some of the highest fire risk in eastern WA. Fuels treatments are needed to break up the large patches of dense forest to reduce the likelihood of large crown fire. Relatively lower fire risk in the southeastern portion is due in part to recent treatments on USFS and private land, as well as the 2012 Table Mountain Fire. However, fire risk is still high to extreme in some areas around Liberty and Highway 97, including private parcels with homes. The planned Swauk Pine treatments will reduce the risk of wildfire and insect outbreaks. Additional treatments in dense forest in northern and western portions will further mitigate these risks.

Increase resilience and prepare for climate change

Projected warming will increase moisture stress and risk of wildfire and insect outbreaks, which are already generally high in currently dry and moist forest types. By mid-century, 41% of the planning area is projected to have moisture stress levels currently associated with woodland and shrub-steppe, indicating that these locations may no longer support forest (Fig. 3). Treatments to reduce density and favor drought-tolerant species on projected future high and very high deficit sites will support forest persistence into the future.

Sustain wildlife habitat

Habitat for dry forest, large tree, open canopy species (e.g. White Headed Woodpecker) is well represented in central portions of the planning area, primarily in locations with recent thinning treatments. Habitat for species that depend on moist, closed canopy forest with large trees (e.g. Northern Spotted Owl) is in the middle or upper end of desired ranges, though it is overly abundant in large patches in western portions. In high fire risk locations, reducing tree density and canopy cover will reduce crown fire potential and drought vulnerability, help maintain habitat in the most sustainable locations (Fig. 7), and broaden the spatial distribution of open canopy habitat. When consistent with the Northwest Forest Plan, lighter, variable density thinning in mid-sized stands can accelerate habitat development. Habitat for cold forest, large-tree, closed canopy species (e.g. American Marten) is a relatively minor component of this planning area.

Enhance rural economic development

Reducing fire risk will help sustain recreation and tourism while reducing the potential of smoke affecting nearby communities. Warming trends may make it difficult to sustain timber production on south-facing slopes in the planning area (Fig. 3). In the remainder, long-term timber production will likely be possible if proactive strategies to shift species composition and manage for lower tree density are adopted over time.

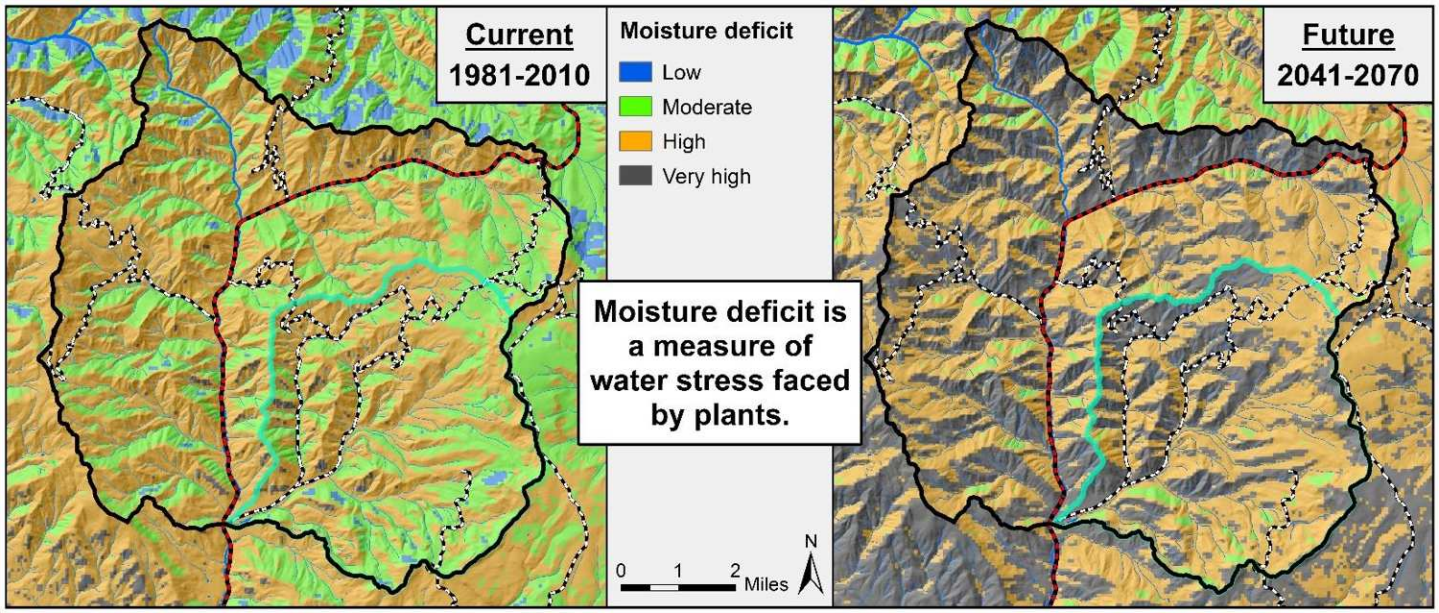


Figure 3. Current (left) and future (right) moisture stress levels based on water balance deficit. Low levels are associated with moist and cold forest types, high with dry forest types, and very high with woodland or shrub-steppe. Future climate is based on a business as usual greenhouse gas emissions scenario (RCP 8.5).

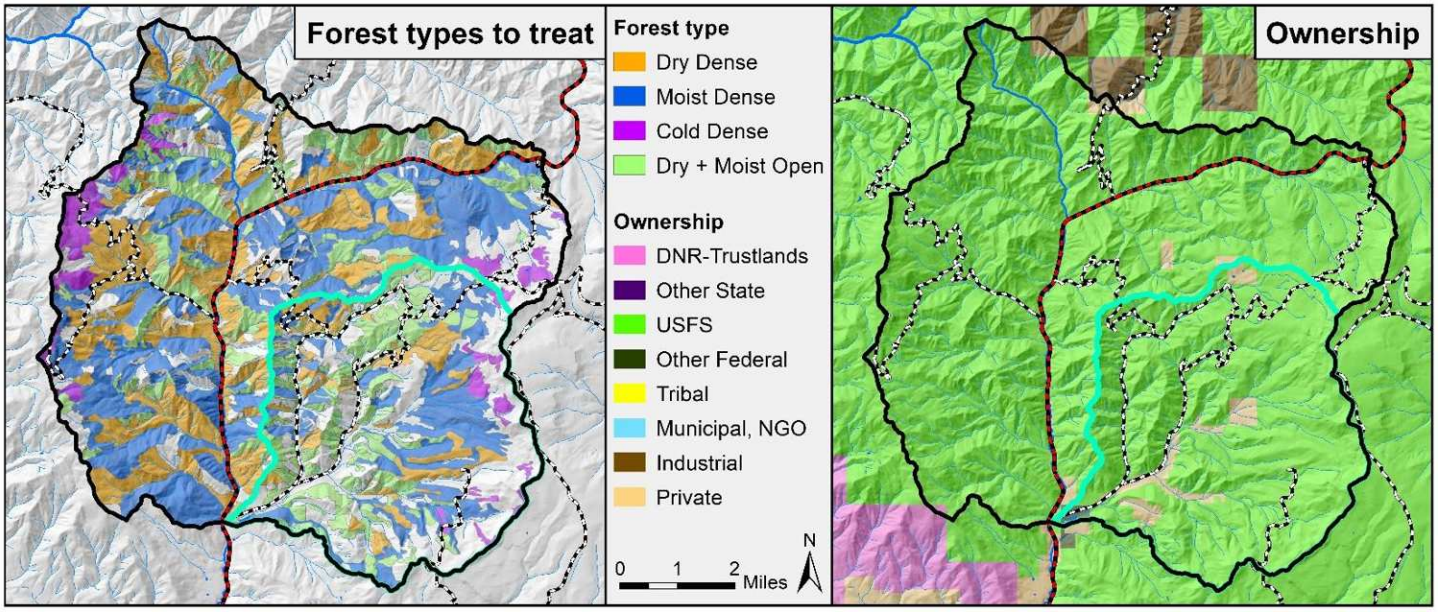
Forest Health Treatment Needs

Treating 14,000 to 22,000 acres is recommended to move the landscape into a resilient condition (39-62% of forested acres; Table 1). This total includes an estimated 11,000-16,750 acres of dense forest and 3,000-5,250 acres of maintenance treatments in existing open forest, based on current condition data from 2012 aerial photos. The majority of the treatment need and opportunity is on USFS land, although substantial need exists for private landowners in the community of Liberty.

Meeting this target range will require multiple treatment strategies (Table 1). Managed wildfire under safe conditions will be needed, especially in less accessible locations. Based on tree size class, many areas are commercially viable, although treatment type will depend on road access, logging systems, and other considerations. Individual landowners will conduct their own planning and decision-making processes to determine acres and types of treatments to achieve the landscape goals while meeting their own objectives and regulatory requirements.

Table 1. Summary of forest health treatment needs *(range represents low and high end of treatment need).*

Forest conditions to treat		Treatment need (acres)	Current acres by major landowner*			
Type	**Size class**		**USFS**	**Private**	**Federal**	**Other**
Dry Dense	Medium-Large	5,500 - 7,500	8,898	117	8	0
Moist Dense	Medium-Large	4,500 - 8,000	11,266	88	18	0
Cold Dense	Medium-Large	1,000 - 1,250	1,625	0	0	0
Dry + Moist Open	Medium-Large	3,000 - 5,250	6,922	163	27	0
Total		**14,000 - 22,000**	**These are current acres, not targets*			
Anticipated treatment type		Commercial thin plus fuels treatment if access exists. May be noncommercial, fire only (prescribed or managed wildfire), or regeneration treatment.				
		Maintenance treatment: prescribed fire, managed wildfire, or mechanical fuels treatment. *Target range corresponds to 50-75% of dry open and 25-50% of moist open forests.*				



Left: Figure 4. Forest structure types that are overabundant relative to targets for a resilient landscape, as well as potential maintenance treatments. Only a portion of the areas shown need to be treated. Right: Figure 5. Current land ownership.

Forest Health Treatment Needs (continued)

Dry dense forest treatment need

Currently, dense, multistory forest structure is over-represented on dry sites, especially sites dominated by Douglas-fir. Treating 5,500-7,500 acres of dense dry forest (Table 1) is recommended to shift the landscape from dense to open forest. In locations with large trees, removing smaller trees and treating fuels with mechanical or fire-based methods will create more fire-, insect-, and drought-resistant forest structure. Favoring ponderosa pine and reducing Douglas-fir and grand fir on drier sites is also recommended.

Definitions

Vegetation Types

Cold forest: Upper elevation mixed-conifer forests with high-severity fires every 80-200+ years.

Dry forest: Ponderosa pine and Douglas-fir dominated forests that historically had surface fires every 5-25 years.

Moist forest: Forests that historically had mixed-severity fires every 30-100 years and were composed of fire-resistant (western larch, Douglas-fir) and fire-intolerant (grand fir) trees.

Woodland/Steppe: Grass and shrub lands that may have oak woodlands or up to 10% cover of conifers.

Forest structure

Large tree: Overstory diameter > 20 inches; **Medium tree:** Overstory diameter 10-20 inches; **Small tree:** Overstory diameter < 10 inches; **Dense canopy:** Greater than 40% tree canopy; **Open canopy:** Less than 40% tree canopy.

***Fuels*:** Shrubs, grasses, small trees, litter, duff, and dead wood.

Fuels Treatments: some combination of mechanical density reduction (commercial or non-commercial) and surface and ladder fuel reduction (prescribed fire, piling & burning, etc.).

Managed wildfire: fire is allowed to burn under safe conditions to achieve management goals; can be suppressed if conditions change.

Moist and cold dense forest treatment need

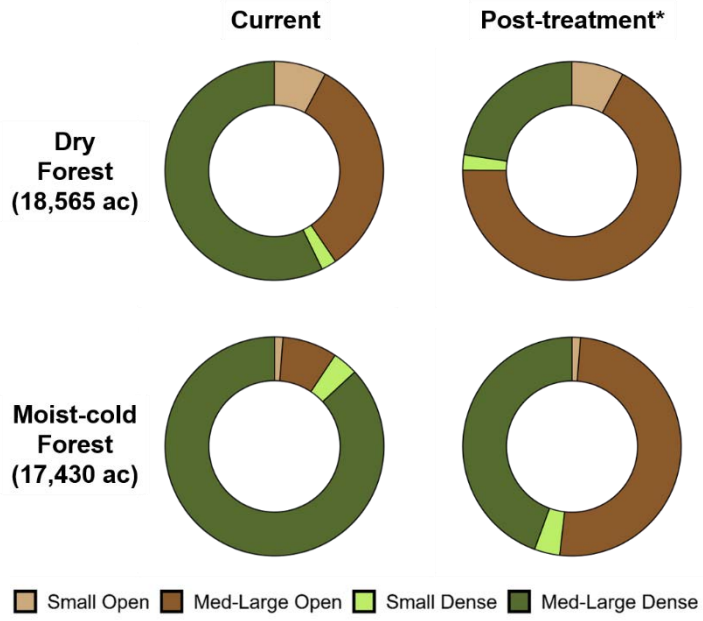
Dense, multistory forest on moist and cold sites exceeds or is at the upper end of desired ranges throughout the planning area, and patch sizes are too large. Treating 5,500-9,250 acres of dense forest on moist and cold sites (Table 1, Fig. 4) is recommended to reduce the risk of large crown fire and help forests adapt to a warming climate. Increasing the relative composition of ponderosa pine and western larch is also needed. Following treatments, approximately half of the total moist and cold forest area would remain dense (Fig. 6) to meet habitat, wood production, and other objectives.

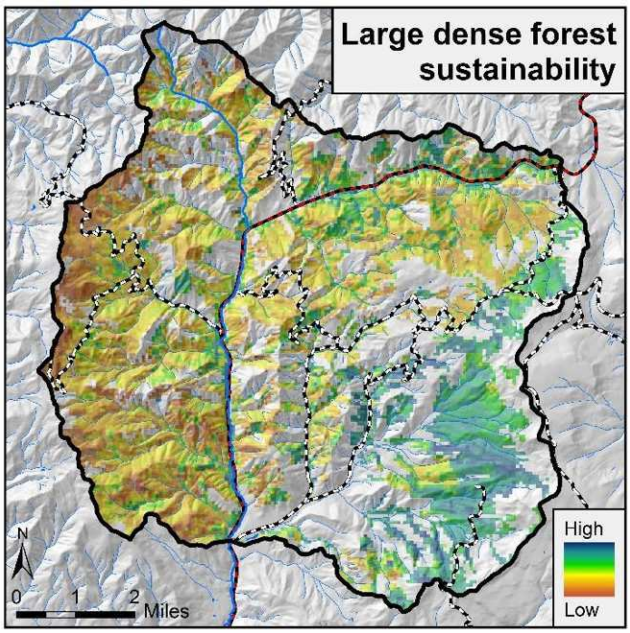
Open forest maintenance treatment need

Over the next 15 years, an estimated 3,000-5,250 acres of currently open forests on dry and moist sites will need prescribed fire, managed wildfire, or mechanical methods to maintain open conditions by reducing surface fuels and small trees. Specific maintenance strategies depend on landowner objectives and time since prior treatments.

Sustainable locations for dense forest with large trees

Locations with low to moderate current and future moisture deficits (Fig.3) and low fire risk (Fig. 2) offer the most sustainable locations to maintain sufficient area and patch sizes of this forest habitat type and associated ecosystem functions. Sustainable locations include the eastern end of the planning area, as well as north-facing slopes in the central portion and valley bottom areas in the northeastern corner (Fig. 7).





Left: Figure 6. Current and post-treatment proportions of forest types and structure classes. * mid-point of range in Table 1.
Right: Figure 7. Sustainability of current and potential large tree, dense forest based on fire risk and drought vulnerability.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – forest fire risk (Fig. 2), drought vulnerability (Fig. 3), and presence of overabundant forest structure types (Fig. 4) – with wildfire transmission to homes (Fig. 8). To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is high across the western half of the planning area, representing potential fire exposure to communities in Liberty, along the Highway 97 corridor, and in the Cle Elum area.

Treatment priorities

Treatment priority is particularly high in western and northern portions of the planning area, reflecting high wildfire transmission on the slopes east of Teanaway Ridge (Fig. 8). Within those areas, north-facing slopes are especially high priority due to fire risk (Fig. 1) and current forest structure (Fig. 4). Treatment priority is generally lower in southeastern portions due to recent treatments near Liberty and lower fire probability where the Table Mountain Fire burned in 2012. Planned Swauk Pine treatments will help reduce fire and forest health risks in remaining high priority locations.

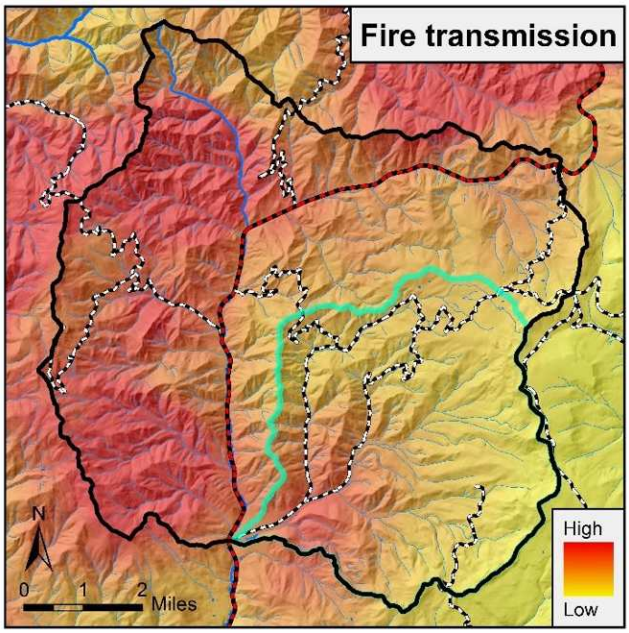


Figure 8. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

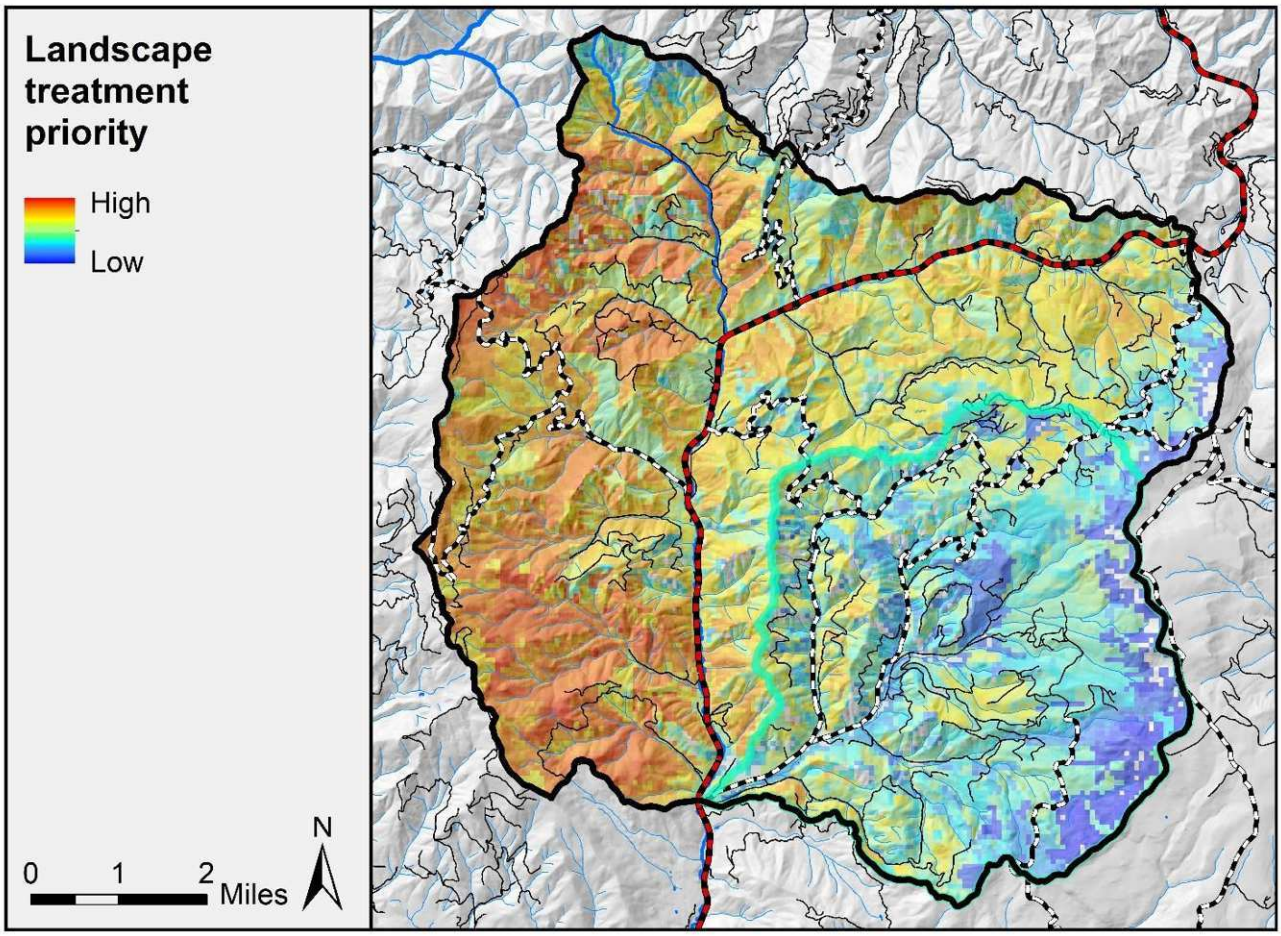


Figure 9. Landscape treatment priority is based on three metrics of forest health – forest fire risk (Fig. 1), drought vulnerability (Fig. 3), overabundant forest structure (Fig. 4) – as well as wildfire transmission to homes (Fig. 8).

UPPER WENATCHEE PLANNING AREA LANDSCAPE EVALUATION SUMMARY (2020)

Update from 2018 Landscape Evaluation

This summary updates the landscape evaluation completed in 2018 to incorporate landscape treatment priority and wildfire response benefit priority. This planning area was part of the WA HB 1784 pilot project to incorporate prioritization for dual benefits (forest health and wildfire response benefit) into the Forest Health Assessment and Treatment Framework.

Landscape Treatment Prioritization

Prioritizing for forest health & to reduce fire exposure of homes

Landscape treatment priority integrates three metrics of forest health – fire risk, drought vulnerability, and presence of overabundant forest structure types – with wildfire transmission to homes. To ensure that habitat for closed canopy dependent wildlife is incorporated into the prioritization, we recommend overlaying the large dense forest sustainability layer (Fig. 7) when selecting treatment locations. Wildfire transmission is high throughout most of the planning area (Fig. 2), indicating that wildfires starting in these locations are expected to expose homes in Plain, Chumstick, and along highway and river corridors.

Treatment priorities

Landscape treatment priority is highest in the eastern and southern portions of the planning area (Fig. 1). Medium priority areas on roadless USFS lands in the north and southeastern portions indicate that managed wildfire will be needed to restore this landscape. Some low priority areas may need treatment to address species composition, insect and disease risk, or other issues. In addition, fuel reduction treatments, defensible space, and home hardening are needed on private parcels to protect homes along Highways 2 and 207 and in the Wenatchee River corridor.

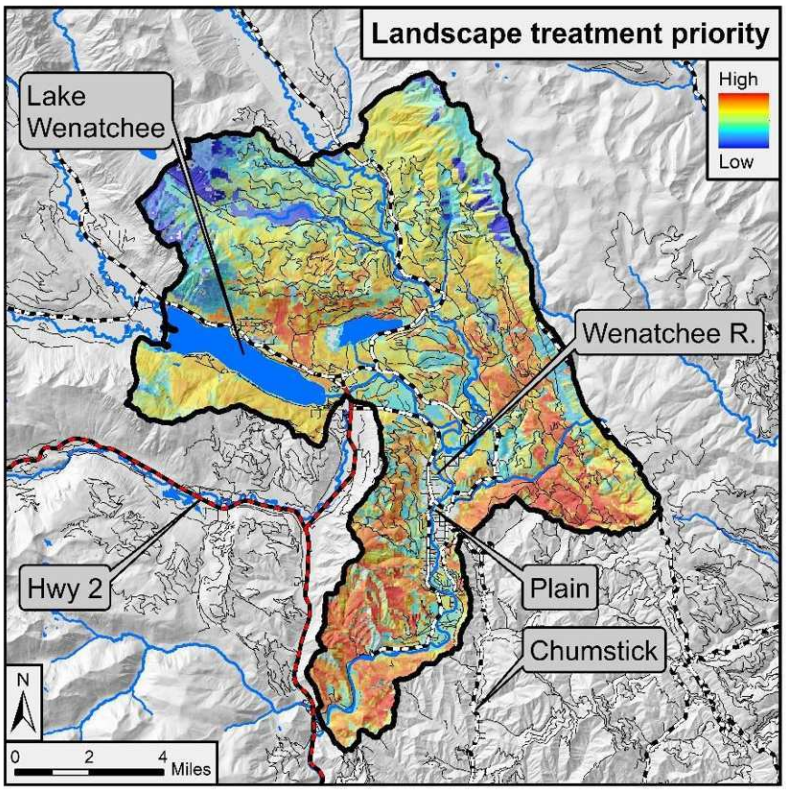


Figure 1. Landscape treatment priority is based on three metrics of forest health – forest fire risk, drought vulnerability, overabundant forest structure – as well as wildfire transmission to homes (Fig. 2).

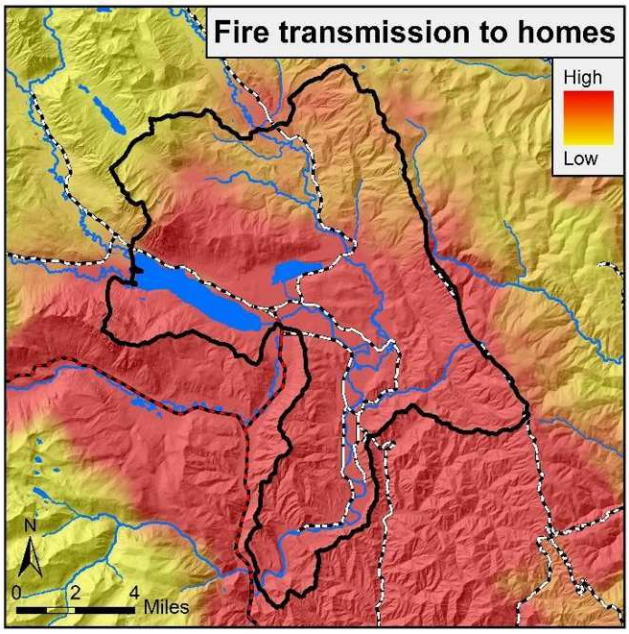


Figure 2. Fire transmission to homes shows where fires that expose structures are most likely to originate. It is based on simulated fire perimeters given contemporary patterns of fuels, topography, and wind.

Wildfire Response Benefit Prioritization

Dual benefits for forest health and wildfire response

It is necessary to conduct treatments to both improve forest health and reduce fire risk to communities as well as provide conditions where firefighters can safely and efficiently conduct fire operations (e.g. suppression, prescribed burning, and managed wildfire). The wildfire response benefit metric (WRB; Fig. 10) identifies and prioritizes locations where values at risk that are more likely to be the focus of fire operations (homes, infrastructure, sources of drinking water, and commercially managed lands) coincide with areas likely to transmit wildfire to homes and generate severe fire behavior. Because there are positive feedbacks between healthy, resilient forests and safe, effective fire operations, the WRB metric also integrates the landscape treatment priority map (Fig. 9).

Where WRB is highest, actions may be needed to create and maintain conditions that provide a tactical advantage for fire operations. These actions will vary with the local context and can include landscape-level forest health and fuel treatments, treatments along escape routes, resident and community fire mitigation activities (e.g. defensible space, home hardening), and improving signage and road conditions. The WRB metric provides a high-level prioritization, and additional work at the local level will be required to identify appropriate actions and assess their feasibility. WRB is useful for prioritizing Potential Control Lines (PCLs) for fire operations (Fig. 4). PCLs are a part of Potential Operational Delineations (PODs); see page 3.

In the Upper Wenatchee planning area, wildfire response benefit is highest around Lake Wenatchee and in southern end of the planning area, southwest of Plain (Fig. 1, Fig. 3). The two regions represent important sources of surface drinking water. Wildfire response benefit is also high north of Lake Wenatchee because there is high risk to commercially managed lands and forest health treatment needs (Fig. 1). The Wenatchee River corridor has moderate to high wildfire response benefit and represents high wildfire transmission to homes (Fig. 2).

Definitions (continued)

Wildfire response benefit: Any tactical advantage gained for wildfire response activities from actions on the landscape, including identifying and consolidating existing anchor points and control lines and reducing potential fire behavior. Wildfire response benefit is not restricted to any specific fire management strategy; it is centered on conditions that improve fire operations safety and efficacy during suppression, prescribed fire, or managed wildfire.

Potential Control Lines (PCLs): Boundaries of Potential Operational Delineations (PODs) relevant to fire control operations (e.g. roads, ridgetops, and water bodies).

Potential Operational Delineations (PODs) for wildland fire: Landscape containers whose boundaries are potential control lines (PCLs). PODs are useful for planning strategic response to unplanned ignitions, strategic fuel planning, and prioritizing fuel treatments within PODs.

Commercially managed lands: Commercially managed forestlands include: DNR Trustlands, tribal forests, industrial forests, non-industrial private forests, and US Forest Service forests where timber is a primary management objective.

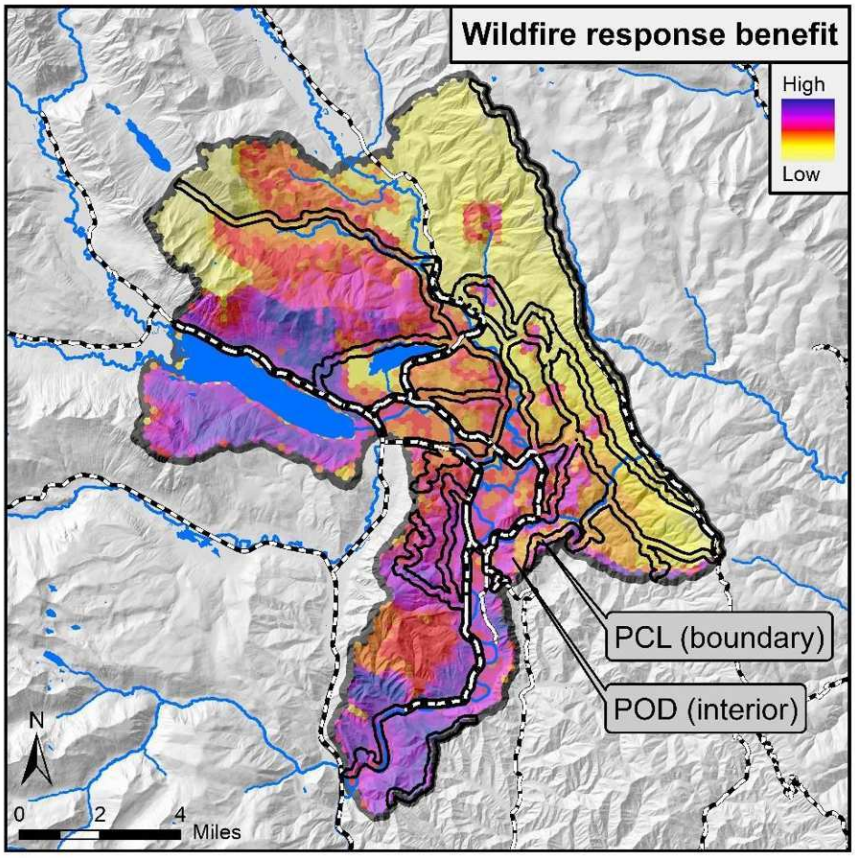


Figure 3. Wildfire response benefit (WRB) integrates multiple fire risk and forest health components. It includes four fire risk metrics representing highly valued resources – risk to homes, infrastructure, drinking water, commercially managed lands – as well as crown fire potential and wildfire transmission to homes (Fig. 2). Combined, these account for 75% of the wildfire response benefit. Landscape treatment priority (Fig. 1) accounts for the remaining 25%. Also shown are PODs: units bounded by PCLs (open black lines). One use of the WRB metric is to prioritize Potential Control Lines (PCLs) for fire operations (Fig. 4).

Prioritizing Landscape Treatments for Dual Benefits

Integration of forest health and wildfire response benefit using PODs

Potential Operational Delineations (PODs) provide a powerful spatial framework to communicate and identify locations that will deliver dual benefits for forest health and wildfire response at the landscape scale. PODs are large landscape areas delimited by Potential Control Lines (PCLs) for fire operations (suppression, prescribed fire, and managed wildfire) delineated by fire operations personnel. PCLs can be roads, ridgelines, or any artificial or natural fuelbreak that provides a strategic opportunity for fire operations. Summarizing landscape treatment priorities (Fig. 9) within PODs and wildfire response benefit priorities (Fig. 10) within PCLs enables planners and managers to identify, at a high level, locations where forest health or fuels treatments can be connected to a high-priority PCL that will support firefighter operations (e.g., ingress/egress route or opportunity for engagement).

Achieving forest health and wildfire response goals will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs.

There is important work to do in all Upper Wenatchee PODs. First priority PODs are located in the southern portion of the planning area and are consistently associated with first priority PCLs, showing strong alignment for dual benefit. Two large second priority PODs surround Lake Wenatchee, and these are partially surrounded by first priority PCLs along the northern shore of the lake. Other first priority PODs are located east of Plain. These areas have high landscape treatment priority but are relatively farther from homes, infrastructure, and sources of drinking water, and they are associated with second priority PCLs.

Achieving forest health and wildfire response dual benefits will require primarily large, landscape-level treatments across PODs (~100's-1,000's of acres) and, to a lesser extent, targeted treatments along PCLs. These two approaches combined will contribute to restoring and maintaining large portions of the landscape in a resilient condition while providing safe and effective areas for firefighter engagement during suppression, prescribed fire, or managed wildfire operations.

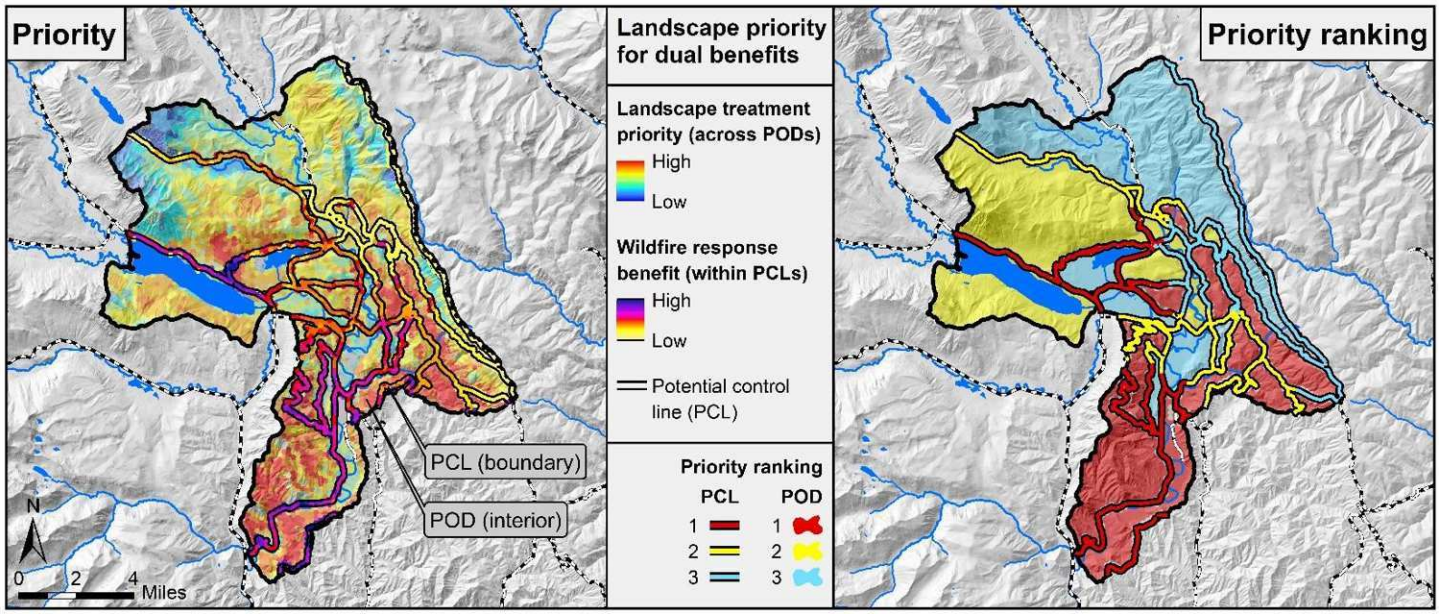


Figure 4. Landscape prioritization of dual benefits using PODs as a spatial framework to summarize treatment priorities. Both maps display landscape treatment priority within PODs and wildfire response benefit within PCLs. The map on the left shows the datasets at the raster level, while the map on the right shows the same information summarized and ranked within PODs and PCLs. PCL width is inflated to display spatial patterns. *PODs shown here are part of an ongoing process towards an all-lands delineation; POD boundaries are subject to change following on-the-ground vetting and continued dialogue among wildfire agencies and stakeholders.*

LEARN MORE

This landscape evaluation was updated in 2020.
More details about DNR's priority planning areas are available on the 20-Year Forest Health Strategic Plan website:
https://www.dnr.wa.gov/ForestHealthPlan

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Appendix E: 20-Year Forest Health Strategic Plan Monitoring Framework

Monitoring forest conditions across eastern Washington: a multi-level and multi-party monitoring framework in support of the 20 Year Forest Health Strategic Plan

Washington State Department of Natural Resources, Forest Health and Resiliency Division[1]
November 2020

Table of Contents

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I. Introduction

A primary goal of the 20 year Forest Health Strategic Plan for Eastern Washington (PLAN) is to "develop and implement a forest health resilience monitoring program that establishes criteria, tools, and processes to monitor forest and watershed conditions, assess progress, and reassess strategies over time." During the 2019-2021 biennium, the DNR Forest Health and Resiliency Division (DNR FHR) worked with a wide range of partners to develop a monitoring framework based on the strategies outlined in Goal 5 of the PLAN (pages 37-39). Anticipating rapid and unprecedented changes across forest landscapes, DNR developed this framework to track progress toward forest health goals, including landscape restoration and climate change adaptation.

This monitoring framework is a crucial component of adaptive management – the process of planning, implementing, monitoring, and integrating new information into management practices over time. Monitoring is essential for reporting and accountability, building shared understanding and trust, and increasing the effectiveness of forest health treatments over time. This document describes how the DNR FHR framework spans multiple levels and engages with multiple partners encompassing all lands in the area addressed by the PLAN. The framework is based on two overarching questions:

How are forest conditions and associated forest health indicators changing over time?
This question is the foundation of forest health monitoring. DNR FHR will comprehensively map and quantify changes in forest structure, composition, and pattern from treatments as well as growth, mortality, and natural disturbances over time. This baseline information will be used by DNR FHR scientists, as well as other partners, to assess changes and trends in key indicators of forest health and wildfire risk. Indicators include predicted fire intensity and severity, vulnerability to drought and insect mortality, wildlife habitat, and departure from resilient landscape conditions (e.g., ranges and patch sizes of dense vs. open forest structure, species composition). Treatment need in planning areas and across eastern Washington will also be periodically updated.

What are the outcomes of forest health treatments?
Understanding how forest health treatments (mechanical, prescribed fire, and managed wildfire) affect the resilience of landscapes and communities is critical to the success of the 20 Year Plan. This will be achieved in three ways. First, treatment effects on forest structure will be quantified through remotely sensed data and in the field by partners. Second, models and indices will be used to quantify how treatments change forest health indicators, particularly predicted drought vulnerability, wildfire behavior, and risks to homes and infrastructure from wildfires. Third, the effects of treatments on wildfires and drought-related insect outbreaks will be evaluated as capacity permits. This will include opportunistically assessing the extent to which selected treatments reduce uncharacteristic wildfire severity and provide more options for wildfire management. In addition,

DNR will maintain a database of completed treatments.
Monitoring and reporting of trends will be conducted at three distinct levels that reflect the spatial scales at which different forest health indicators are best measured. These include the regional level (all of eastern Washington), priority planning area level, and treatment unit level.

Multi-party monitoring involves numerous partners—land management agencies, tribes, forest collaboratives, research institutions, private landowners, local government agencies, the forest products industry, NGOs, community members, and other stakeholders—working together to design, fund, implement, and oversee monitoring programs. While the DNR FHR has the mandate and staff to anchor the program over time, the participation of partners in collecting and analyzing monitoring data and reporting results will be essential. DNR FHR is currently funding a number of different organizations to help develop key parts of the framework. To formalize the critical role for partners in this effort, DNR FHR will create a standing monitoring working group that will help with the technical, organizational, and communication work of implementing this framework

This framework is not intended to be a one-size-fits-all solution for all landowners to follow rigidly. Instead, landowners can utilize and adapt the framework to address their monitoring needs while also contributing information to answer larger-scale questions that are beyond the scope of any single landowner. DNR recognizes that partners will engage differently with this framework depending on their expertise and areas or levels of interest. Some partners may prefer to engage with the higher-level questions and objectives, whereas others may prefer the detailed methods and datasets described in the text and tables. Partners interested in collaborative monitoring and research can find details on currently funded projects in section IV and future topics in section V. Partners focused on field-based monitoring can jump to the treatment unit level section as well as the detailed treatment unit protocol that can be found here.

The monitoring framework presented here is primarily designed to monitor changes in forest conditions and to assess how these conditions relate to forest health and resilience objectives, treatment needs, and reduction in fire and drought risk over time. DNR recognizes the importance of monitoring the social and economic impacts of forest restoration and risk reduction work, including smoke impacts to human health, economic inputs to rural communities, social equity and environmental health disparities, collaborative engagement and capacity, and others. There are also key questions regarding the ecosystem service benefits of achieving the goals of the PLAN. As staff capacity and funding permit, DNR will work with partners to expand social and economic monitoring, as well as treatment impacts on aquatic function, carbon, snowpack, and streamflow.

Finally, monitoring is a dynamic process that will continue to evolve as forests, communities, and methods change. Over time, the information and cooperative engagement with partners created through implementing this monitoring framework will be essential in collectively learning how to

most effectively increase the resilience and adaptive capacity of our forests and communities.

II. Monitoring Framework

Over the last two years, DNR FHR staff have been working with partners at the University of Washington, US Forest Service, DNR State Lands and Wildfire Divisions, WA Department of Fish and Wildlife, and Yakama, Colville and Kalispel Tribes, the Nature Conservancy, and other organizations to develop this framework. A key insight that emerged from discussions with partners was the need to organize the framework at three distinct levels that mirror the hierarchical structure of landscapes: regional level, watershed or planning area level, and treatment unit level (Fig. 1). These three levels reflect the spatial and temporal scales at which different forest health indicators are best measured. Each level has a specific set of monitoring questions, indicators, datasets, and roles for DNR FHR and partners. The monitoring framework is described in the following section based on these three levels. A detailed description of datasets and methods is provided in a subsequent section.

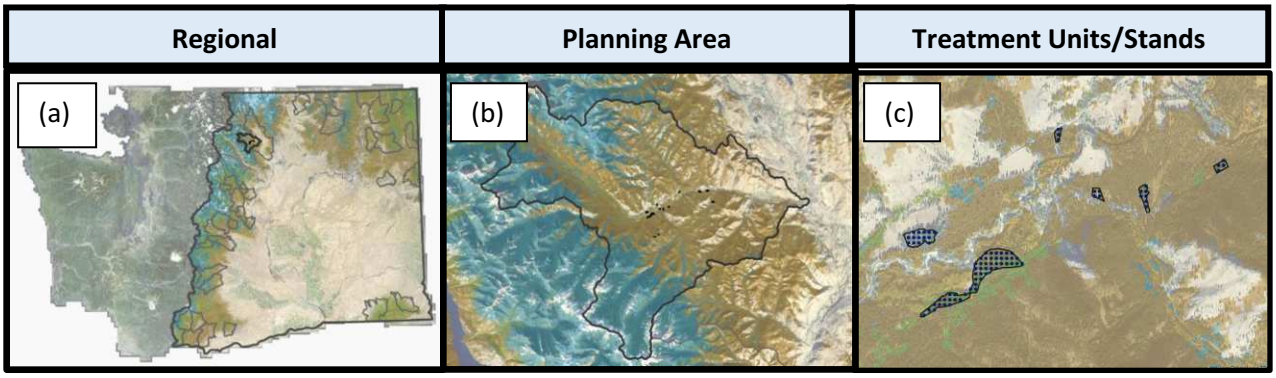

Figure 1. *Examples of the 3 levels of monitoring: (a) Regional , (b) Twisp River planning area, and (c) hypothetical treatment units within the planning area, with potential plots shown as points.*

1. Regional Level

This level encompasses all of Eastern Washington or sub-regions such as the Eastern Cascades, or Northeast Washington. At the regional level, monitoring describes and tracks changes in forest conditions pertaining to forest resilience, wildfire risk, and restoration needs at the cumulative scale addressed by the overall strategic PLAN. The primary goal of monitoring at the regional level is to detect and track changes and trends in forest conditions caused by treatments and different natural disturbances. Components of forest conditions that will be tracked include canopy cover, tree height, and the amount and patterns of different structural classes. Species composition may be added as detection methods improve. This work will be a major focus of the DNR FHR science team.

Wildfires will be analyzed every year by DNR FHR scientists to quantify total acres burned and fire severity with a one year lag in order to detect secondary mortality. The proportion of low, moderate,

and high severity by broad forest type (i.e., dry, moist, cold forests) will be tracked over time. Trends in the number of acres burning at uncharacteristically high severity will be monitored. Combined with change detection of forest structure, this analysis of fire severity will allow DNR FHR scientists to assess the work of wildfires in terms of moving conditions towards or away from desired goals. In addition, information from the annual Aerial Insect and Disease Detection Survey will be utilized to monitor major drought-related insect outbreaks.

Updated current conditions data from these monitoring datasets will allow DNR FHR to periodically re-analyze restoration need. Improved methods will be developed to better estimate the potential economic outputs from treatments and the investments required to complete the work, as well as maintenance treatment needs over time. Most analyses will be done across all of eastern Washington, but some may focus on particular regions such as the Eastern Cascades, Northeast Washington, or the Blue Mountains. DNR FHR science staff will hold primary responsibility for producing, analyzing, and summarizing monitoring information at this level, but will work with partners at the USFS Forest Service and research institutions.

As the PLAN approaches its mid-point (2026-2028), DNR FHR will re-assess statewide forest health metrics and values at risk to evaluate how risks and relative treatment priority have changed across eastern Washington compared to the initial PLAN. This will assist DNR and partners in prioritizing remaining planning areas and perhaps redoubling efforts in some existing planning areas. DNR will use monitoring datasets for some of these metrics (e.g., restoration need, wildfire risk, drought vulnerability), but will rely on other agencies for updates to most of them (e.g., climate change projections, insect and disease risk, Aquatic Habitat Condition Index, Drinking Water - Forests to Faucets, Ecological Systems of Concern, etc.).

A complete list of indicators and monitoring questions for the regional level, including a summary of response variables, methods, and timelines, is provided in Table 1 below.

Table 1. Summary of indicators, questions, response variables, methods, timeline, level of DNR support for regional level of monitoring.

Regional Level					
Indicator	**Question/Goal**	**Response Variables**	**Methods & Frequency**	**Status & Timeline**	**DNR Support**
Forest Conditions	How much & how are treatments, & natural disturbances changing forest conditions?	Acres with detected change in conditions by veg. & disturbance type. Changes in forest structure class.	Every 4 years, summarize changed acres by disturbance type using satellite imagery, DAP data, treatment tracking info, and other data sources.	NE WA results in 2022, then staggered by region every 4 years. Species composition may be added in the future.	**High** Science staff
Wildfires	How and how much are our forests burning?	Proportion of high, mod., & low severity fire relative to HRV by forest type.	Annually summarize burn severity data from satellite data using Google Earth Engine method (1 year lag).	Results for 1984-2018 by Dec. 2020. Methods have been developed.	**High** Science staff
Insect & Disease	How are I & D affecting forests?	Acres, locations, and trends of I&D outbreaks.	Annual Insect and Disease Aerial Surveys.	Continue existing program that is separate from 20Y plan.	**High** DNR + USFS
Fire Risk	Is wildfire risk to communities, infrastructure, & forests declining?	Changes in risk components: predicted flame lengths, fire probability, and net value change scores	Rerun PNW Quantitative Wildfire Risk Assessment. Compare with past data by HUC12. Use updated LANDFIRE fuel models and DNR structure data.	Run by Pryologix & USFS for 2017. DNR acquiring capability to run FSIM model. Rerun all WA in ~2025.	**High** Science staff + USFS
Treatment Implemen-tation	Track overall progress towards PLAN treatment goals.	Number of acres of treatments by treatment type and ownership class.	Annual or every 2 years summary of treatment tracking data for EWA. Compare to overall 20 year goal of 1.25 million acres or updated goal.	First results in Dec 2020. Forest Health Tracker database in development. Public land data obtained & summarized.	**High** GIS & planning staff
Treatment Need	Is the overall treatment need in EWA declining?	Acres needing active and passive restoration based on departure of forest structure relative to HRV.	Every 2-4 years, re-run departure analysis using Haugo/Demeo approach & compare to past results. Use DAP structure data when ready.	2017 restoration need results for EWA by Dec. 2020. Harvey-Bakker labs funded by DNR in 2019-2020 for this work.	**Moderate** Funding to augment USFS-R6
Treatment Priority	Prioritize remaining planning areas. Re-assess forest health indicators & values at risk.	Changes in relative rankings by HUC12 of resiliency: fire, insect, drought, departure; and values at risk: WUI, habitat, water, timber, etc.	At mid-point of 20 YP, rerun HUC 12 watershed ranking/prioritization using similar methods & datasets at used for 2017 prioritization in PLAN.	2026-2028.	**Moderate** Science staff

2. Planning Area/Watershed Level

This level covers DNR priority planning areas from the PLAN, large USFS project areas, or watersheds (~10,000–200,000 acres). The DNR FHR tracks forest health conditions for planning areas and analyzes restoration needs via landscape evaluations. These planning areas typically follow watershed boundaries, although the boundaries may differ slightly from exact watershed delineations. Monitoring at this level focuses on tracking changes in forest conditions from completed treatments and natural disturbances relative to the treatment targets and priority areas established by landscape evaluations. Associated changes in wildfire risk to forests, homes, and infrastructure will be assessed through wildfire modeling. Changes in drought vulnerability, wildlife habitat, departure from reference conditions, and potentially other indicators of forest health will also be tracked using the same metrics and indices that are used in the landscape evaluations.

Planning area monitoring is critical for adaptive management under the PLAN. Initial landscape evaluations in planning areas identify restoration needs and assist managers to prioritize treatments. Updated current conditions data from monitoring will be utilized to periodically re-run these evaluations after a significant amount of treatment has been completed and/or a major disturbance has occurred. DNR FHR science staff will produce, analyze, and summarize baseline monitoring information for planning areas, including tracking treatment implementation. However, DNR will rely on partners to organize local stakeholder involvement, add additional monitoring indicators and datasets of local interest, drive or assist with analyses, and communicate monitoring results to the legislature, local media, and the general public. For planning areas where local stakeholders have developed their own monitoring protocols (e.g., Manastash-Taneum Resilient Landscapes Restoration Project), DNR FHR will provide monitoring data and analytical support as needed.

When wildfires, droughts, and/or insects and diseases occur in planning areas or other locations, DNR FHR and our partners will have the baseline data to opportunistically assess how treatments affected these disturbances and evaluate how disturbances moved watersheds towards or away from desired conditions. DNR FHR science team will have some capacity for this component of monitoring, but will rely on partnerships with other agencies and stakeholders for informal assessments and funded research projects for in-depth research studies of treatment effects on disturbances.

A complete list of indicators and monitoring questions for the planning area level, including a summary of response variables, methods, and timelines, is provided in Table 2 below.

Table 2. Summary of indicators, questions, response variables, methods, timeline, level of DNR support for planning area level of monitoring.

Planning Area Level					
Indicator	**Question/Goal**	**Response Variables**	**Methods & Timing**	**Status & Timeline**	**DNR Support**
Treatment Implemen-tation	Track progress towards treatment targets from LEs for each planning area.	Acres of treatments by type & ownership class. Treatments in high, mod, & low priority locations.	Every 2 years, summarize treatment tracking data for each planning area by high, moderate, & low treatment priority.	First results in Dec. 2020. Forest Health Tracker database in development. Public land data obtained & summarized.	**High** Science staff
Treatment Need	Effect of treatments & disturbances on forest conditions & treatment needs.	Acres with detected change in conditions by veg. & disturbance type. Changes in forest structure class relative to landscape eval goals.	Every 4 years, summarize changed acres by disturbance type. Integrate change detection methods with treatment tracking data. Re-assess treatment need & priority areas.	Results for select planning areas in 2021. Stagger updates for most areas every 4 years or after major disturbance. Species comp. added in future.	**High** Science staff
Fire Risk	Are treatments reducing risk to homes,infrastructurek ey wildlife habitat, and & forests?	Predicted flame lengths, fire probability, and net value change scores to highly valued resources.	Rerun PNW Quantitative Wildfire Risk Assessment for selected planning areas. Compare with past risk data.	DNR acquiring capability to run FSIM model. Methods to update LANDFIRE fuel models based on treatments and fires progress.	**High** Science staff + USFS
Fire Risk	Are wildfire response benefits materializing?	Acres of potential control lines (PCL) implemented & maintained. Survey results from managers.	Survey managers every 2-3 years to determine treatment of PCLs and how they are being used to support wildfire, managed fire and Rx fire.	Future project (2023-2025) once PCLs have been established in planning areas.	**Moderate** Science staff + partners
Wildfires	How are wildfires & treatments moving landscapes towards desired conditions?	Change in forest structure relative to landscape eval. targets. Fire severity in treated vs untreated areas.	For a selection of wildfires each year, analyze how wildfire modified forest structure and how treatments affected fire behavior and severity.	Begin in 2021 or 2022 after a major wildfire in a planning area.	**High** Science staff + partners
Drought Vulner-ability	Is vulnerability to drought increasing or decreasing?	Acres of high, medium, & low drought vulnerability. Acres at risk of shift to non-forest.	Every 4 years, calculate drought vulnerability index from forest density, current/future moisture deficit data. Add species composition.	First results in 2021. Methods in development. Improved methods for composition being researched by OSU.	**Moderate** Science staff + TNC, State Lands, USFS
Habitat	How did treatments & disturbances change wildlife focal species habitat.	Changes in acres and pattern metrics (e.g.,patch size, patch density, aggregation) for focal species, relative to HRV.	Every 4 years, update habitat maps for focal species derived from DAP, LiDAR, veg. type map, climate data, & photo interpreted data. Compare current conditions with HRV ranges.	Methods to map habitat with DAP being developed. Results for select planning areas in 2021. Staggered for most plan area every 4 years.	**Moderate** Science staff + WDFW, USFS, others
Drought & Insect Resistance	Did treatments reduce mortality from drought & related insect outbreaks?	Amount of mortality in treated vs untreated areas.	When droughts occur, analyze changes in forest structure, and mortality data from satellite imagery, DAP, & aerial survey data.	When major drought occurs. Baseline DAP forest structure and species composition data being built.	**Low** Potential DNR Funding

3. Treatment Unit/Stand Level

The goals of monitoring at this level include gathering a detailed view of on-the-ground forest conditions in treatments to evaluate where prescription objectives were met and how treatments have impacted forest health indicators at the stand level that are difficult to measure using remote sensing or modeling (e.g., fuels, density of small trees, snags, understory vegetation). A Treatment Unit Monitoring Protocol and data collection system was developed with help from Sharon Frazey from the Mt. Adams Resource Stewards and DNR FHR. This protocol was designed to monitor on the ground treatments before and after treatment. The protocol has three intensity different levels for monitoring that users can choose from depending on their monitoring needs, experience level, and time availability. The three levels are simple, moderate, and advanced and are outlined in Table 4. The protocol can be found here.

A sample of treatments can be monitored by landowners, local partners, DNR staff, or other organizations in different planning areas, depending on funding and staff capacity. Plots may also be installed after wildfires or other major disturbances to monitor regeneration of trees and vegetation. This protocol has different intensities of monitoring (Table 3) and can be adapted to fit local needs. Monitoring data collected using this protocol will be compiled by DNR and made publically available for partners to use in their forest health treatment analyses. Periodically, partners, research institutions, and/or DNR FHR will analyze compiled data to evaluate aggregate treatment effects and trends within and across planning areas as funding permits. When disturbances occur in locations with prior forest health treatments, targeted sampling will be particularly valuable at plots already sampled before and after treatments.

Table 3. Summary of indicators, questions, response variables, methods, timeline, level of DNR support for treatment unit level of monitoring

Treatment Unit Level					
Indicator	**Question/Goal**	**Response Variables**	**Methods & Timing**	**Status & Timeline**	**DNR FHR Support**
Treatment Implemen-tation	Did thinning treatments meet Rx targets for trees?	Trees per acre or basal area. Species comp. & size distribution of trees.	Post treatment (1-5 years) monitoring using DNR Treatment Monitoring Protocol. A sample of treatments will be monitored by landowners, local partners, DNR staff, or other organizations in different planning areas, depending on funding and staff capacity. Plots may also be installed after wildfires or other disturbances. Raw monitoring data will be compiled by DNR and made publically available for partners. Where funding and/or staff capacity allows, formal BACI (Before, After, Control, Impact) monitoring designs are encouraged. Drone based LiDAR & imagery over treated areas may be pursued to compliment plot data.	Sharon Frazey (MARS) and DNR FHR staff have completed draft Treatment Unit Protocol. Need for partners to test, refine, and utilize protocol. Then analyze data for individual units. Once data has been collected over a significant number of units, external research institutions or others will compile data to evaluate aggregate treatment effects and trends.	**Moderate** GIS, planning, & science staff will maintain data collection system. Landowners, stakeholders, and others will install plots. Research institutions or others compile & analyze data.
Treatment Implemen-tation	Did Rx fire meet targets for fuels & tree mortality?	Tons per acre of surface fuels. Tree scorch. Tree mortality. Crown base ht.			
Fire & Fuels	Have activity, ladder, surface fuels, and piles been treated?	Tons per acre of surface fuels. Crown base height. Presence of hand, machine, & landing piles.			
Habitat,	Were snags & live old (~>150 yrs) and large trees of fire resistant species retained?	Number of snags, old & large trees retained. Criteria will depend on landowner objectives.			
Habitat, Fuels	How do treatments affect understory plants & invasives?	Percent cover by lifeform or species of vegetation, including invasives.			
Insect & Disease Risk	Effect of treatments on insects, disease, & drought mortality.	Mortality of trees by agent, species, and size class.			
Habitat, Fire	Do treatments create simplified or variable spatial patterns?	Proportions of widely spaced individual trees, different size dense patches & openings.	Every 4-6 years, assess treatments in planning areas using pre- and post-treatment DAP (with LIDAR & field plots for calibration).	DAP methods to quantify tree patterns are currently being developed. Drone based LiDAR & imagery may be pursued.	**Moderate** Science staff
Fuels, Economics	How do vegetation & fuels respond 10-20 years post treatment & wildfire? When is retreatment needed?	Growth, density, and mortality of trees. Density & height growth of new trees. Percent cover of understory veg. Woody surface fuels.	Re-measure plots 10-20 years after first post treatment (& post wildfire) plot installation to assess response of vegetation.	DNR is funding UW in 2020-2021 to conduct this study. Possible continuation of study in 2021 – 2022.	**Low** Potential DNR Funding
Fire & Fuels	How did treatments affect wildfire severity?	Percent basal area mortality of trees.	2-5 years post fire, partners & DNR monitor treatments as funding & capacity permits.	No current plans.	**Low** Potential DNR Funding

Table 4. Summary of stand-level field data collection options for the Forest Health Treatment Unit Monitoring Protocol.

Simple	Moderate	Advanced
Number of Plots: On 80 acre unit - Uniform Treatment: Min. 6 plots Variable Treatment: Min. 8 plots - If 2 treatments, 4 for each type **Estimated Time:** 30 min/plot w 1 person **Data to Collect:** **Plot Description** • Descriptive • Geospatial • Photo point • Estimate Veg Cover (shrubs and forbs/grasses) in bins • Invasive plants (P/A) • Soil disturbance (P/A) **Fuels** • Burn piles (P/A), machine or hand, distance to nearest, average height • Average litter and duff depth in bins • Average surface fire severity **Trees** • Number of live and dead trees • Average diameter at breast height (DBH) • Dominant species in overstory, midstory, understory • Average canopy scorch height	**Number of Plots:** On 80 acre unit - Uniform Treatment: Min. 9 plots Variable Treatment: Min. 12 plots - If 2 treatments, 6 for each type **Estimated Time:** 45 min/plot w 2 people **Data to Collect:** **Plot Description** • Descriptive • Geospatial • Photo point • Estimate Veg Cover (shrubs and forbs/grasses) in bins • Dominant (2) Veg composition by strata • Dominant invasive plant species & % cover, in bins • Soil disturbance (P/A) **Fuels** • Burn piles (P/A), machine or hand, distance to nearest, average height • Stand height • Average canopy fuel base height • Measured litter and duff depths • Fire severity - Composite Burn Index (CBI) • Photoload fuel loading estimate **Trees** • Number & dominant species of seedlings, in bins • Number (large bins) & dominant species of saplings • Individual tree measurements (> 5 or 8in): species, diameter, tree status code, strata level, % scorch, damage code • Canopy Cover (%)	Under development. Please refer to the *Advanced Protocol Introduction* for more information about how to partner and collaborative with our team in developing and implementing these efforts.

III. Datasets

A major challenge in large-scale monitoring is obtaining consistent, wall to wall datasets that can reliably detect changes in conditions at regular time intervals. In order to conduct and integrate monitoring across all three levels, these datasets must be accurate at fine scales (trees and stands) and be scalable to larger spatial extents (watersheds, planning areas, regions). To achieve the goals outlined in this framework, DNR FHR is integrating a variety datasets spanning multiple spatiotemporal scales, including existing forest inventory and remote sensing datasets (Table 5). DNR FHR recognizes that each dataset has inherent strengths and uncertainties and that addressing some monitoring objectives will become more feasible as datasets and methods evolve (e.g., tree species mapping and structure-based change detection).

LiDAR is the most accurate large-scale data source but is currently too expensive to fly across all of Eastern Washington on a regular basis. DNR State Lands has developed a LiDAR-like process utilizing aerial imagery for their inventory of State Trust lands. This process, called Digital Aerial Photogrammetry (DAP), uses stereo NAIP imagery (National Agricultural Imagery Program) that is flown every two years across all of Washington. DAP generates a point cloud of the forest canopy surface that allows for measurements of tree height, canopy volume, and canopy cover that can be used to quantify and monitor changes in forest structure at fine scales (Fig. 2). The data are not as accurate as LiDAR data but are a major step forward in that consistent structural information can be collected on a recurring basis without the need to re-fly LiDAR.

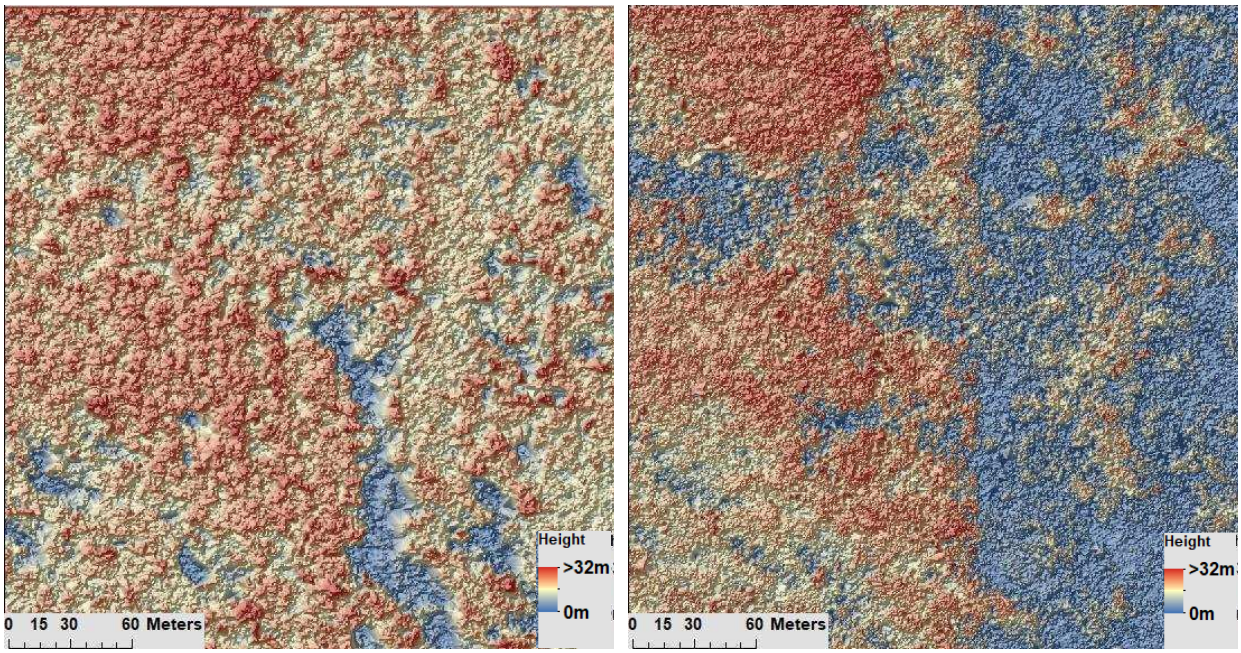

Figure 2. *Example of Digital Area Photogrammetry (DAP) tree height data pre (left panel) and post fire (right panel). Blue areas in the right panel indicate patches of tree mortality.*

When combined with field plot data, biophysical data (climate, topography, soils), and other remotely sensed data (satellite imagery), DAP data can be used to generate forest inventory, habitat, and other metrics at a pixel scale (20-30m) such as basal area, merchantable volume, carbon, crown bulk density, and structure class. Obtaining accurate forest inventory information from DAP imagery requires a LiDAR ground model, but once a high quality LiDAR ground model has been acquired for an area, it does not need to be re-flown. If LiDAR becomes affordable to fly on a regular basis in the future, however, DNR may pursue shifting to LiDAR over DAP.

The DNR has partnered with the University of Washington and the USFS to expand DNR's current DAP-based inventory program to all of the forested areas in Washington. This "Current Conditions Dataset" will provide consistent, wall to wall forest inventory information using 2015, 2017, and 2019 NAIP imagery that DNR FHR will use for landscape evaluations, statewide assessment, and monitoring. Other landowners can also use the imagery for both monitoring and planning. Currently, most of Washington has been flown with LiDAR, allowing for accurate DAP data to be created over most of Washington (Fig. 3). Additionally, the DNR Geology LiDAR program will continue its program of completing the LiDAR footprint in Washington and re-flying LiDAR in areas that had low quality initial acquisitions.

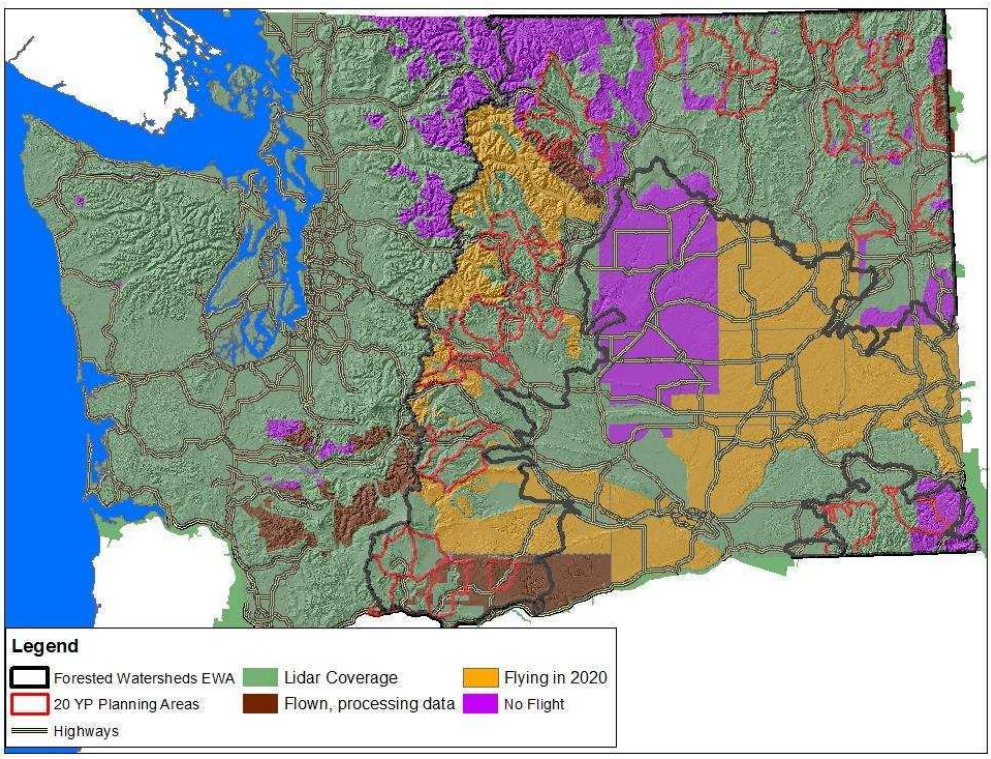

Figure 3. *Current LiDAR coverage in Washington as of March 2020. Monitoring with Digital Area Photogrammetry (DAP) data can be reliably done in areas where LiDAR has been flown. DAP data will be available in the orange areas in 2021 or 2022.*

To monitor changes in forest conditions from 2015 through 2019, tree mortality estimates will be derived using satellite imagery (Landsat, Sentinel) and existing change detection methods (e.g., LandTrendr). DAP data, in combination with satellite and aerial imagery, will be used to evaluate potential locations of change for more detailed assessment of changes in forest structure and landscape pattern. DNR FHR will consult the Kane lab at UW and the Kennedy lab at OSU for this work, and the methods and timeline for this work may change.

DNR plans to acquire high-resolution NAIP imagery for all of Washington for the foreseeable future and has the capacity to process the imagery to produce inventory metrics. DNR FHR staff are currently working with research partners at UW to determine what DAP metrics are best suited for detecting and monitoring change. A number of other wall to wall, remotely sensed datasets that are updated on a regular basis will be combined with DAP to detect and monitor changes in forest conditions and create the "Current Conditions Dataset" (Table 5). As previously mentioned, Landsat 4 – 8 and Sentinel 2 satellite imagery will be used to detect tree mortality and other forest change and improve models for forest inventory metrics. Color bands from the NAIP imagery may also be used for these purposes. Stereo NAIP imagery at 40cm resolution will be made available for partners to use for photo interpretation (PI). In planning areas where the landscape evaluations previously used PI to generate forest condition data, re-doing photo interpretation after treatments are complete and/or wildfires have occurred will be an important monitoring tool for a wide range of indicators. DNR FHR will assist partners with re-doing PI for specific planning areas as funding permits.

Table 5. *Datasets generated and used by DNR for monitoring. Recognizing that each dataset has inherent strengths and scales as well as uncertainties and limitations, DNR FHR will continue to develop and adopt new datasets and methods.*

Dataset	Description, Derivative Products	Data Creation, Time Interval & Maintenance	Status
NAIP Imagery	DAP point clouds; Stereo imagery for Photo Interpretation	USDA – Hexagon. Purchased by DNR for all of WA every 2 years.	Missing 2019 Imagery for NC WA being flown. Delivery in Fall 2020.
Digital Aerial Photogrammetry (DAP) from NAIP	Forest structure classes, forest inventory metrics. Canopy height models	DNR Photogrammetry, FHR, Forest Resources. Created every 2 years.	2017 complete, 2019 & 2015 in QC for all EWA.
LiDAR	Ground models (DEM); Canopy height; Forest structure & inventory metrics	DNR Geology and other funding partners.	Fig. 3 shows coverage. Most of remaining areas will be complete by 2022.
Satellite imagery	Landsat 4 – 8 & Sentinel 2	Freely available through open archives.	Available for all WA.

Fire perimeters & burn severity	Perimeters from DNR Large Fires database & MTBS. Burn severity from satellite imagery (developed in house to reduce lag time).	DNR Wildfire maintains fire perimeter layer. FHR creates severity maps.	Severity for all WA fires processed through 2018.
Climate data at 90m pixels + mid-century projections	Moisture Deficit, AET, SWE, SRI, TWI, SWC. Temp & precip. from Climate WNA	DNR FHR. Updated when new base data or projections released.	Complete for all WA.
Focal species habitat maps for planning areas	Derived from DAP, LiDAR, photo interpretation, & veg. type map.	DNR FHR & WDFW. Updated every 4 years.	Complete for NE WA and Klickitat area. In progress for ECA.
Forest Health Tracker database	Polygons or points of treatments across all landowners with basic info.	DNR FHR. Updated annually based on data provided by partners.	Database in development. Public lands data acquired.
Pacific Northwest Quantitative Wildfire Risk Assessment (PNRA)	Burn probability, Flame Length, selected location of Highly Valued Resources and response functions	Created by Pyrologix & the USFS. DNR FHR will update for WA based on updates to LANDFIRE input data	Complete for all of WA through 2017.
LANDFIRE surface and canopy fuels used for fire spread modeling	Used to generate fire modeling outputs	Freely available from LANDFIRE. Updated for select areas by DNR FHR.	Available for all WA
Aerial detection surveys for Insect and disease	General patterns of forest health, hotspots of tree mortality.	Established USFS & DNR program. Annual.	Available for all WA.
Vegetation Type (Forest and Non-Forest types)	Forest and non-forest types for all lands. Same as potential vegetation types.	USFS. Base data from Henderson-ILAP PVT. Landfire for non-forest.	USFS R6 working on new version of forest types/PVTs.
Forest Mask	Forest, including forest capable sites, and non-forest.	DNR FHR; source data: Landfire, GAP, NLCD.	Complete for eastern WA.
Field Plot database	LiDAR grade plots, stand exams, CVS, others.	UW, DNR, USFS. Updated as new data are created.	Being developed by UW-Luke Rogers lab.
Current Conditions Forest Metrics	Structure classes, forest inventory metrics. Derived from plots & DAP or LiDAR data.	UW, DNR, USFS. Updated every 4 years, possibly every 2 years.	Being developed by UW-Luke Rogers lab.
Gradient Nearest Neighbor Forest Metrics	Forest inventory metrics based on imputation of plots using field and satellite data.	LEMMA: USFS, Oregon State University.	1984-2017 data available.

DNR FHR staff will generate burn severity maps from Landsat imagery using fire perimeter databases and Google Earth Engine from 1984 to present with a one year lag. Burn severity data are produced by DNR FHR to reduce the lag time relative to federal programs (e.g., MTBS). DNR FHR has produced a suite of current and predicted future climate metrics at a 90m pixel scale for Eastern Washington using the latest climate change projections. Primary among these are water

balance deficit (Fig. 4) and actual evapotranspiration that are used to determine drought vulnerability and insect risk in combination with forest condition data. DNR will continue to update this climate dataset as climate models improve over time.

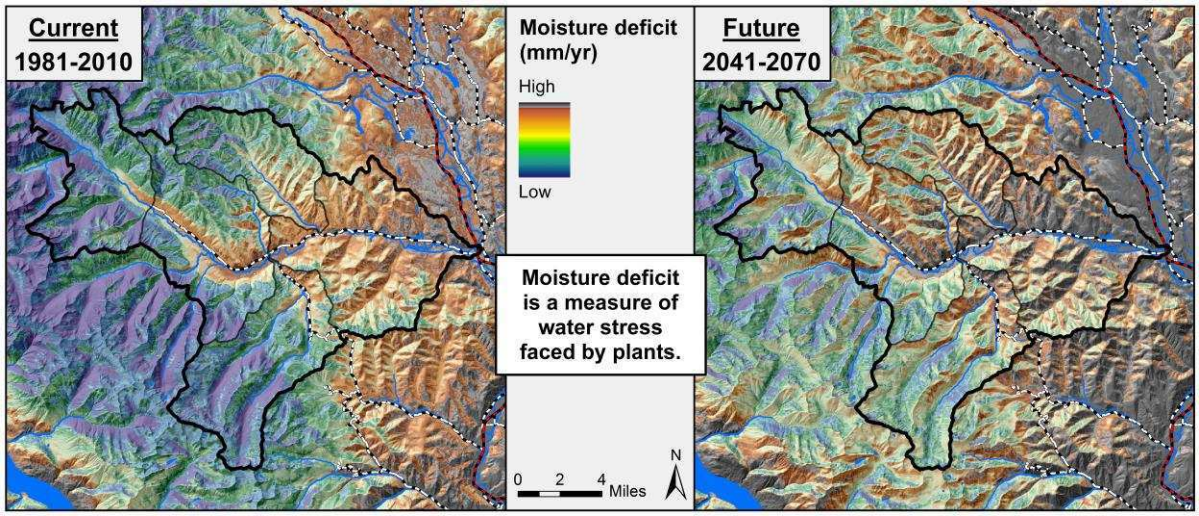

Figure 4. *Maps of modeled water balance deficit for (a) 1981-2010, and (b) 2041-2070, for the Twisp River planning area. Blue areas indicate lower water deficits, while brown and gray areas indicate higher deficits.*

Another critical dataset is the Pacific Northwest Region Quantitative Wildfire Risk Assessment (PNRA) produced by the USFS in 2017 (Gilbertson-Day et al. 2018). DNR will continue to use the PNRA framework for quantitative risk assessment and will update the analysis as often as new vegetation data become available for all of Washington and more frequently for specific planning areas as needed. A major limitation of DAP is that species composition measurements are not a resulting product. To address this limitation, DNR FHR is funding researchers at Oregon State University to improve methods to map species composition using satellite imagery in combination with DAP and biophysical data (Appendix A).

In addition to remotely sensed data, DNR and the UW are working with partners to integrate field plot data into a single database. Plots with accurate GPS locations will be used in conjunction with DAP and imagery to generate forest inventory metrics for the "Current Conditions Dataset". Plots from stand exams, monitoring, research studies, and other sources will be used to evaluate species composition, forest inventory, potential vegetation, climate, and other spatial datasets. DNR is currently funding researchers at UW to locate and pool together research and monitoring plots that were installed after fuel reduction/dry forest restoration treatments in eastern Washington over the last 25 years (Appendix A). A subset of these plots was re-measured in 2020 by UW researchers to assess long-term response (~10-20 years) to treatments, the need for re-treatment, and potential for future wood production. Wildfires will be accounted for as a type of treatment in this study.

A final core dataset is the treatment tracking database that DNR FHR will maintain over time. The DNR FHR is currently collecting treatment data from public and private landowners and generating summary results of treated acres for each planning area. A formal database system, called the Forest Health Tracker is being developed where landowners will be able to directly input their treatments. Treatment polygons will be used in conjunction with remotely sensed datasets to assess changes in conditions across planning areas.

All datasets generated by the DNR FHR and its research partners (Table 1) will be made publically available, except for any data that individual landowners do not want to share. This combination of accurate, wall to wall remotely sensed data with up to date treatment polygons and extensive field plot data will likely attract interest from a variety of researchers and funding institutions to study changes in Washington's forests over time. External researchers will greatly leverage DNR efforts to improve our understanding of Washington's forests and how best to adaptively manage them over time.

IV. Multi-party engagement

Multi-party monitoring involves numerous partners—land management agencies, tribes, forest collaboratives, research institutions, private landowners, local government agencies, the forest products industry, NGO's, community members, and other stakeholders—working together to design, fund, implement, and oversee monitoring programs. The development of this framework has involved a large number of partners, and DNR looks forward to continuing this engagement.

Although the DNR FHR has the capacity and expertise to lead on the core components of this framework, adequately monitoring forest conditions across eastern Washington and addressing the three main monitoring questions in this document will require robust coordination and integration among partners. This is especially true for the stand-level monitoring components of this framework. Stand-level monitoring is time intensive and will require contributions from many partners to provide meaningful amounts of data as well as adequately synthesizing and reporting results from the data.

The DNR FHR has been working with monitoring partners through multiple venues to develop this monitoring framework, including the Forest Health Advisory Committee monitoring subcommittee and several related research/monitoring projects. DNR FHR will formalize a process and venue to coordinate partners' monitoring efforts in support of this framework. We envision a standing monitoring working group that helps to refine monitoring questions and methods, defines partner roles and responsibilities to answer these questions, and develops approachable and compelling communication materials to describe monitoring results. This working group will also help coordinate and align monitoring efforts among different agencies,

particularly with DNR and the US Forest Service. This multi-party engagement will likely require some formal memorandum of understandings between DNR and various partners to solidify these relationships and commitments.

Research institutions and outside contractors have played a key role in developing many of the methods and datasets that are integral to this monitoring framework. In the 2019-2021 biennium, DNR FHR utilized funding primarily from the forest health capital budget to fund these projects (Table 6). Funding for projects in future years will be critical to fulfill monitoring and adaptive management goals over time. DNR needs this added expertise and capacity. In addition, partnering with universities and other research institutions adds scientific credibility to DNR's efforts and helps build and maintain long-term societal support. Finally, DNR funding can often be used to leverage other funding sources to expand projects.

Table 6. Projects funded by DNR FRH in the 2019-2021 biennium to help build methods and datasets for monitoring framework.

Project	Partner	Completion Date	Amount
1. Treatment unit monitoring protocol • Develop template protocol for landowners to use for treatment monitoring	Sharon Frazey: MARS	Jun 2020	$9,900
2. Current conditions & monitoring dataset: • Generate fine scale, all lands, statewide dataset of forest inventory metrics for planning and monitoring. • Create portal where all data are publically available • Improve methods for change detection with NAIP imagery (DAP)	UW: Luke Rogers, Van Kane	June 2021	$143,378
3. Restoration Needs Assessment: 2017 Data • Replicate Haugo-DeMeo methods with 2017 current conditions & HRV ranges • Look at trends in restoration need from 1984-2017. • Examine effects of wildfires and treatments	UW: Brian Harvey, Jon Bakker	June 2021	$89,106
4. Effects of treatments on snow pack • Install field study on effects of treatments on snow pack and generate data to improve landscape scale water yield models (DHSVM)	UW: Jessica Lundquist & Susan Dickerson-Lange	June 2021	$15,000
5. Treatment effectiveness & longevity: • Results will inform long term treatment needs for Eastern WA. • Combine all existing plot data on treatments & re-measure plots in 2020	UW: Brian Harvey, Jon Bakker	June 2021	$188,812
6. Investigate improvements in species composition maps. • Improve species composition layer for EWA using new remotely sensed data and methodologies.	OSU: Matt Gregory	June 2021	$55,439
7. Integrate focal species habitat into Landscape Evaluations	WA Conservation Science: Bill Gaines	June 2020	$27,900

• Work with wildlife biologists from multiple agencies to refine and implement methodology to integrate habitat into 20 YP treatment recommendations.			
8. FSim Calibration for WA • Develop Fire Simulation (FSim) calibration files for all the Fire Occurrence Areas in Washington State. This give DNR FHR the capacity to perform FSim fire modeling in support of the PLAN.	Pyrologix	June 2021	$39,176
8. Develop DAP treatment unit monitoring tools • Develop metrics to assess changes in canopy cover, tree height, and spatial pattern from treatments. • Analyze sample of recent treatment units in eastern Washington using DAP.	Sean Jeronimo Precision Forestry	June 2020	$20,800
Total			$589,511

V. Future Topics

The current monitoring priority of the DNR FHR is to track forest conditions over time and how they relate to the forest health treatment needs identified in landscape evaluations, particularly in terms of fire risk. There are many other important social, economic, and ecological components of forest health that are essential to monitor over time. There are also key questions regarding the direct and indirect ecosystem service benefits of achieving the goals of the 20-Year Forest Health Strategic Plan, some of which can be answered by monitoring and some answered by collaborative research.

DNR FHR would like to work with our partners to help prioritize and further define the following future monitoring and research questions and develop plans to address them. Some of these questions may require synthesizing existing research, whereas others may require a full study design and monitoring plan with data acquisition. Our intent would be to work within the context of a newly established monitoring working group to develop plans to address these questions in the short and long term. There may be additional items not on this list that the working group recommends.

1. What are the direct and indirect economic benefits of achieving the goals of the 20-Year Forest Health Strategic Plan? If 1.25 million acres of scientifically sound, forest restoration and management treatments are conducted in our forest health planning what does that means in terms of jobs, income, and community well-being?

2. What are the ecosystem service benefits of achieving the goals of the 20-Year Forest Health Strategic Plan?

3. What are important social dimensions of forest health work that we want to monitor and research? These may include social equity and environmental health disparities, collaborative engagement and capacity, and others.

4. What are the implications for water quality and water quantity when we shift 30 to 40% of a watershed from dense forest to open forest conditions?

5. How do completed and/or planned treatments within a planning area change resistance and resilience to future wildfire and other disturbances? Develop a modeling toolset using a dynamic, coupled state and transition and fire simulation models to be able to game out different treatment scenarios and examine tradeoffs.

6. How can we incorporate climate change into fire and state transition modeling to improve estimates of future fire probability, behavior, and risks in the future, as well as developing future range of variability targets for landscape evaluations?

7. How are fire suppression strategies and costs changing as the PLAN is implemented?

8. What are the carbon implications between different treatment scenarios over time?

9. Can drone based LiDAR and imagery be used to accurately measure surface and ladder fuels after treatments, as well as spatial pattern of overstory trees?

10. What are the relationships among forest conditions, drought, insect-induced tree mortality, and fuel dynamics?

11. Can improved insect and disease risk maps be developed for Washington using DAP based inventory data, improved species composition maps, and water balance metrics?

12. How can economic outputs of completed treatments associated with the PLAN be tracked and reported over time?