PROPOSED FINAL REPORT:

Wildfire Prevention, Preparedness, and Expenditure Review

LEGISLATIVE AUDITOR'S CONCLUSION:

DNR's long-term approach to wildfire prevention and preparedness is supported by science and best practices. The approach requires coordination with other entities and can reduce fire severity, which may impact costs to suppress fires.

January 2021

Executive Summary

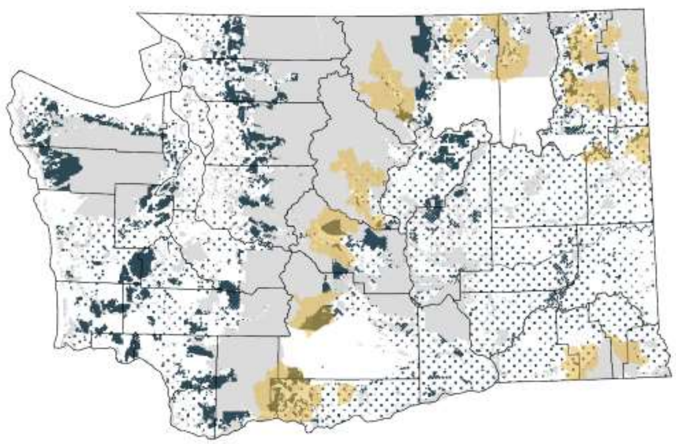
In 2019, the Joint Legislative Audit and Review Committee (JLARC) directed its staff to review the Department of Natural Resources' (DNR) wildfire prevention and preparedness activities and related expenditures. The study directive also required a review of research to identify whether there is evidence to show how effectively the activities reduce the negative impacts and costs of wildfire.

DNR has a strategic, science-based approach to prevention and preparedness

DNR developed long-term wildfire and forest health plans that provide a strategic approach to prevention and preparedness. The approach is grounded in science and the planned activities (e.g. thinning, chipping, prescribed fire) are consistent with science and best practices. Plans address:

- **Prevention** - activities that are aimed at reducing the number of human caused fires.
- **Preparedness** - activities that are intended to improve forest health and help communities adapt to wildfire. For this report, preparedness does not include suppression-related activities to control or extinguish fires (e.g., training, placing staff and equipment near anticipated fires).

Since the plans were developed in 2017 and 2018 and have 10-20 year timelines, DNR is still in the early stages of implementation. To date, DNR has identified 33 initial priority areas in eastern Washington (yellow areas on map) to focus forest health efforts, and activities have begun in these areas.



Source: JLARC staff analysis of DNR data.

DNR spent a total of $70 million on preparedness and prevention in fiscal years 2018-2020. More detail is available in Appendix B.

DNR is one of many partners that must work together to achieve prevention and preparedness goals

Statute requires DNR to assess and treat one million acres of forest land in eastern Washington by 2033. DNR manages only 500,000 acres within its priority areas, so meeting this goal will require working with other federal, state, private, and tribal entities.

Landscape preparedness activities are coordinated through formal agreements and collaboratives. DNR also provides financial and technical assistance to small forest landowners.

Community preparedness and prevention activities (e.g. Firewise USA®[1], Community Wildfire Protection Plans) involve conservation districts, community groups, fire agencies, and local governments. Research suggests that community preparedness can increase firefighter safety and reduce loss to private property.

Currently, DNR cannot systematically show how much it has spent on forest health treatments in a specific area. However, DNR is developing a new system that could provide this information.

DNR currently uses multiple systems to track prevention and preparedness information needed to meet statutory reporting requirements. These systems are unable to connect activity location and cost, so DNR cannot easily show how much it has spent on preparedness activities in the

[1]A program that encourages residents of wildfire-prone areas to take voluntary actions to reduce wildfire risks to their homes and neighborhoods.

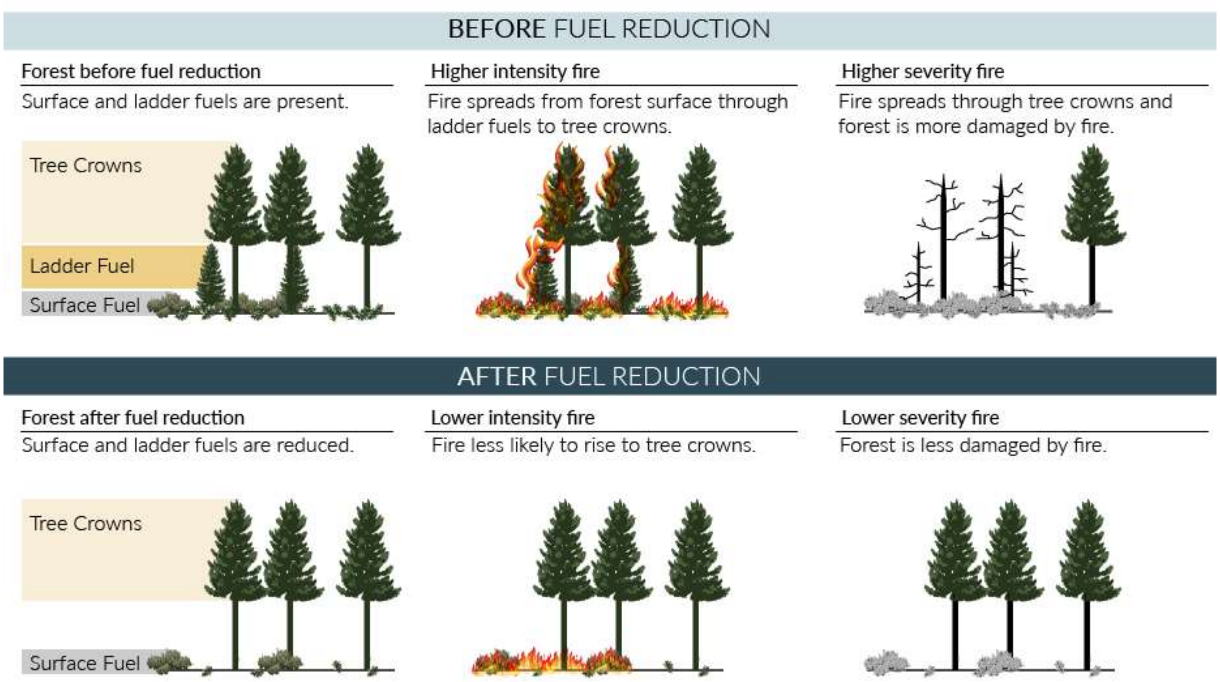
specific priority areas. This makes it difficult to know if the agency's spending is consistent with its plans and goals.

However, as required by law, DNR is developing a monitoring strategy to track forest health accomplishments. One component of the broader monitoring strategy is a forest health tracking system. The system will include maps, activity type, and project level information, such as location, funding, and costs. DNR plans to provide public access to the tracking system in 2021.

Research indicates that preparedness activities can reduce fire intensity and severity, and may decrease suppression costs for individual fires

JLARC staff worked with consultants to review more than 300 peer reviewed articles, guidance documents, and published reports about fire ecology and management (see Appendix A for bibliography). Research, which is generally applicable to eastern Washington forests, suggests that fuel reduction projects that combine thinning and prescribed fire effectively reduce fire intensity, fire severity, and have other ecological, public safety, and economic benefits. DNR is taking steps to increase its use of prescribed fire.

- **Fire intensity** measures a fire's energy, usually in terms of temperature or flame length.
- **Fire severity** refers to the effects of fire on forest material, such as percent of trees that burned or died.



Source: JLARC staff depiction based on diagrams created by the U.S. Forest Service.

There are many factors that influence overall fire suppression costs, and the relationship between prevention, preparedness, and suppression spending is too complex for a simple equation (e.g. a dollar spent in one area equates to reducing suppression costs by $X). However, research models predict that preparedness activities may reduce suppression costs for individual fires.

REPORT DETAILS

1. DNR has a strategic, science-based approach

DNR's wildfire and forest health plans provide a strategic approach to fire prevention and preparedness. The approach is grounded in science and the planned activities are consistent with best practices.

In 2019 and 2020, the Legislature considered bills that would create a new funding source for the Department of Natural Resources' (DNR) wildfire suppression, prevention, and preparedness activities. DNR stated that the proposal would reduce "wildfire damage and cost by investing in proven wildfire prevention and preparedness strategies."

The bills did not pass and the Joint Legislative Audit and Review Committee (JLARC) directed its staff to:

- Review the Department of Natural Resources' wildfire prevention and preparedness activities and related expenditures.
- Identify whether there is evidence to show how effectively the activities reduce the impacts and costs of wildfire.

Terms used in this report

For purposes of this report, we use the following terms to describe DNR's activities:

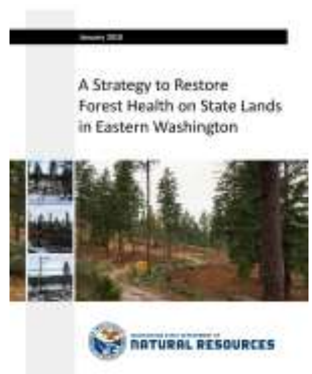
- **Prevention** activities are aimed at reducing the number of human caused fires.
- **Preparedness** activities are intended to improve forest health and help communities adapt to wildfire. Preparedness does not include suppression-related activities that extinguish or control the spread of fire (e.g., training, placing staff and equipment near anticipated fires).

DNR developed long-term wildfire and forest health plans

While there are many factors that contribute to wildfire, there is broad agreement among many scientists and land managers that historic forest management practices and fire suppression policies at the federal and state level have led to an unnatural buildup of fuels[2] on the landscape. Dense, unhealthy forests create fuels that make fires harder to control and more expensive to suppress.

DNR developed long-term forest health plans, as required by state and federal law. It also developed a 10-year plan to address wildfire. The plans set forth strategies to achieve healthy forests, resilient landscapes, fire adapted communities, and safe wildfire response. Since the plans were written in 2017 and 2018 and have 10-20 year implementation timelines, DNR is still in the early stages of implementation.

Exhibit 1.1: DNR's plans provide a strategic approach to achieve prevention and preparedness goals

Forest Health Strategic Plan and Implementation Strategy			
	*20-Year Forest Health Strategic Plan: Eastern Washington (2017)* Overarching framework for addressing forest health needs on all forest lands in eastern Washington, regardless of ownership.		*Strategy to Restore Forest Health on State Lands in Eastern Washington (2017)* Implements the 20-Year Forest Health Strategic Plan on DNR-owned lands.

[2]These include grasses, shrubs, woody debris, and small trees.

Wildfire Strategic Plan and Forest Action Plan			
	*Washington State Wildland Fire Protection 10-Year Strategic Plan (2018)* Strategy and implementation plan to address wildland fire issues across the state. Aligns with the National Cohesive Wildland Fire Strategy.		*Forest Action Plan (2017)* Strategy for using DNR's forestry programs to address threats to forest resources and advance federal goals. DNR published an update in the fall of 2020, after the field work for this study was complete.

Source: JLARC staff analysis of DNR planning documents.

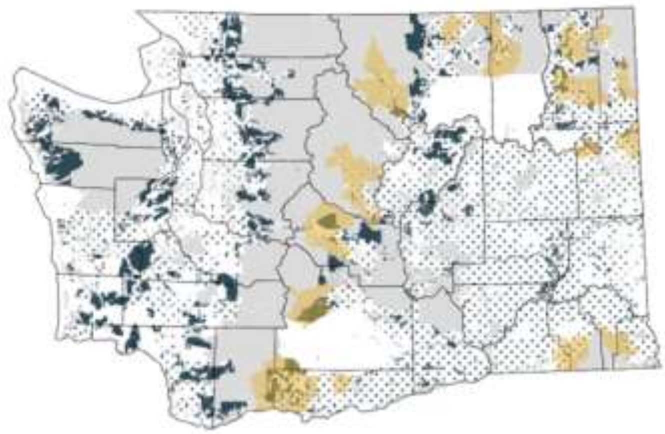
DNR used a scientific approach to identify 33 initial priority areas for preparedness activities in eastern Washington

Statute[3] defines healthy forests as sound in ecological function, sustainable, resilient to insects, diseases, fire, and other disturbances, and able to meet landowner objectives. DNR's Forest Health Plan identifies priority areas to focus forest health treatments, as state law requires (see Exhibit 1.2).

- DNR identified 33 initial priority areas in eastern Washington based on data that includes fire risk, wildland urban interface, drinking water, wildlife habitat, climate change, timber volume, and aquatic resources. DNR's methodology is included in the Plan. DNR plans to identify additional priority areas each biennium.
- After identifying priority areas, DNR conducted landscape evaluations to assess forest health conditions and determine treatment needs. The evaluations summarize vegetation changes compared to historical conditions, current fire and drought risk, and wildlife habitat needs. This information is used to identify specific actions needed to move the landscape into a more ecologically resilient condition and reduce fire risk.

[3] RCW 76.06.020

Exhibit 1.2: The 33 priority areas in eastern Washington cross multiple ownership boundaries



Source: JLARC staff analysis of DNR data.

DNR compiled agency and partner data about forest health treatments into a database. The database includes information from 2017 through 2019 and shows that treatments took place on state, federal, and private land in the 33 priority areas. Treatments include fuel reduction projects such as thinning, chipping, piling and burning vegetation.

DNR is developing a tracking system to monitor forest health accomplishments, as described in Section 3.

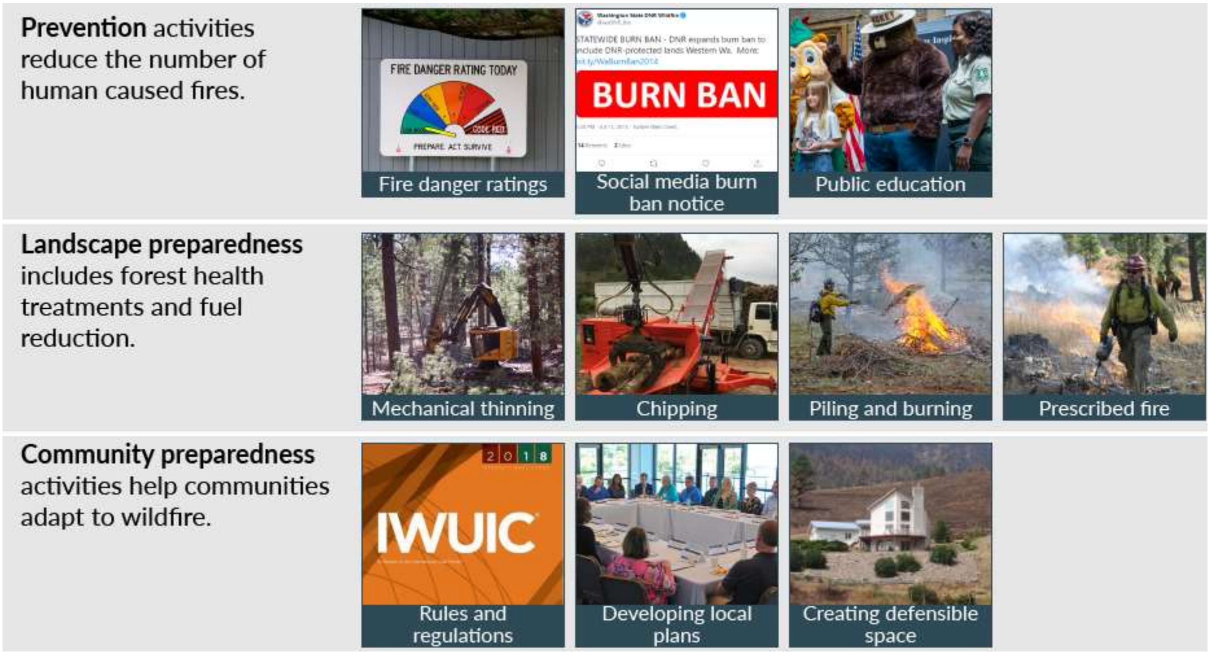
Activities identified in DNR's plans align with federal guidance and best practices

DNR's plans and activities are consistent with national guidance. For example, the National Cohesive Wildland Fire Management Strategy[4] has three goals: restore and maintain resilient landscapes, create fire adapted communities, and respond to wildfires safely and effectively. DNR's Wildfire Strategy adopts the same goals and identifies similar activities such as fuel reduction treatments, prescribed fire, reduction of human-caused ignitions, and community action. DNR's Forest Health Plan provides an approach for creating healthy, resilient landscapes in eastern Washington.

The activities in DNR's plans also are consistent with best practices identified in scientific literature. For example, research shows that activities such as thinning, chipping, and prescribed fire reduce the fuels that allow fires to grow and spread. More information is in Section 4.

[4]Federally mandated strategy that sets national-level direction for fire preparedness and management across all lands.

Exhibit 1.3: DNR's plans identify a variety of prevention and preparedness activities for itself and its partners



Source: JLARC staff analysis.

DNR spends more on preparedness activities than prevention

DNR spent a total of $70 million on preparedness and prevention in fiscal years 2018, 2019, and 2020. Of this, $63 million was spent on landscape preparedness activities such as forest health and fuel reduction.

Sources include state, federal, and non-appropriated funds. State budget provisos and federal grants have directed more funding to preparedness (e.g., forest health, hazard reduction) than to prevention (e.g., public education).

DNR uses unique accounting codes to differentiate prevention and preparedness spending from other DNR activities including wildfire suppression. The codes also provide details about its spending, such as the type of activity (e.g., forest health, prevention education), specific projects, and the region where funds were spent.

Additional detail for fiscal year 2020 is in Appendix B.

REPORT DETAILS
2. DNR must work with other entities

DNR is one of many partners that must work together to achieve prevention and preparedness goals

There are 22 million acres of forest land in Washington. Landowners include the Department of Natural Resources (DNR), the U.S. Forest Service (USFS), the U.S. Fish and Wildlife Service (USFWS), Washington Department of Fish and Wildlife (WDFW), State Parks, Tribes, and private forest landowners.

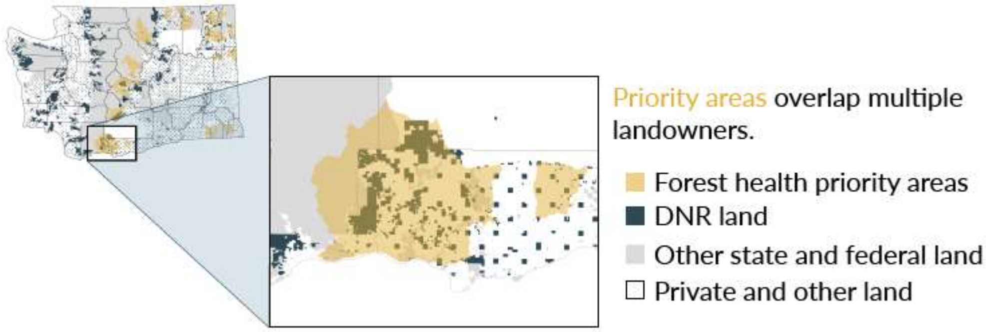
Federal, tribal, and private landowners collectively own more Washington forest land than DNR, which owns about three million acres. Landowners may have objectives prioritized differently for their land, such as emphasizing timber revenue or recreation opportunities.

State law directs DNR to treat one million acres and coordinate with others

Statute sets requirements for DNR's forest health treatments and interagency collaboration. For example:

- DNR must aim to complete forest health treatments on one million acres in eastern Washington by 2033 (RCW 76.06.200). DNR identified 33 initial priority areas to focus treatments. It plans to identify additional areas each biennium (see Section 1). Because DNR owns or manages only 500,000 acres within these areas, it will need to work with others to accomplish the Legislature's goal.
- DNR must coordinate with other parties to monitor forest health and provide education or technical assistance (RCW 76.06.030). Additional stakeholders include city and county governments, non-forest landowners, other residents, community groups, and businesses.

Exhibit 2.1: There are multiple landowners and other stakeholders in each of the 33 priority areas[5]



Source: JLARC staff analysis of DNR data.

Landscape preparedness is coordinated through formal agreements, collaboratives, and assistance programs

As described below, DNR and federal agencies use the Good Neighbor Authority (GNA), a Shared Stewardship agreement, and forest collaboratives to coordinate landscape preparedness across state and federal land.

- The GNA is an agreement signed in 2017 that allows DNR to plan and implement forest health treatments on land managed by the U.S. Forest Service (USFS) and Bureau of Land Management. The federal agencies reimburse DNR. There are 46 GNA projects completed or underway in Washington.
- The Shared Stewardship agreement, signed in 2019, encourages larger, more targeted restoration efforts based on the state's Forest Action Plan (see Section 1). The USFS and Washington Department of Fish and Wildlife participate. There are currently no projects completed or in progress.
- Forest health collaboratives help DNR, federal agencies, Tribes, conservation groups, and others reach non-binding agreements about forest management on federal forest land. Two of the nine Washington forest collaboratives also address other public and private land.

[5]Those with less than 5,000 acres.

Financial and technical assistance is available to small private forest landowners

DNR provides free forest stewardship consultations to private forest landowners across the state. In eastern Washington, DNR offers a landowner assistance program to help small forest landowners[6] improve forest health and resilience to wildfire. Through the program, DNR and the landowner share the cost of approved forest health treatments (e.g., thinning, chipping, pruning). DNR aims to have 80% of landowner assistance projects located within the priority areas.

Other agencies also support the work of small forest landowners. For example, conservation districts provide technical assistance and can help connect DNR with interested landowners. A 2019 agreement between DNR, USFS, conservation districts, Washington State University Extension, and other partners clarifies responsibilities for information sharing, technical assistance, funding, and administration.

Community preparedness and prevention activities involve conservation districts, community groups, fire agencies, and local governments

Many communities in the wildland urban interface (WUI)[7] take steps to prepare for wildfire. The WUI is the area where homes are built near or among lands prone to wildland fire. Research suggests that fire in the WUI is a key driver of suppression costs. Research also suggests that community preparedness can increase firefighter safety and reduce loss of private property (see Appendix A for bibliography).

Residents, government agencies, and private organizations share responsibility for prevention and preparedness in the WUI. For example:

- **Prevention:** DNR and fire agencies offer wildfire prevention education. They also establish and communicate burn restrictions.
- **Defensible space and home hardening:** Residents can create defensible space[8] and use fire-resistant materials on homes. Conservation districts, fire agencies, and DNR provide information through print materials, web sites and social media, and public meetings.

[6]Those with less than 5,000 acres.

[7]Pronounced as "woo-ee."

[8]Area in which vegetation and debris has been cleared or reduced to slow the spread of fire.

Many fire agencies[9] and conservation districts conduct home assessments and provide assistance. DNR and conservation districts also help communities receive formal recognition through Firewise USA®[10].

- **Regulations:** Local governments adopt and enforce building codes, including those specific to the WUI.
- **Information sharing:** Groups called fire adapted community learning networks and coalitions connect stakeholders so that they can share best practices, resources, and lessons learned. Members include fire agencies, conservation districts, DNR, residents, and others.
- **Planning:** Local governments may develop a Community Wildfire Protection Plan (CWPP) to identify and prioritize local needs for hazard mitigation, community preparedness, and structure protection. Participants have included conservation districts, federal agencies, emergency management, forest collaboratives, businesses, residents, and nonprofit conservation groups. DNR, local fire agencies, and local governments must agree to the CWPP. There are 62 plans in Washington reflecting the needs of counties, cities, towns, and other communities.

REPORT DETAILS
3. Treatment costs for specific areas not currently available

Currently, DNR cannot systematically show how much it has spent on forest health treatments in a specific area. However, it is developing a tracking system that could provide this information.

State law and federal grants require DNR to report forest health treatments, including acres and costs

Each biennium, the Department of Natural Resources (DNR) must submit two reports to the Legislature. They both must identify areas prioritized for forest health treatments, report progress on completing the treatments, and estimate the work and costs for the next biennium.

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[9] Fire agencies are responsible for structure protection in the WUI.

[10] A program that encourages residents of wildfire-prone areas to take voluntary actions to reduce wildfire risks to their homes and neighborhoods.

The Legislature passed these requirements in 2017 and the next reports are due in December 2020.

1. One report focuses on state lands (RCW 79.10.530).
2. The other addresses the 20-Year Forest Health Strategic Plan (see Section 1). In addition to the requirements above, DNR must report on the treatments completed in the preceding biennium, the costs, and treatment outcomes (RCW 76.06.200).

Federal grant agreements also require DNR to submit annual progress reports on the acres treated and associated costs.

DNR collects financial and spatial data

DNR collects the information it needs to fulfill its reporting requirements and make management decisions about where to direct its spending on landscape preparedness.

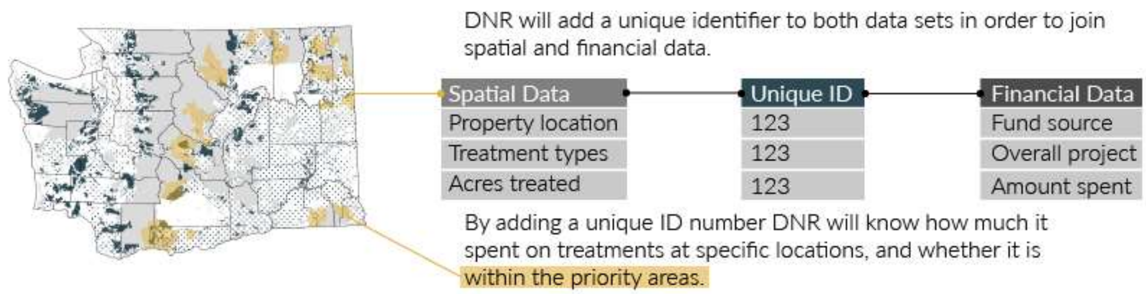
- DNR maintains financial data in the state accounting system and in spreadsheets that track landowner assistance projects. The data includes information such as amount spent, fund source, and project. The data allows DNR to report the amount spent from federal grants or state appropriations, as well as overall costs (see Section 1 and Appendix B).
- DNR stores spatial data in a separate database. The spatial data includes the specific location and information about the types of forest health treatments completed. This data can be mapped with the other spatial information to show whether the treatment took place within a priority area. DNR began collecting this data for treatments conducted in 2017 through 2019. Currently, it allows DNR to show the treatments at specific locations and whether those locations overlap with priority areas.

DNR's systems currently do not link financial and spatial data, so it is unclear how much has been spent on treatments in specific priority areas

The financial and spatial data systems do not currently share a set of common unique identifiers that could be used to link treatment location and costs. Further, data quality issues in the spreadsheets and database (e.g., null fields, inconsistent name and date conventions) hinder efforts to create the link manually. As a result, DNR cannot systematically show the cost of treatments at specific locations or know whether its spending is consistent with its plans and goals.

DNR reports that it is working to correct this problem with proposed data standards, beginning with landowner assistance projects. DNR intends to complete this work by June 2021 for projects completed since 2017.

Exhibit 3.1: DNR has proposed data standards to link financial and spatial data by June 2021



Source: JLARC staff analysis.

DNR is developing a forest health tracking system to monitor forest health accomplishments from multiple entities. DNR plans to include treatments and costs.

As required by state law[11], DNR is developing a monitoring strategy to track forest health treatments, outcomes (e.g., changes to forest condition), and effectiveness over time.

One component of this is a forest health treatment tracking system. The system includes information from the spatial database described above, as well as data from other state, federal and private landowners. The tracking system will include information about where treatments are located and basic information about each treatment, such as treatment type, objectives, and completion date. The system is intended to provide a multiparty view of forest health treatment activities that does not currently exist.

DNR began developing the tracking system in September 2018. It plans to make the data and maps viewable on its web site in 2021. At that time, the tracking system will:

- Include a map of project locations.
- Filter projects by completion stage and type.

[11] RCW 76.06.030

- Provide available project-level information such as project name and number, project description, start and completion dates, location, organization and contacts, funding and cost, grants and agreements, and photos.

Subject to funding, the tracking system will eventually replace the spreadsheets and include data for forest health treatments statewide and ongoing monitoring.

REPORT DETAILS
4. Preparedness can reduce fire intensity, severity

Research indicates that preparedness activities can reduce fire intensity and severity, and may decrease suppression costs for individual fires

JLARC directed its staff to evaluate whether research identifies certain types of activities that affect the negative impacts and costs of wildfire. Staff worked with expert consultants to review more than 300 peer reviewed articles, guidance documents, and published reports about fire ecology and management (see bibliography in Appendix A).

Research suggests that removing fuels from the landscape has reduced the intensity and severity of individual fires

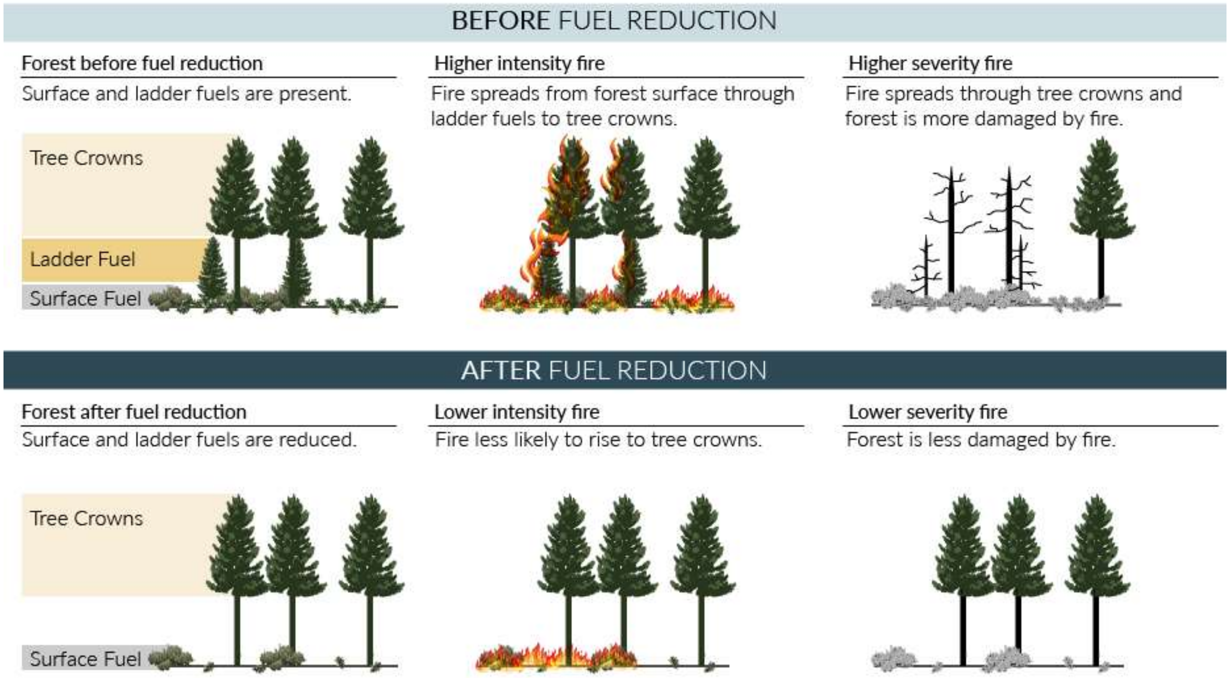
Landscape preparedness activities such as thinning, chipping, and prescribed fire can reduce or alter the fuels on the ground (surface fuels[12]), increase gaps[13] between trees, and increase distance from the forest floor to its canopy. The goal of these activities is not to stop all fires, but to make it more difficult for a fire to move from the ground into the canopy and then spread from canopy to canopy. This has been shown to decrease the fire's intensity and severity.

- **Fire intensity** measures the fire's energy, usually in terms of temperature or flame length. For example, a high intensity fire is hotter than a low intensity fire.
- **Fire severity** refers to the effects of fire. It reflects the loss or change in forest material, such as the percent of trees that burned or died.

[12]These include grasses, brush, and wood debris.

[13]Referred to as the canopy distance.

Exhibit 4.1: Preparedness activities reduce fuels on the landscape



Source: JLARC staff depiction based on diagrams created by the U.S. Forest Service.

Prescribed fire is a best practice for removing surface fuels

Fuel reduction projects are most effective when they combine thinning and the removal of surface fuels. When appropriate, prescribed fire[14] is one way to reduce surface fuels, and is generally less labor intensive and costly than other methods.

Research that is generally applicable to forests in eastern Washington shows that fires are less severe in areas that have been treated with thinning and prescribed fire compared to similar areas without these activities.

- Researchers studied areas burned during the 2014 Carlton Complex fire in north-central Washington. They found that areas with fuel reduction treatments that included thinning and prescribed fire burned with less severity even when there was high wind and temperatures.
- Computer models that simulate the effect of fuel reduction activities confirm the effectiveness of thinning combined with prescribed fire for reducing fire intensity and severity in forests like those in eastern Washington.

[14]The controlled application of low to moderate intensity fire under specific weather conditions to meet management objectives.

The Department of Natural Resources (DNR) is taking steps to increase the use of prescribed fire in Washington. For example, DNR's planning documents provide goals and strategies for the use of prescribed fire. At the Legislature's direction, DNR conducted a prescribed fire pilot project (2016 HB 2928) and is developing a certification program for prescribed fire (2018 HB 2733).

Exhibit 4.2: Thinning and prescribed fire reduced fuels and fire impacts

Source: JLARC staff analysis. Photographs taken by Justin Haug, Washington Department of Fish and Wildlife (WDFW).

Research indicates landscape preparedness may have ecological, public safety, and economic benefits

By reducing fire intensity and severity, fuel reduction activities can provide ecological benefits and improve public safety. The activities can also provide economic opportunities. The research cautions that these types of benefits are often site-specific and the experiences from one location may not directly apply to another.

Ecological: Research has found that fuel reduction can improve habitat for some species (e.g. deer, elk) and preserve water sources that could be affected by high severity fire.

Public safety: Fuel reduction activities may modify a fire's behavior, allowing firefighters safer access and improved suppression opportunities. Less intense and severe fires produce less harmful air quality impacts and smoke emissions than more severe fires.

Economic: Landowners and management agencies often hire contractors to perform fuel reduction activities such as thinning and chipping. This may provide jobs in rural economies and marketable timber products.

Models predict that preparedness activities may reduce suppression costs for individual fires

The relationship between prevention, preparedness, and suppression spending is complex. Without extensive and detailed information on costs and benefits, it cannot be simplified to an equation (e.g. a dollar spent on preparedness equates to reducing suppression costs by $X). This cost and benefit information is often unavailable or unknown.

Instead, researchers use two key methods to evaluate the effect of fuel reduction activities on fire suppression costs: case studies and computer simulations.

- **Case studies** compare actual suppression costs in areas with and without fuel reduction activities. This approach is uncommon and some researchers show reduced suppression costs in areas with past fuel reduction activities, while others find no significant relationship.
- **Computer simulations** assess the effect of fuels on fire growth, behavior, and size, and the subsequent effect on suppression response and costs. The simulations suggest that preparedness activities that reduce fuels may lower suppression costs for individual fires when they occur in a treated area.

DNR's ability to relate prevention, preparedness, and suppression spending is further complicated by the agency's data systems (see Section 3 and below).

DNR's systems cannot yet identify costs for individual fires

JLARC directed its staff to evaluate DNR's progress in implementing the recommendations from the 2018 JLARC report *Wildfire Suppression Funding and Costs*. The three recommendations instructed DNR to:

- Refine its collection of key data elements.
- Improve the accuracy and reliability of the key data elements.
- Develop a systematic and verifiable way to identify the costs of individual fires.

DNR concurred with each recommendation and has taken some steps towards implementation. However, it did not meet the implementation deadlines, and as of August 2020, DNR reports that implementation is "in progress."

Preparedness activities are among many factors that may influence overall suppression costs

Rising suppression costs have led researchers to study the factors driving suppression costs. It is important to note that a small percentage of fires each year typically account for a large percentage of suppression costs.

Some of the many factors that affect suppression costs include:

- **Fire size and behavior:** costs increase with fire intensity and severity and the area burned is often correlated with annual suppression costs.
- **Development in the wildland urban interface (WUI):** there is wide recognition among fire managers and researchers that increased development in the WUI has led to higher suppression costs.
- **Climate and weather:** long term climatic patterns that increase temperature, produce drought, and lengthen the annual fire season increase fire suppression costs. Specific weather patterns that produce high winds and low relative humidity can also increase fire severity and suppression costs.
- **Fuels:** the widespread buildup of forest fuels on the landscape makes fires more intense, severe, and costly to suppress.
- **Fire management decisions**: resource allocation and suppression strategies can affect costs.

Some of these factors may be influenced by DNR's and other entities' preparedness activities (e.g. fuel reduction, community preparedness), while others, such as suppression management decisions and weather patterns, are not.

REPORT DETAILS

Appendix A: Literature review methodology

Staff and consultants reviewed more than 300 sources

JLARC staff worked with two consultants to review fire ecology and management literature. Collectively, we reviewed more than 300 documents and worked with subject matter experts to reach the conclusions in Section 4. A list of sources is available in the table below.

Jump to Appendix B.

Sources include peer reviewed articles, guidance documents, and published reports

Author	Year	Title
Abrams, J., Huber-Stearns, H., Gosnell, H., Santo, A., Duffey, S. and Moseley, C.	2020	Tracking a governance transition: identifying and measuring indicators of social forestry on the Willamette National Forest
Abrams, J., Nielsen-Pincus, M. Paveglio, T. and Moseley, C.	2016	Community wildfire protection planning in the American West: homogeneity within diversity?
Absher, J.D., Vaske, J.J. and Shelby, L.B.	2009	Residents’ responses to wildland fire programs: a review of cognitive and behavioral studies
Abt, K.L., Butry, D.T., Prestemon, J.P. and Scranton, S.	2015	Effect of fire prevention programs on accidental and incendiary wildfires on tribal lands in the United States
Agee, J.K. and Huff, M.H.	1986	Structure and process goals for vegetation in wilderness areas
Agee, J.K. and Skinner, C.N.	2005	Basic principles of forest fuel reduction treatments
Agee, J.K., Wright, C.S., Williamson, N. and Huff, M.H.	2002	Foliar moisture content of Pacific Northwest vegetation and its relation to wildland fire behavior
Agee, J.K., Bahro, B., Finney, M.A., Omi, P.N., Sapsis, D.B., Skinner, C.N., Van Wagtendonk, J.W. and Weatherspoon, C.P.	2000	The use of shaded fuelbreaks in landscape fire management
Agee, J.K.	1998	The landscape ecology of western forest fire regimes
Agee, James K	1993	Fire ecology of Pacific Northwest forests
Ager, A.A., Finney, M.A., Kerns, B.K. and Maffei, H.	2007	Modeling wildfire risk to northern spotted owl (Strix occidentalis caurina) habitat in Central Oregon
Ager, A.A., Vaillant, N.M. and Finney, M.A.	2010	A comparison of landscape fuel treatment strategies to mitigate wildland fire risk in the urban interface and preserve old forest structure

Author	Year	Title
Ager, A.A., Vaillant, N.M. and Finney, M.A.	2011	Integrating fire behavior models and geospatial analysis for wildland fire risk assessment and fuel management planning
Alexander, M.E. and Cruz, M.G.	2013	Are the applications of wildland fire behaviour models getting ahead of their evaluation again?
Alexander, M.E. and Yancik, R.F.	1977	The effect of precommercial thinning on fire potential in a lodgepole pine stand
Alexander, M.E.	1988	Help with making crown fire hazard assessments
Alexandre, P.M., Stewart, S.I., Keuler, N.S., Clayton, M.K., Mockrin, M.H., Bar-Massada, A., Syphard, A.D. and Radeloff, V.C.	2016	Factors related to building loss due to wildfires in the conterminous United States
Allen, C.D., Savage, M., Falk, D.A., Suckling, K.F., Swetnam, T.W., Schulke, T., Stacey, P.B., Morgan, P., Hoffman, M. and Klingel, J.T.	2002	Ecological restoration of southwestern ponderosa pine ecosystems: a broad perspective
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Boerner, R.E., Huang, J. and Hart, S.C.	2009	Impacts of Fire and Fire Surrogate treatments on forest soil properties: a meta-analytical approach
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Cochrane, M.A., Moran, C.J., Wimberly, M.C., Baer, A.D., Finney, M.A., Beckendorf, K.L., Eidenshink, J. and Zhu, Z.	2012	Estimation of wildfire size and risk changes due to fuels treatments
Cohen, J.D.	2004	Relating flame radiation to home ignition using modeling and experimental crown fires
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Cooper, C.F.	1961	Controlled burning and watershed condition in the White Mountains of Arizona
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Covington, W.W. and Moore, M.M.	1994	Southwestern ponderosa forest structure: changes since Euro-American settlement
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Fight, Roger D. and Barbour, R. James	2006	Financial analysis of fuel treatments on national forests in the Western United States
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Fischer, A.P. and Charnley, S.	2012	Risk and cooperation: managing hazardous fuel in mixed ownership landscapes
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Meyer, G.A., Pierce, J.L., Wood, S.H. and Jull, A.T.	2001	Fire, storms, and erosional events in the Idaho batholith
Mhawej, M., Faour, G. and Adjizian-Gerard, J.	2015	Wildfire likelihood’s elements: A literature review
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Miller, C. and Urban, D.L.	2000	Modeling the effects of fire management alternatives on Sierra Nevada mixed-conifer forests

Author	Year	Title
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Moghaddas, J.J. and Craggs, L.	2008	A fuel treatment reduces fire severity and increases suppression efficiency in a mixed conifer forest
Moghaddas, J.J., Collins, B.M.,Menning, K., Moghaddas, E.E. and Stephens, S.L.	2010	Fuel treatment effects on modeled landscape-level fire behavior in the northern Sierra Nevada
Moore, M.M., Wallace Covington, W. and Fulé, P.Z.	1999	Reference conditions and ecological restoration: a southwestern ponderosa pine perspective
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Naeher, L.P., Brauer, M., Lipsett, M.,Zelikoff, J.T., Simpson, C.D., Koenig, J.Q. and Smith, K.R.	2007	Woodsmoke health effects: a review
Nagy, R., Fusco, E., Bradley, B.,Abatzoglou, J.T. and Balch, J.	2018	Human-related ignitions increase the number of large wildfires across US ecoregions
Narayan, C., Fernandes, P.M., van Brusselen, J. and Schuck, A.	2007	Potential for CO2 emissions mitigation in Europe through prescribed burning in the context of the Kyoto Protocol
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National Wildfire Coordinating Group	2014	Fire behavior field reference guide

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North, M., Collins, B.M. and Stephens, S.	2012	Using fire to increase the scale, benefits, and future maintenance of fuels treatments
North, M.P. and Hurteau, M.D.	2011	High-severity wildfire effects on carbon stocks and emissions in fuels treated and untreated forest
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O'Connor, C.D. and Calkin, D.E.	2019	Engaging the fire before it starts: a case study from the 2017 Pinal Fire (Arizona)
Omi, P.N., Martinson, E.J. and Chong, G.W.	2006	Effectiveness of pre-fire fuel treatments
Omi, P.N.	2015	Theory and practice of wildland fuels management
Parisien, M.A., Snetsinger, S., Greenberg, J.A., Nelson, C.R., Schoennagel, T., Dobrowski, S.Z. and Moritz, M.A.	2012	Spatial variability in wildfire probability across the western United States
Parkinson, T.M., Force, J.E. and Smith, J.K.	2003	Hands-on learning: its effectiveness in teaching the public about wildland fire
Parks, S.A., Holsinger, L.M., Miller, C. and Nelson, C.R.	2015	Wildland fire as a self-regulating mechanism: the role of previous burns and weather in limiting fire progression
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Author	Year	Title
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Parrish, J.D., Braun, D.P. and Unnasch, R.S.	2003	Are we conserving what we say we are? Measuring ecological integrity within protected areas
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Peterson, J., Lahm, P., Fitch, M., George, M., Haddow, D., Melvin, M., Hyde, J. and Eberhardt, E.	2018	NWCG smoke management guide for prescribed fire
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Author	Year	Title
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Reinhardt, E., Lutes, D. and Scott, J.	2006	FuelCalc: A method for estimating fuel characteristics
Reinhardt, E.D., Keane, R.E., Calkin, D.E. and Cohen, J.D.	2008	Objectives and considerations for wildland fuel treatment in forested ecosystems of the interior western United States
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Ritchie, M.W., Skinner, C.N. and Hamilton, T.A.	2007	Probability of tree survival after wildfire in an interior pine forest of northern California: effects of thinning and prescribed fire
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Rocca, M.E., Brown, P.M., MacDonald, L.H. and Carrico, C.M.	2014	Climate change impacts on fire regimes and key ecosystem services in Rocky Mountain forests
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Author	Year	Title
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Rummer, R.B.	2005	A strategic assessment of forest biomass and fuel reduction treatments in western states
Safford, H.D., Schmidt, D.A. and Carlson, C.H.	2009	Effects of fuel treatments on fire severity in an area of wildland–urban interface, Angora Fire, Lake Tahoe Basin, California
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Schultz, C.A. and Moseley, C.	2019	Collaborations and capacities to transform fire management
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Author	Year	Title
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Thomas, D.S. and Butry, D.T.	2014	Areas of the US wildland–urban interface threatened by wildfire during the 2001–2010 decade
Thompson, M. and Anderson, N.	2015	Modeling fuel treatment impacts on fire suppression cost savings: A review
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Thompson, M.P., Vaillant, N.M., Haas, J.R., Gebert, K.M. and Stockmann, K.D.	2013	Quantifying the potential impacts of fuel treatments on wildfire suppression costs
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United States Government Accountability Office (GAO)	2015	Wildland fire management: agencies have made several key changes but could benefit from more information about effectiveness
USDA Forest Service, Rocky Mountain Research Station	2004	Fuels planning: science synthesis and integration
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Vasilakos, C., Kalabokidis, K.,Hatzopoulos, J., Kallos, G. and Matsinos, Y.	2007	Integrating new methods and tools in fire danger rating
Veblen, T.T., Kitzberger, T. and Donnegan, J.	2000	Climatic and human influences on fire regimes in ponderosa pine forests in the Colorado Front Range
Venn, T.J. and Calkin, D.E.	2011	Accommodating non-market values in evaluation of wildfire management in the United States: challenges and opportunities
Wade, D.D.	1989	A guide for prescribed fire in southern forests
Wagner, C.V.	1973	Height of crown scorch in forest fires
Waldrop, T., and Goodrick, S.	2012	Introduction to prescribed fires in Southern ecosystems
Warziniack, T. and Thompson, M.	2013	Wildfire risk and optimal investments in watershed protection
Weatherspoon, C.P. and Skinner, C.N.	1996	Fire-silviculture relationships in Sierra forests
Weaver, H.	1943	Fire as an ecological and silvicultural factor in the ponderosa-pine region of the pacific slope
Wells, C.G.	1979	Effects of fire on soil: a state-of-knowledge review (No
Westerling, A.L., Hidalgo, H.G., Cayan, D.R. and Swetnam, T.W.	2006	Warming and earlier spring increase western US forest wildfire activity
Wiedinmyer, C. and Hurteau, M.D.	2010	Prescribed fire as a means of reducing forest carbon emissions in the western United States
Willis, J., Roberts, S., and Harrington, C.	2018	Variable density thinning promotes variable structural responses 14 years after treatment in the Pacific Northwest
Wimberly, M.C., Cochrane, M.A., Baer, A.D. and Pabst, K.	2009	Assessing fuel treatment effectiveness using satellite imagery and spatial statistics

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Wolk, BH, Stevens-Rumann, CS, Battaglia, MA, Wennogle, C, Dennis, C, Feinstein, JA, Garrison, K, and Edwards, G.	2020	Mulching: A knowledge summary and guidelines for best practices on Colorado's Front Range
Wondzell, S.M. and King, J.G.	2003	Postfire erosional processes in the Pacific Northwest and Rocky Mountain regions
Wotton, B.M.	2009	Interpreting and using outputs from the Canadian Forest Fire Danger Rating System in research applications
Wright, C.S. and Agee, J.K.	2004	Fire and vegetation history in the eastern Cascade Mountains, Washington
Wurtzebach, Z. and Schultz, C.	2016	Measuring ecological integrity: history, practical applications, and research opportunities
Yager, L.Y., HEISE, C.D., EPPERSON, D.M. and HINDERLITER, M.G.	2007	Gopher tortoise response to habitat management by prescribed burning
Yoder, J. and Gebert, K.	2012	An econometric model for ex ante prediction of wildfire suppression costs
Youngblood, A., Grace, J.B. and McIver, J.D.	2009	Delayed conifer mortality after fuel reduction treatments: interactive effects of fuel, fire intensity, and bark beetles
Youngblood, A.	2010	Thinning and burning in dry coniferous forests of the western United States: effectiveness in altering diameter distributions

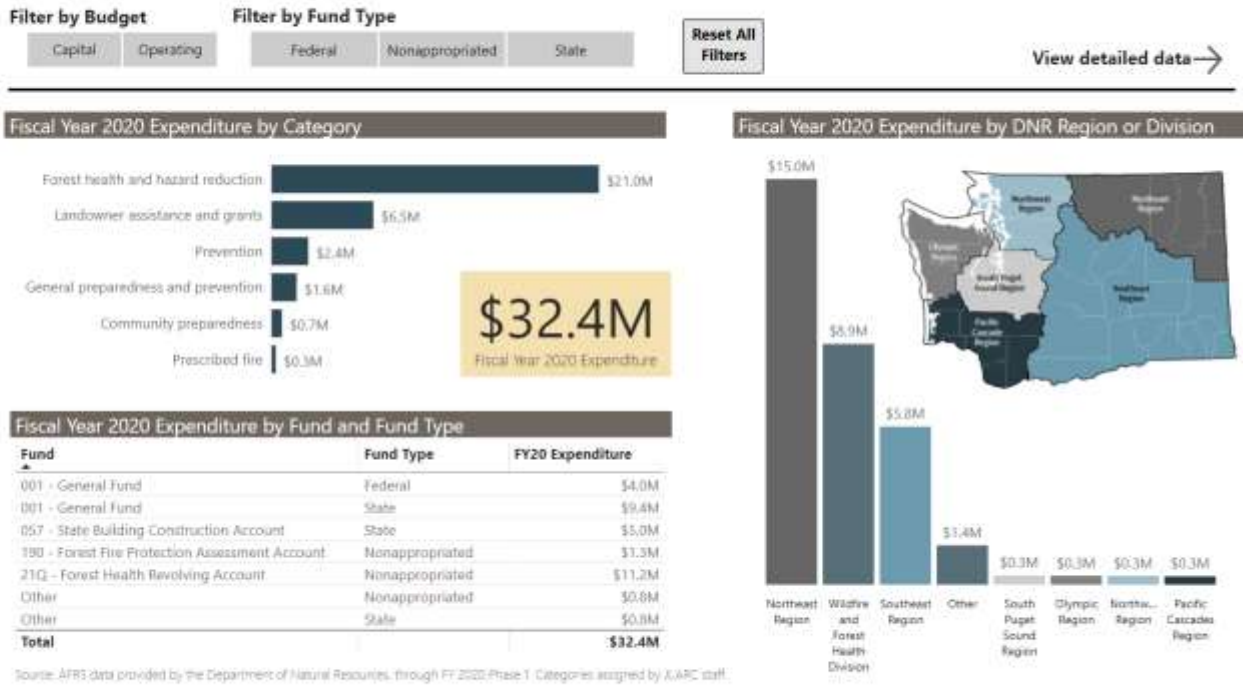
REPORT DETAILS

Appendix B: Fiscal year 2020 expenditure detail

Interactive dashboard of DNR's spending in FY 20

The Department of Natural Resources (DNR) uses budget codes to track expenditure data. The tool below provides additional information about DNR's spending in fiscal year 2020.

Click image to go to interactive report.



Fund	Fund Type	FY20 Expenditure
001 - General Fund	Federal	$4.0M
001 - General Fund	State	$9.4M
057 - State Building Construction Account	State	$5.0M
19O - Forest Fire Protection Assessment Account	Nonappropriated	$1.3M
21Q - Forest Health Revolving Account	Nonappropriated	$11.2M
Other	Nonappropriated	$0.8M
Other	State	$0.8M
Total		**$32.4M**

Source: AFRS data provided by the Department of Natural Resources, through FY 2020 Phase 1. Categories assigned by JLARC staff.

Source: AFRS data provided by DNR and summarized for presentation by JLARC staff. Data is accurate as of Phase 1 fiscal year close.

RECOMMENDATIONS & RESPONSES

No Legislative Auditor Recommendations

The Legislative Auditor did not issue recommendations for this study

The agencies and institutions involved with this study were given an opportunity to respond to the content of this report.

Department of Natural Resources Response

DEPARTMENT OF NATURAL RESOURCES
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December 7, 2020

Keenan Konopaski
Legislative Auditor
Joint Legislative Audit & Review Committee
PO Box 40910
Olympia, WA 98504-0910

Dear Mr. Konopaski,

Thank you for the opportunity to provide the Department of Natural Resources' (DNR) formal response to the Joint Legislative Audit and Review Committee's (JLARC) *Wildfire Prevention, Preparedness, and Expenditure Review*. On behalf of DNR, I want to thank you, and your team, for exemplary work in producing this review. This letter comprises DNR's formal response to JLARC's preliminary report; beyond my remarks below, DNR does not have any substantive comments to make or positions to offer.

I was delighted to read your overall conclusion that "DNR's long-term approach to wildfire and preparedness is supported by science and best practices. The approach requires coordination with other entities and can reduce fire severity, which may impact costs to suppress fires."

As your review highlights, with support from the Legislature, DNR can continue to strategically invest in practices that are supported scientifically and also result in real change on the ground, ultimately reducing the impacts from wildfire and affecting positive outcomes for people, communities and natural resources all across our state.

At the same time, we recognize the importance of ensuring our fiscal practices keep pace with the significant work DNR is accomplishing with landowners, partners, tribes and environmental organizations to bend the curve of wildfire costs and losses in Washington. Our goal is always to make wise and informed decisions about where to invest scarce resources, while striving to protect people and our natural resources.

Thank you again for the great work by you and your team. Staff here at DNR have expressed that it was a pleasure to coordinate with the JLARC review team, and have said your team was diligent in understanding the complexities of the work DNR must carry out, and it shows.

Thank you for this opportunity to comment on this review.

Sincerely,

Hilary S. Franz
Commissioner of Public Lands

RECOMMENDATIONS & RESPONSES

Office of Financial Management Response

The Office of Financial Management (OFM) was given an opportunity to comment on this report. OFM responded that it does not have any comments.

MORE ABOUT THIS REVIEW

Audit Authority

The Joint Legislative Audit and Review Committee (JLARC) works to make state government operations more efficient and effective. The Committee is comprised of an equal number of House members and Senators, Democrats and Republicans.

JLARC's non-partisan staff auditors, under the direction of the Legislative Auditor, conduct performance audits, program evaluations, sunset reviews, and other analyses assigned by the Legislature and the Committee.

The statutory authority for JLARC, established in Chapter 44.28 RCW, requires the Legislative Auditor to ensure that JLARC studies are conducted in accordance with Generally Accepted Government Auditing Standards, as applicable to the scope of the audit. This study was conducted in accordance with those applicable standards. Those standards require auditors to plan and perform audits to obtain sufficient, appropriate evidence to provide a reasonable basis for findings and conclusions based on the audit objectives. The evidence obtained for this JLARC report provides a reasonable basis for the enclosed findings and conclusions, and any exceptions to the application of audit standards have been explicitly disclosed in the body of this report.

MORE ABOUT THIS REVIEW
Study Questions

Washington JLARC

PROPOSED STUDY QUESTIONS
Wildfire Prevention, Preparedness, and Expenditure Review

State of Washington Joint Legislative Audit and Review Committee — April 2020

JLARC directed a study of DNR's wildfire prevention and preparedness activities and expenditures

The Department of Natural Resources (DNR) includes wildfire prevention and preparedness activities in many of its planning documents. The intent of these activities is to reduce the risk of wildfire. Examples include public education, landowner assistance, forest health assessments and treatment, fuel mitigation, good neighbor agreements, and fire adapted communities. DNR may work with other agencies and landowners to implement the plans.

In 2019, the Joint Legislative Audit and Review Committee directed its staff to review DNR's wildfire prevention and preparedness activities and related expenditures, and to identify if evidence exists about how effectively they reduce the risk of wildfire.

JLARC also directed its staff to evaluate DNR's progress in implementing recommendations from the 2018 JLARC report *Wildfire Suppression Funding and Costs*. The recommendations are focused on refining DNR's data collection and reporting efforts and improving its ability to identify the costs of individual fires.

Study will address DNR's activities, costs, and potential results

1. What fire prevention and preparedness activities is DNR planning and/or performing? How does DNR work with other agencies and landowners?
2. How does DNR track information about its activities and related spending? How does it use and report this information?
3. Does research identify certain types of activities that affect the number, size, and cost of wildland fires? How do the activities DNR is planning or performing align with those identified in the research?
4. What actions has DNR taken to fulfill the recommendations in JLARC's 2018 *Wildfire Suppression Funding and Costs* report to improve fire data collection and reporting?

Fire suppression and pre-suppression activities (e.g., staging resources) are not part this study.

Study Timeframe

Preliminary Report: December 2020 — Proposed Final Report: January 2021

Study Team

Team Lead	Casey Radostitz	(360) 786-5176	casey.radostitz@leg.wa.gov
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Legislative Auditor	Keenan Konopaski	(360) 786-5187	keenan.konopaski@leg.wa.gov

JLARC Study Process

Study Mandate (Budget, legislation, committee direction) → Proposed Study Questions → Legislative Auditor's Preliminary Report → Legislative Auditor's Proposed Final Report (Agency response included) → Final Report (Option to append committee comment)

Committee votes to distribute completed audit

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MORE ABOUT THIS REVIEW

Methodology

The methodology JLARC staff use when conducting analyses is tailored to the scope of each study, but generally includes the following:

- **Interviews** with stakeholders, agency representatives, and other relevant organizations or individuals.
- **Site visits** to entities that are under review.
- **Document reviews**, including applicable laws and regulations, agency policies and procedures pertaining to study objectives, and published reports, audits or studies on relevant topics.
- **Data analysis**, which may include data collected by agencies and/or data compiled by JLARC staff. Data collection sometimes involves surveys or focus groups.
- **Consultation with experts** when warranted. JLARC staff consult with technical experts when necessary to plan our work, to obtain specialized analysis from experts in the field, and to verify results.

The methods used in this study were conducted in accordance with Generally Accepted Government Auditing Standards.

More details about specific methods related to individual study objectives are described in the body of the report under the report details tab or in technical appendices.

CONTACT

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Lynda Wilson, Secretary

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Larry Hoff

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