2024

Forest Health Highlights in Washington

A summary of insect, disease, and other disturbance conditions affecting Washington's forests

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Main cover photo:
Western spruce budworm defoliation observed in 2024 in the North Cascade mountains (Desolation Ridge and Mt. Hozomeen).

Credit: Justin Hof / USFS

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A summary of insect, disease, and other disturbance conditions affecting Washington's forests

Washington State Department
of Natural Resources (DNR)
Forest Resilience Division
May 2025

Summary

This report summarizes insect, disease, and other disturbance conditions impacting Washington's forests in 2024 by compiling information from ground monitoring, field observations, and the annual insect and disease aerial detection survey (ADS).

In 2024, ADS surveyors flew approximately 22 million forested acres across Washington. This is the 78th year of interagency coordination between the USDA Forest Service (USFS) and Washington State Department of Natural Resources (DNR) on an annual insect and disease aerial detection survey (ADS). Since 1947, the two agencies and Oregon Department of Forestry have flown across millions of acres in Washington yearly to observe recently killed and currently damaged forest trees. This acreage represents the forested land in Washington, excluding large urban areas and restricted airspaces.

- **In 2024, the statewide insect and disease survey recorded some level of tree mortality, tree defoliation, or foliar disease on approximately 545,000 acres.** The area with damage from mortality agents was roughly 404,000 acres, including 270,000 acres attributed to bark beetles and 54,000 acres attributed to young conifer mortality (primarily bear damage or root disease). Approximately 110,000 acres with damage were attributed to defoliators while 31,000 acres were attributed to tree diseases or other damage causes. Previous annual totals for all damage agents were:

2023: 517,000 acres with damage out of approximately 22 million acres surveyed

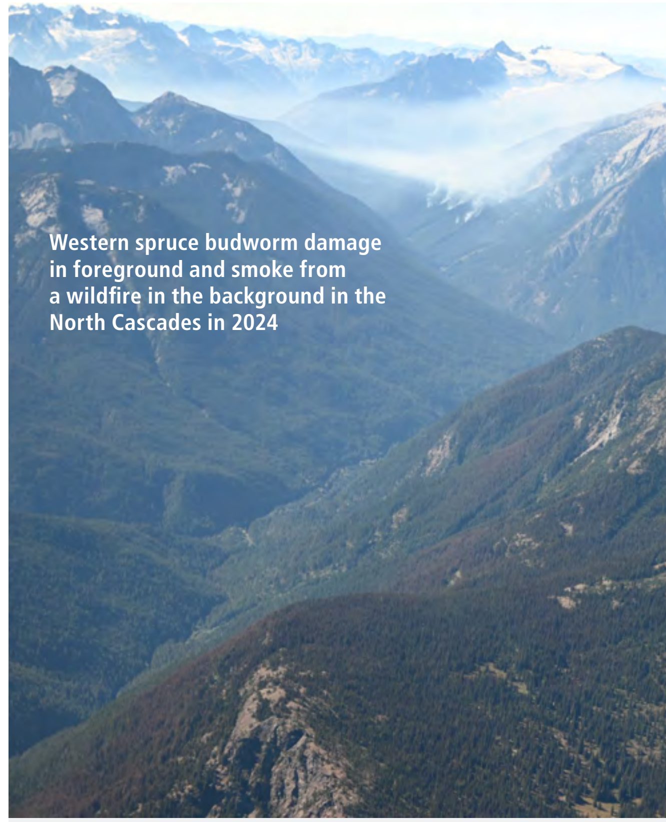
2022: 672,000 acres with damage out of approximately 22 million acres surveyed

2021: 555,000 acres with damage out of approximately 19 million acres surveyed

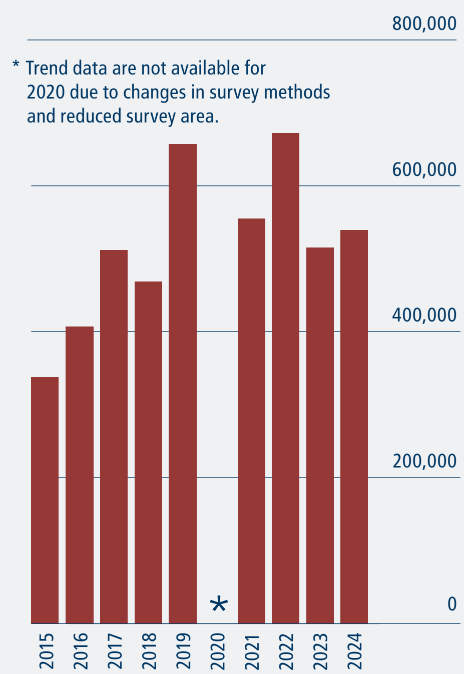
2020: 322,000 acres with damage out of approximately 10.5 million acres surveyed

2019: 658,000 acres with damage out of approximately 22 million acres surveyed

CREDIT: JUSTIN HOF / USFS



Western spruce budworm damage in foreground and smoke from a wildfire in the background in the North Cascades in 2024



CREDIT: ISAAC DAVIS / DNR

Figure 1.

TOTAL ACRES WITH INSECT AND DISEASE DAMAGE, 2015-2024

Recorded during annual aerial detection surveys

Washington experienced above average temperatures for the bulk of 2024, with some level of drought observed on most lands by fall.

- **Washington experienced above average temperatures for the majority of 2024, with some level of drought observed on most lands by fall.** Monthly average temperatures were consistently warmer than average, excluding May. Drought conditions developed throughout much of the state during the summer months before diminishing in fall and winter. Unusually dry and warm weather tends to increase tree stress and insect success.

- **Mountain pine beetle activity remains high in areas.** Mountain pine beetle damage decreased from 90,200 acres in 2023 to approximately 83,600 acres in 2024. The majority of annual pine bark beetle mortality is in lodgepole pine killed by mountain pine beetle, which totaled 67,300 acres in 2024 ADS Data. Surveyors mapped the highest concentrations of mountain pine beetle mortality in lodgepole at high elevation areas in Yakima, Kittitas, Chelan, Okanogan, Ferry, and Pend Oreille counties.

- **Western pine beetle also remains active.** Mortality of ponderosa pine due to western pine beetle was approximately 32,800 acres in 2024, similar to 2023 measurements but still above the 10-year average (ADS data). Recent drought conditions have driven a steady increase in western pine beetle damage since 2012, reaching a peak of approximately 44,300 acres in 2022, the highest level recorded since 2006. Concentrations of mortality were widespread throughout lower elevation forested areas of eastern Washington, but damage was especially severe in Klickitat County and western Yakima County.

- **Pine mortality attributed to California fivespined Ips continued to be elevated in urban forest settings in the Puget Sound area.** Affected host trees include shore pine, ponderosa pine, western white pine, and Austrian pine.

- **The area with Douglas-fir beetle damage continued to decrease to approximately 42,800 acres in 2024 and is now below the 10-year average of 51,900 acres (ADS data).** Mortality due to Douglas-fir beetle had been increasing in recent years, reaching a recent peak of 105,000 acres in 2022, the highest level recorded since 2001.

- **Fir engraver damage decreased but remains high.** Fir engraver has been increasing since 2015 and reached a 10-year high of 166,300 acres in 2019. Following a drop to 52,500 acres in 2021, the upward trend resumed with an increase in 2023 to 99,000 acres. In 2024, the number of acres affected decreased to approximately 80,500 acres but remains above the 10-year average of 69,300 acres (ADS data).

- **A new outbreak of western spruce budworm (WSB) defoliation has developed in the North Cascades, east of Ross Lake in Whatcom, Skagit, and Okanogan counties, affecting approximately 63,500 acres in 2024.** Outbreaks of this native defoliator are not unusual in Washington. This outbreak is currently smaller than the last significant western spruce budworm outbreak in 2011 and 2012, which impacted more than 500,000 acres in the central Washington Cascades. A separate outbreak of **western blackheaded budworm** has developed farther west in Whatcom County, north of Mt. Baker and west of Ross Lake, affecting approximately 9,400 acres primarily in Pacific silver fir and western hemlock.

- **No notable changes regarding *Phytophthora ramorum,* the causal agent of sudden oak death, were observed.** *Phytophthora ramorum* may be found in streams associated with commercial nursery plant trade activity, but there has yet to be any indication that the pathogen is leaving the waterways and impacting bordering vegetation, nor has it been identified in streams not associated with commercial nursery trade activity. No stream sampling locations tested positive for *Phytophthora ramorum* in 2024.

- **Surveys monitoring Swiss needle cast, a native foliar disease of Douglas-fir, indicate no consequential change.** Aerial observers conducted a Swiss needle cast aerial survey in April and May 2024, covering 2.1 million acres along the Pacific coastline. Approximately 50,000 acres with symptoms associated with Swiss needle cast were observed. Ground locations along the coast in addition to areas in Whatcom and Skagit counties were surveyed to support the aerial survey. Findings from both surveys indicate normal or low levels of symptoms and disease.

Abiotic Disturbances

Abiotic disturbances—disturbances caused by non-living factors—are a natural and integral part of forest ecosystems. They are responsible for both positive and negative changes to our forests. They influence forest structure, composition, and function, and can be important for maintaining biological diversity and facilitating regeneration. Abiotic disturbances such as wildfire, drought, landslides, flooding, and other extreme weather events can cause tree mortality at both small and large scales. Surviving trees may be damaged or weakened by these events.

These abiotic disturbances can also influence forests by making them more susceptible to attacks by insects and pathogens. For example, bark beetles can take advantage of large areas of dead and damaged trees leading to beetle outbreaks that can kill healthy trees. Symptoms caused by root disease and other pathogens may also increase when tree defenses are compromised. Foliar pathogens, such as needle casts and blights, may become more common in years with abundant spring precipitation and mild temperatures.

The following section is a summary of recent weather, drought, and wildfire events that may influence forest health conditions in Washington.

CREDIT: BETSY GOODRICH / USFS

Western hemlock dieback near Middle Fork Snoqualmie campground associated with a combination of Heterobasidion root disease and drought

Figure 2.

WASHINGTON STATE PRECIPITATION

Statewide average 2024 monthly precipitation departure compared to normal (1901-2000 mean)

SOURCE: NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION (https://www.ncei.noaa.gov/)

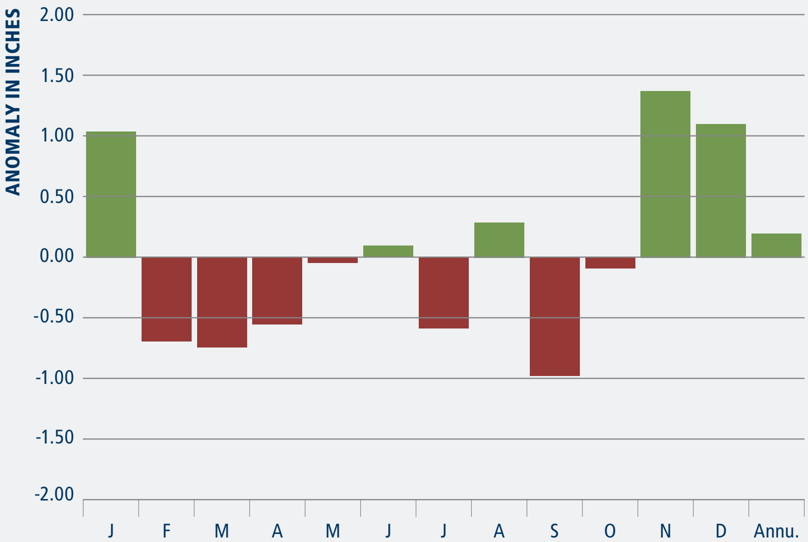
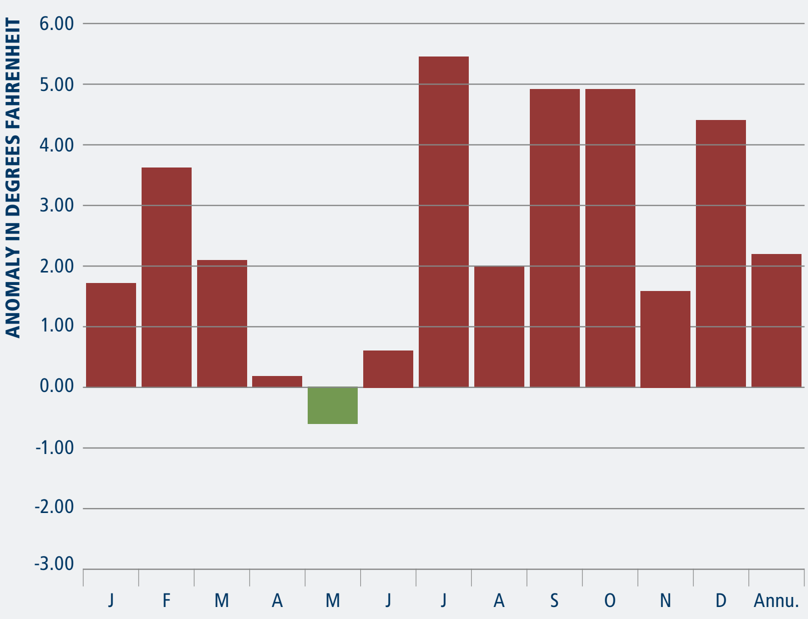


Figure 3.

WASHINGTON STATE MEAN TEMPERATURES

Statewide average 2024 monthly temperature departure compared to normal (1901-2000 mean)

SOURCE: NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION (https://www.ncei.noaa.gov/)



Weather & Climate

When assessing forest health in Washington, it is important to differentiate between the impacts of weather from the impacts of climate. Weather impacts to forest health are produced by distinct events, a result of short-term variability in the atmosphere. Windstorms, heat waves, and atmospheric rivers are all examples of weather events that can directly affect forested ecosystems. The impacts of climate, on the other hand, are due to long-term weather trends within the region, such as rising average temperatures, decreasing summertime precipitation, and increasing susceptibility to long-term drought.

The main climate takeaway for Washington in 2024 was the continuation of long-term warming trends. For the third time in four years, the annual average temperature in Washington was among the 10 warmest on record; May was the only month that recorded below average temperatures. Meanwhile, July and September were each among the five warmest of their respective months on record. The primary weather impacts from temperature in 2024 were concentrated around a July heatwave responsible for 338 daily record high temperatures across the 131 official weather reporting stations statewide.

Precipitation trends in 2024 were heavily influenced by three distinct events: two in late spring and one in late summer. The timing and location of the heaviest rainfall directly influenced how drought conditions developed across the state through the summer and how drought conditions waned into the fall and winter. Further discussion on the evolution of drought conditions through 2024 is included next.

CREDIT: RACHEL BROOKS / DNR

Typical top-down dieback, thinning, and reduced growth caused by drought stress on Douglas-fir

CREDITS: DARCI DICKINSON / USFS

Above: Late spring frost damage on a Douglas-fir tree in the Buckhorn area of the Colville National Forest in 2024

Left: Late spring frost damage on a Douglas-fir tree in the Yakama Indian Reservation in 2024

Drought

Drought conditions were improving across the state at the beginning of 2024 and reached the lowest levels of the year in early February. At that time, no measurable drought was present in 78% of the state, while Moderate Drought was observed in a few small pockets along the east slopes of the Cascades and Severe Drought was measured in a small sliver of far northeast Washington. Drought conditions slowly began to worsen in March and April as both months ended with below average precipitation statewide.

Significant geographic variation in drought conditions across the state began to emerge in the early summer months. Two heavy rain events, one in early May and one in early June, impacted Washington such that areas along and west of the Cascade crest received significant precipitation while areas east of the Cascade crest were left dry. This directly contributed to the development of Severe Drought conditions by late June along the east slopes of the Cascades, while at the same time the majority of western Washington remained drought free.

Above average temperatures across the state in July and through the first half of August exacerbated existing drought conditions in eastern Washington, with the highest statewide drought severity of the year being observed in mid-August. At that time, Extreme Drought was observed across a large swath of forestland along the east slopes of the Cascades with Severe Drought extending eastward into the Columbia Basin. For western Washington, only small pockets of Moderate Drought were observed in the North Cascades and northern Olympic Mountains.

After reaching maximum drought severity in mid-August, a significant storm system brought heavy rain and thunderstorms to much of Washington during the last two weeks of August. This began a long-term decline in drought coverage and drought severity that lasted through the end of the calendar year. By the start of 2025, only 7% of the state remained in Moderate Drought.

The rapid increase in severe and extreme drought conditions along the east slopes of the Cascades was categorized by the Climate Prediction Center as the result of both short- and long-term drought development. Short-term droughts typically last fewer than six months and mostly impact agriculture and grasslands, while long-term droughts impact hydrology and forest ecology. The long-term impacts of drought in Washington are primarily due to the increasing recurrence of Severe and Extreme summertime droughts in the Cascade Mountains, regardless of short-term relief that has been common in the winter months.

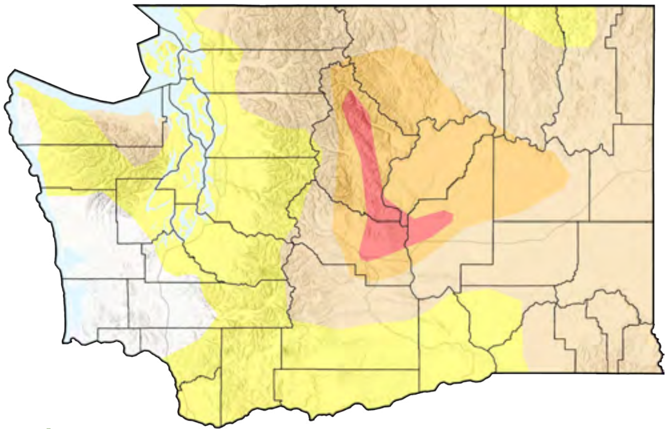


Figure 4.

DROUGHT CONDITIONS IN MID-AUGUST, THE HIGHEST STATE-WIDE DROUGHT SEVERITY OF 2024

No Intensity
Abnormally Dry
Moderate Drought
Severe Drought
Extreme Drought

SOURCE: US DROUGHT MONITOR (https://droughtmonitor.unl.edu)

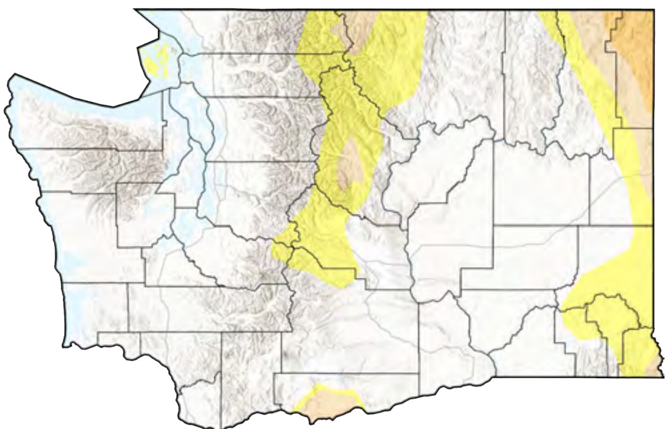


Figure 5.

DROUGHT CONDITIONS IN EARLY FEBRUARY, THE LOWEST STATE-WIDE LEVELS OBSERVED IN 2024

No Intensity
Abnormally Dry
Moderate Drought
Severe Drought
Extreme Drought

SOURCE: US DROUGHT MONITOR (https://droughtmonitor.unl.edu)

Drought classifications and status described above are based on the US Drought Monitor (https://droughtmonitor.unl.edu/About/AbouttheData/DroughtClassification.aspx).

Wildfire

Washington's 2024 fire season started off in moderate conditions, without many early-season fires. A series of low-pressure weather systems cycled through the state from April through June, bringing rain that maximized the green-up period and gave vegetation high levels of live fuel moisture by the beginning of July. Through the summer, fire activity and resulting initial attack increased in part due to thunderstorms abundant with lightning. In 2024, Washington experienced fewer acres burned and fewer fire occurrences than the previous 10-year average.

Critical fire weather days during 2024 fire season peaked between the beginning of July and the first two weeks of August, earlier than a typical fire season. The hot and dry conditions, during the peak of fire season in July and early August gave way to cooler air and increased moisture that began working into the region by the middle of August.

By September 30, 24 significant fires had occurred on DNR jurisdiction or which saw DNR involvement because of a threat to DNR jurisdiction. The majority met the requirements for "large" fire designations, which are typically fires that are greater than 100 acres in timber or 300 acres in grass. In 2024, DNR recorded total 188,558 acres burned across jurisdictions: 40 percent of the acres burned were on federal lands, 29 percent on private and state lands, and 31 percent on tribal land. 68,100 acres burned were forested.

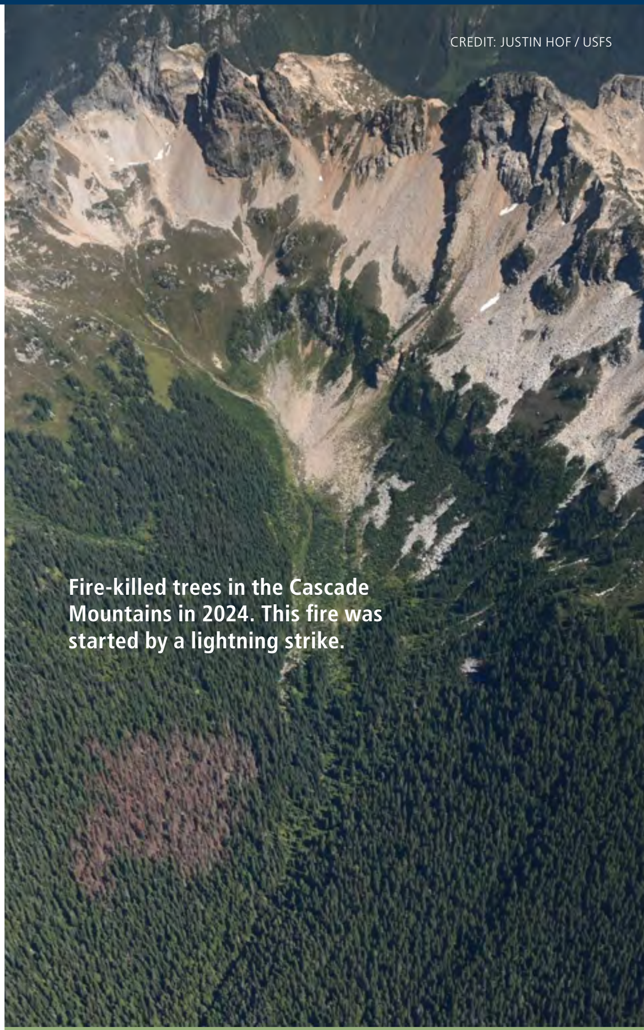
Four significant incidents occurred in eastern Washington which required mobilization of out-of-state resources: The Pioneer, Swawilla I, Cougar Creek, and Retreat Fires. Statewide, the Retreat Fire burned the most forested acres (~21,540) and Swawilla I Fire burned the most non-forested acres (38,260).

Western Washington had few large fires in 2024, considering the persistent drought conditions in the North Cascades and Olympic Mountains leading up to the fire season. Western Washington was lightly impacted due to successful initial attack and use of specialized aviation resources.

Human-caused ignitions were the top cause of wildfires responded to by DNR. As of September 30, debris and open burning were once again the most common confirmed source of human-caused fire. The second highest source of confirmed starts were equipment and vehicle usage. Natural causes, including lightning strikes, accounted for the third most common confirmed source of wildfires statewide.

This report relies on data prepared and provided by our colleagues in the Wildland Fire Management Division in their annual ***Wildfire Summary Report**** *to the legislature.*

* https://www.dnr.wa.gov/publications/rp_fire_leg_24.pdf



CREDIT: JUSTIN HOF / USFS

Fire-killed trees in the Cascade Mountains in 2024. This fire was started by a lightning strike.

Critical fire weather days during 2024 fire season peaked between the beginning of July and the first two weeks of August, earlier than a typical fire season

Figure 6.

2024 LARGE FIRES OF CONCERN

Locations of large wildfires and other fires that occurred in Washington in 2024. Large fire names in text box.

DATA SOURCES: NATIONAL INCIDENT FEATURE SERVICE 2024 (NIFC), DNR FIRE STATISTICS 2024 (EIRS)

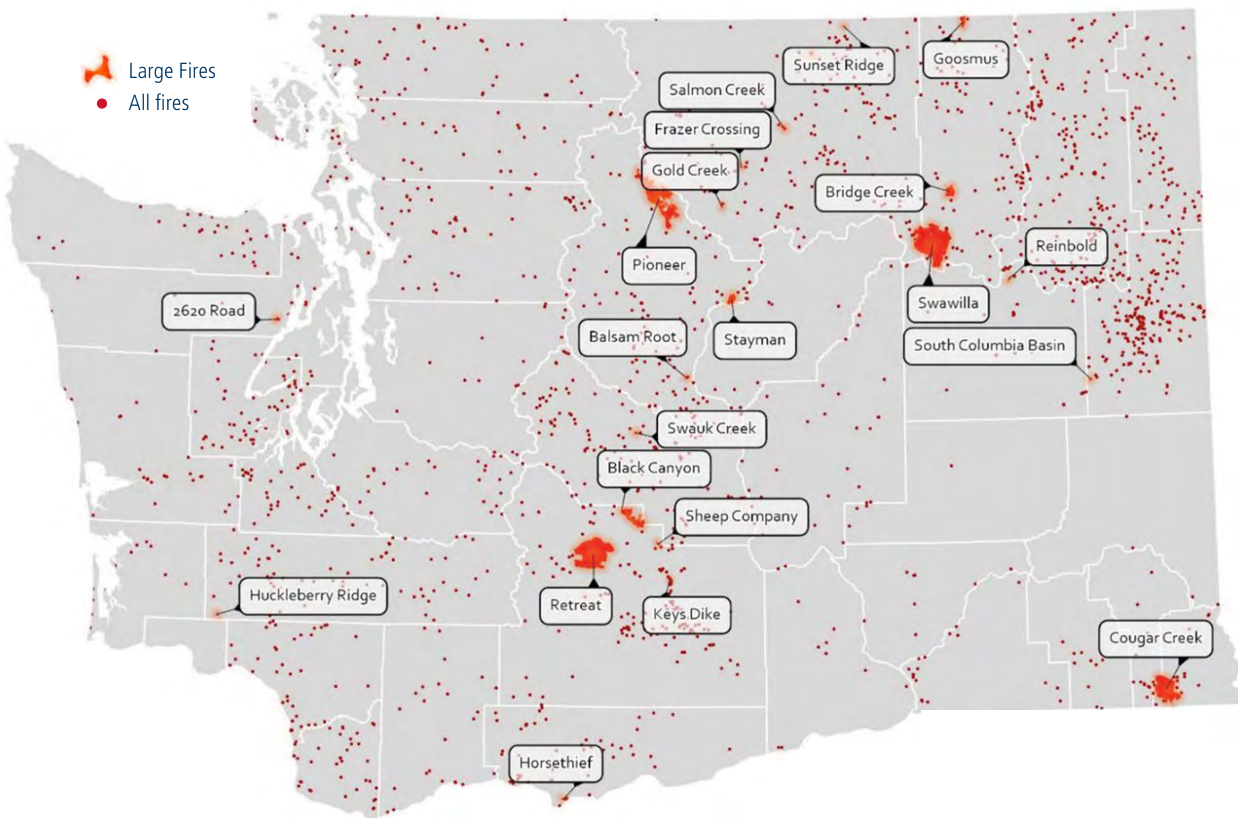
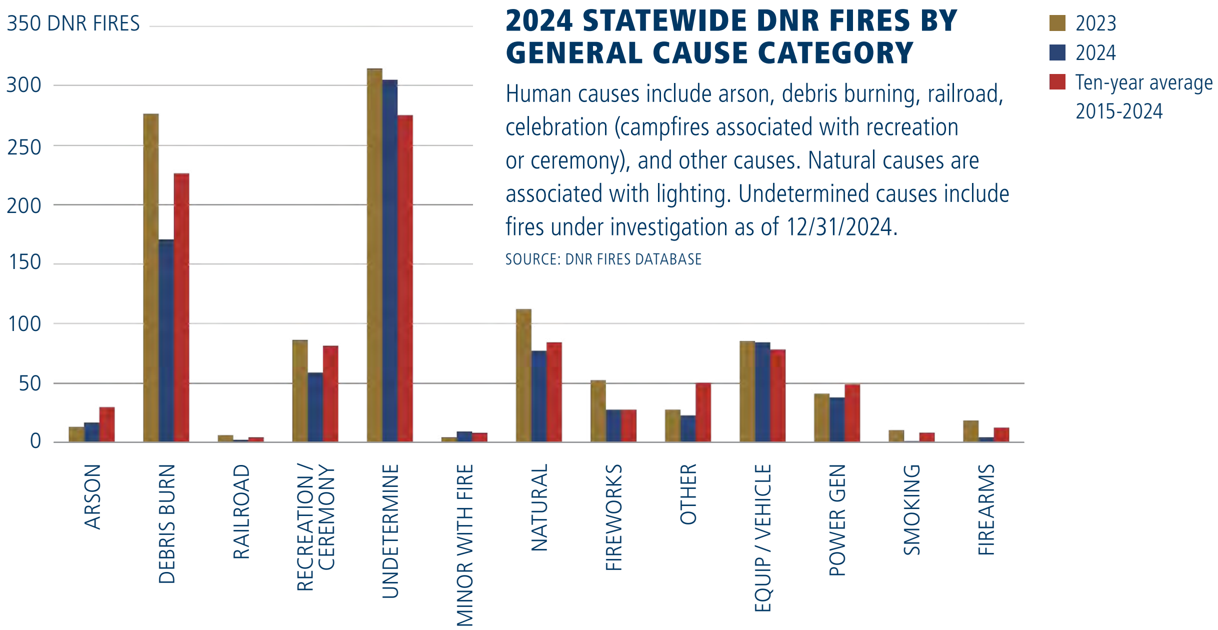


Figure 7.

2024 STATEWIDE DNR FIRES BY GENERAL CAUSE CATEGORY

Human causes include arson, debris burning, railroad, celebration (campfires associated with recreation or ceremony), and other causes. Natural causes are associated with lighting. Undetermined causes include fires under investigation as of 12/31/2024.

SOURCE: DNR FIRES DATABASE



CREDIT: GARRETT MEIGS / DNR

South Gifford Pinchot Forest Collaborative meeting in the Little White Salmon Priority Planning Area, Gifford Pinchot National Forest

CREDIT: ANDREW SPAETH / DNR

Thinning project in the Drano Lake area near Underwood, Washington on USDA Forest Service Columbia River Gorge National Scenic Area land. The project was administered through a State and Federal partnership.

WASHINGTON'S FOREST ACTION PLAN UPDATE

Washington's Forest Action Plan is an overarching strategic plan that offers proactive solutions to conserve, protect, and enhance the trees and forests that people and wildlife depend on.

The Forest Action Plan includes a comprehensive review of forested conditions across the state and identifies 23 goals and more than 100 priority actions to address threats facing forests. This ambitious statewide plan seeks to restore forest resilience and advance ecological, community, and socio-economic objectives.

Each state maintains a Forest Action Plan as required by the 2008 Farm Bill. The plan enables states to access funding for Cooperative Forestry Programs, including Forest Health Protection, a primary source of federal resources to support insect and disease monitoring in Washington. Funding is administered by the USFS in cooperation with state forest agencies such as DNR, to address forest health and threats facing forests.

Cooperative Forestry Programs include:

- **Community Forest and Open Space Conservation Program**
- **Forest Legacy Program**
- **Forest Health Protection**
- **Forest Stewardship**
- **Landscape Scale Restoration**
- **State Fire Assistance**
- **Urban and Community Forestry Program**
- **Volunteer Fire Assistance**

The most recent Washington State Forest Action Plan was published in 2020 and since then, DNR has produced annual reports summarizing key accomplishments and plan updates. The annual reports are available online at: https://www.dnr.wa.gov/ForestActionPlan

Forest Action Plans are required to be reviewed and revised every five years. In 2025, Washington will assess progress against the 2020 strategic plan goals and revise our Forest Action Plan to set goals that will maintain and improve our state's forests through 2030.

Tree planting demonstration for the City of Port Townsend led by DNR's Urban and Community Program Specialist Zeima Kassahun

CREDIT: ROBIN HILL / CITY OF PORT TOWNSEND

The Forest Action Plan includes a comprehensive review of forested conditions across the state and identifies 23 goals and more than 100 priority actions to address threats facing forests

Aerial Detection Survey

The insect and disease aerial detection survey (ADS) is a comprehensive monitoring strategy designed to evaluate the current health of forestlands across the contiguous United States, Alaska, and Hawaii. In Washington, ADS is a cooperative effort between the USFS and DNR. The two agencies have a longstanding agreement to share the responsibility equally by documenting tree mortality and decline throughout the state and reporting findings to federal, state, tribal, and private cooperators.

ADS data are helpful for a variety of practical applications beyond the tracking of endemic and invasive insect outbreaks and foliar diseases. The data are also used to monitor changes in environmental trends, advance scientific research, communicate wildfire risk to local communities, and guide contemporary forest management practices.

ADS is conducted annually between the months of June and September when forest damage is most easily identified. A special survey is conducted biannually along coastal Washington in late April and May when a native foliar disease of Douglas-fir called Swiss needle cast (SNC) is most apparent. In 2024, the Washington ADS program completed both surveys.

The 2024 ADS season marked the third consecutive year all 22 million acres of forestland in Washington were surveyed following a two-year gap where ADS efforts were interrupted by the COVID-19 pandemic or restricted due to limited personnel and aircraft resources. DNR was able to address its staffing shortage in 2022 and currently has one full-time aerial observer/fixed-wing flight manager, two fully trained aircrew members, and one trainee. With a second full-time fixed-wing flight manager employed by the USFS, the multi-agency ADS program is poised to continue reaching annual monitoring goals while supporting forest health initiatives throughout Washington.

CREDITS: RACHEL BROOKS / DNR

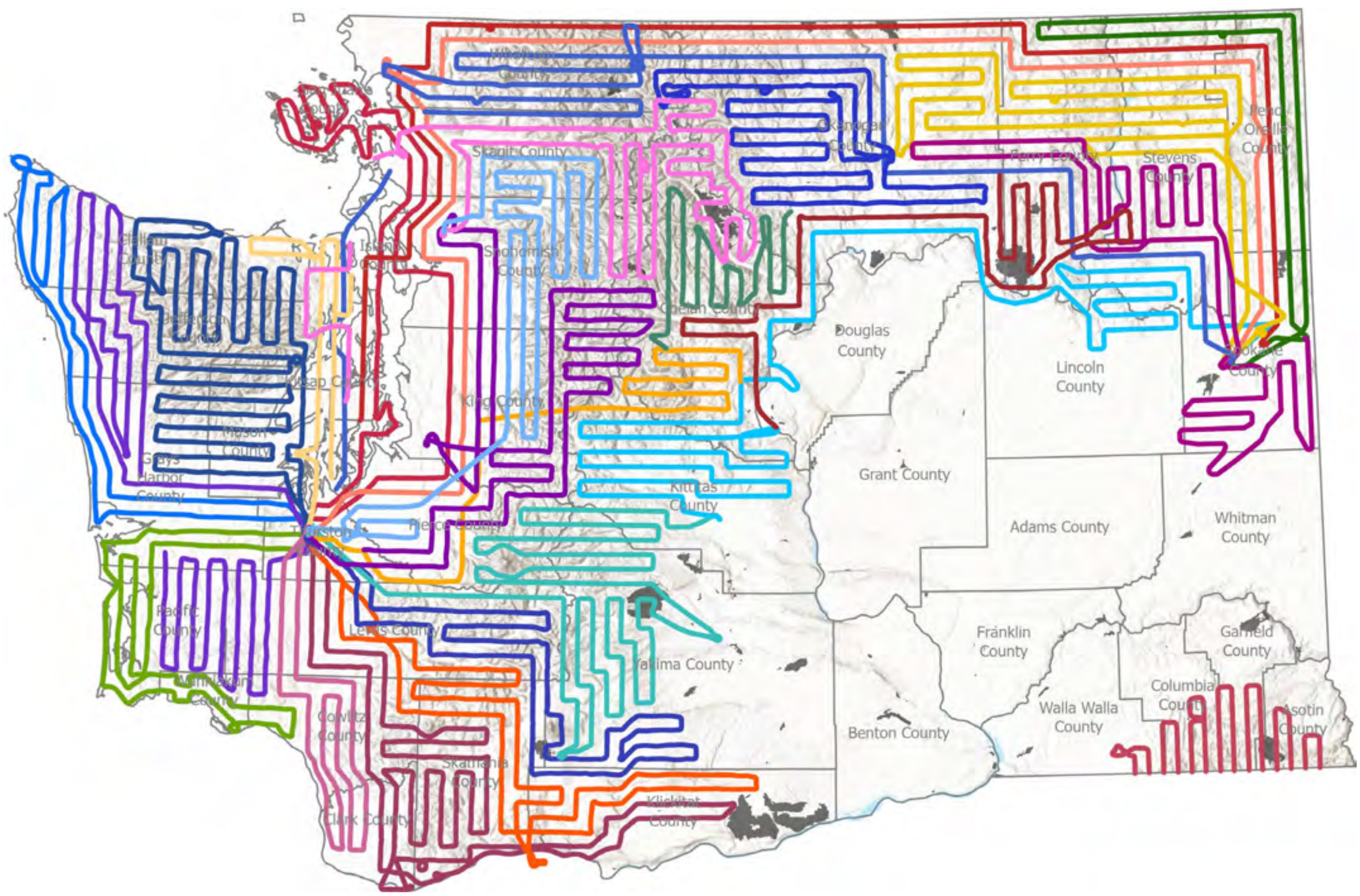
View of the North Cascades Mountains as seen by Isaac Davis, DNR's aerial detection surveyor (ADS)

Figure 8.

2024 | WASHINGTON AERIAL DETECTION SURVEY FLIGHT LINES

Urbanized land and unforested areas are not flown during ADS

SOURCE: DNR, USFS



FLIGHT DATES

07/01/24	07/23/24	08/13/24
07/02/24	07/24/24	08/14/24
07/03/24	07/25/24	08/15/24
07/08/24	07/26/24	08/21/24
07/09/24	08/05/24	08/27/24
07/10/24	08/06/24	08/28/24
07/11/24	08/07/24	08/29/24
07/12/24	08/08/24	08/30/24
07/15/24	08/12/24	2023–24 Fires

In 2024, the Washington ADS program saw some of its greatest achievements in over a decade

In 2024, the Washington ADS program saw some of its greatest achievements in over a decade. Survey missions began in late April and continued through May with the biannual SNC survey along the coast. Despite heavy cloud coverage and hindering weather patterns including uncharacteristically few days of sunshine, DNR's ADS team successfully surveyed 2.1 million acres of coastal forest. The 2024 general survey began July 1 and ended promptly on August 30. Typical survey seasons continue throughout September, occasionally spilling into early October, but this year's general survey took the shortest amount of time to complete compared to recent years.

The benefit to the ADS program of this early completion date was twofold:

1) more time was dedicated to follow-up ground checks of mapped ADS damage ensuring the quality and accuracy of data collected, and

2) fixed-wing flight managers were able to plan several post-season training flights to revisit areas with landscape-wide insect and disease outbreaks while aerial signatures were still present

Forest Pathologist Rachel Brooks completed their ADS training in 2024, and Forest Entomologist Dana Brennan began training. The majority of ADS flights in 2024 were completed using WDFW's Partenavia and pilot, a resource critical for this year's success.

The Washington Wildland Fire Management Division (WFMD) aviation program acquired two Kodiak K100 aircraft in 2023 to meet the needs of state-led wildfire operations. These modern aircraft are ideal for ADS and ADS-training purposes. In 2024, WFMD assisted in a week-long, interagency ADS training event hosted by the USFS in Redmond, Oregon and attended by ADS specialists and trainees from across the nation. WFMD also flew the post-season quality assurance/quality control flights mentioned above.

WFMD will be a critical resource for this program in the years ahead, and a cooperative agreement between the Washington ADS program and WFMD to support ADS mission objectives is in the draft stages.

Adverse weather and large-scale wildfire activity are generally unsuitable for aerial survey and frequently interrupt planned flight missions. Such events often coincide with the months insect and disease damage signatures are most vibrant. Smoke and low hanging clouds reduce visibility, threatening the safety of ADS personnel and compromising the accuracy of ADS data collected. Weather and wildfire events in 2024 had relatively less impact on ADS operations when compared to previous years, thanks to the dedication and flexibility of ADS personnel.

Deviations from planned flight routes due to weather and wildfire concerns did occur in 2024, however, program efficiency and the availability of contracted aircrafts allowed for flexibility throughout the season. Urgency to complete the survey in time was nonexistent, so areas affected by wildfire were revisited once mitigation efforts prevailed. Contingency plans in locations known for unpredictable weather shifts allowed forward progress while target survey areas became reprioritized.

For an in-depth description of the methods used to survey forestland in Washington, see the "Aerial Detection Survey Methodology" section on page 67.

The 2024 Aerial Detection Survey (ADS) season marked the third consecutive year all 22 million acres of forest-land in Washington were surveyed

Since 2013, DNR's ADS program has been reliant on the collaboration with WDFW's Aviation Program, utilizing their Partnavia P68 N357PN (above) piloted by Martin “Marty” Kimbrel (below) for the majority of that flight time.

With over 200 flight days together, Marty's expertise, safety, collaboration, and true love of flying brought an unmatched level of positivity to a demanding, cramped work environment. His dedication to the mission of the forest health aerial survey reached far beyond the standard pilot requirements set by the ADS program. Marty shared endless amounts of aviation knowledge with our survey personnel, stayed on-call nights and weekends to assist with flight planning, and always found creative ways to maximize flight hours during ideal weather windows. Marty even stepped in to help novice flight managers get their bearings in Washington and lead missions with confidence, quite literally taking them under his wing. With the planned dismissal of the Partenavia by WDFW in summer 2025, DNR's survey program will be hard pressed to fill Marty's place.

CREDITS: (BOTTOM) RACHEL BROOKS / DNR; (TOP) GLENN KOHLER / DNR

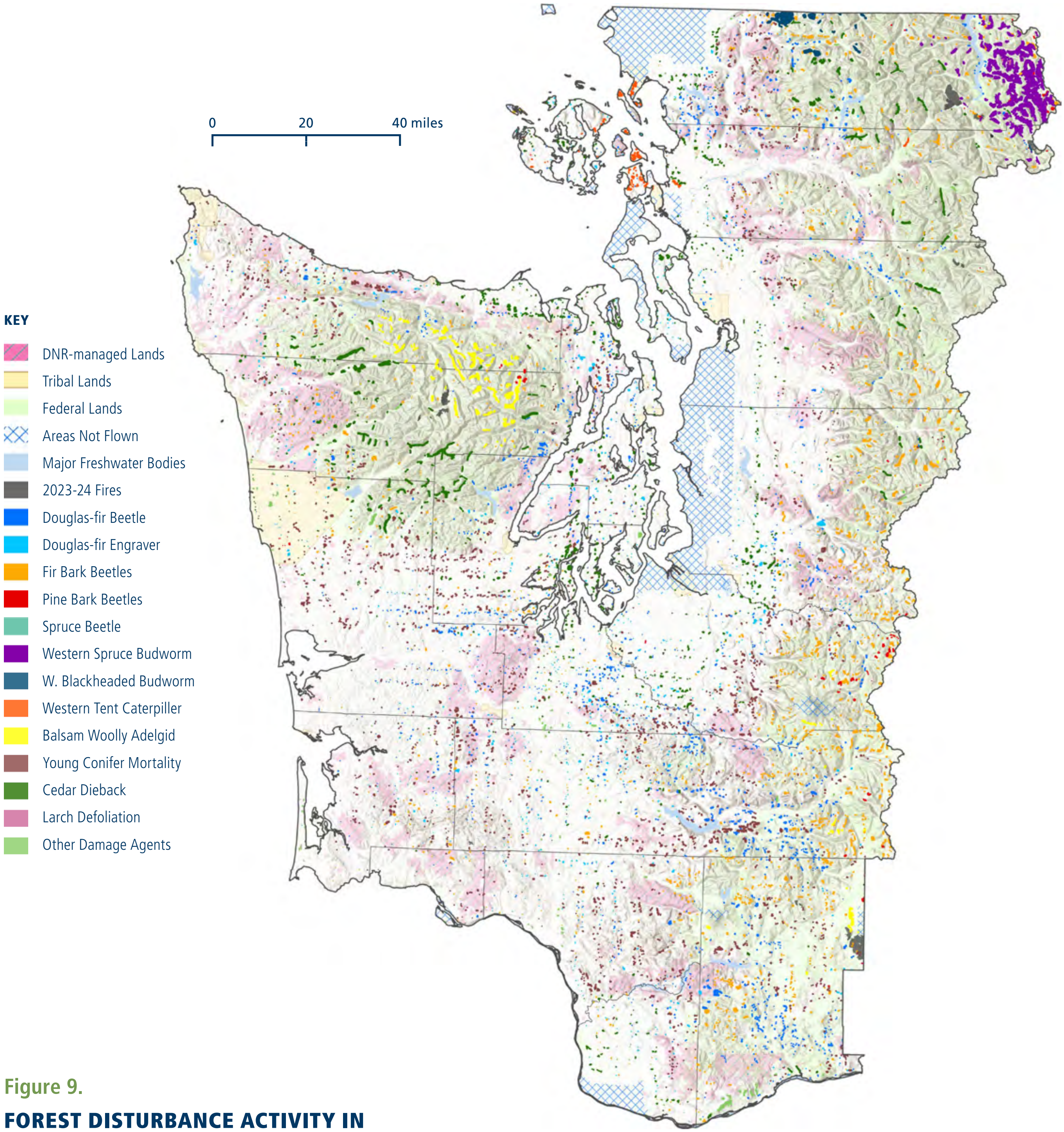


Figure 9.

FOREST DISTURBANCE ACTIVITY IN WESTERN WASHINGTON BASED ON 2024 AERIAL DETECTION SURVEY DATA

Blue cross-hatched areas represent urban land not surveyed. See the section "Data and Services" on page 69 at the end of this report to find out how to obtain more localized and detailed ADS map resources.

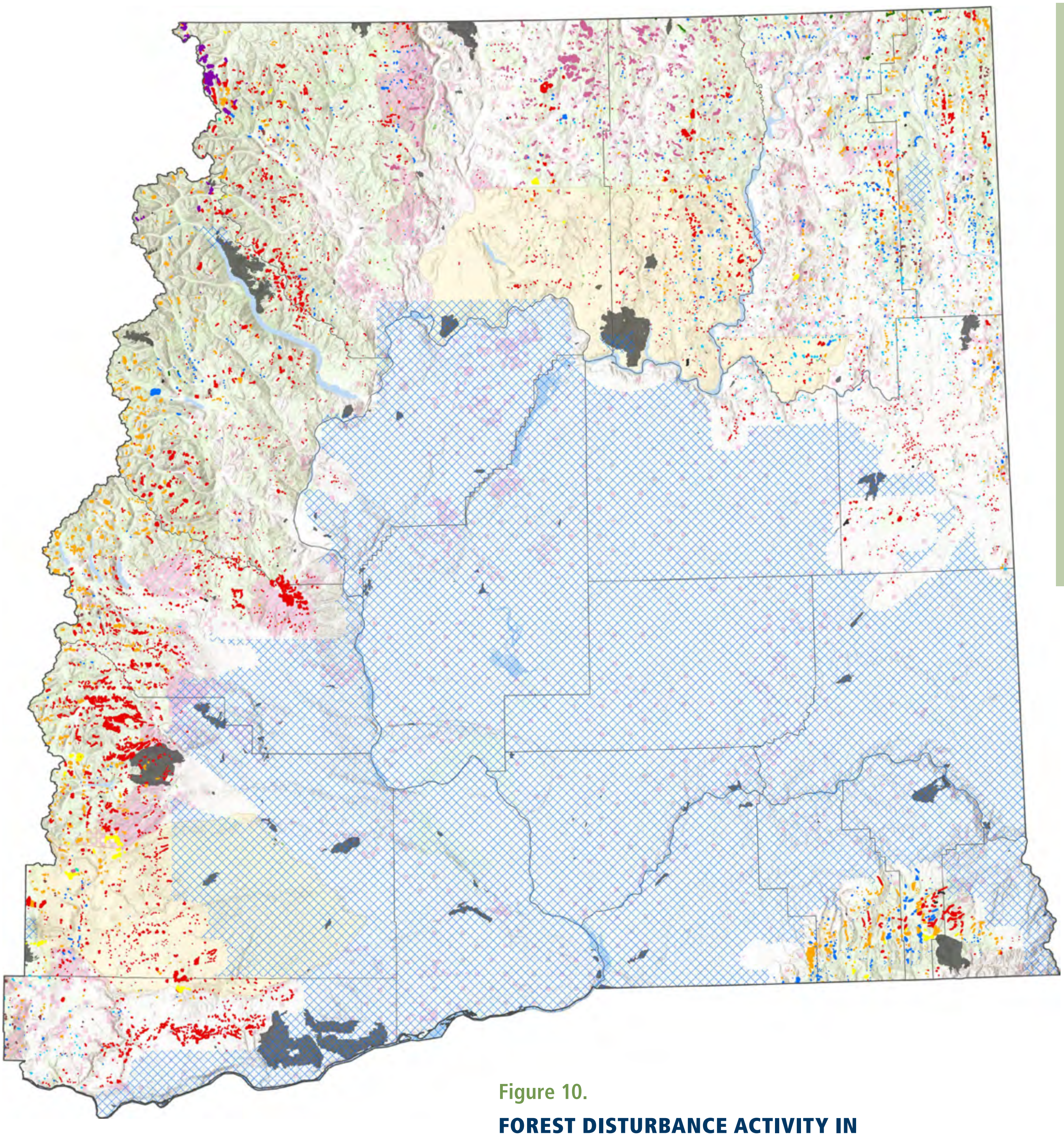


Figure 10.

FOREST DISTURBANCE ACTIVITY IN EASTERN WASHINGTON BASED ON 2024 AERIAL DETECTION SURVEY DATA

Blue cross-hatched areas represent urban or non-forested land not surveyed. See the section "Data and Services" on page 69 at the end of this report to find out how to obtain more localized and detailed ADS map resources.

Table 1.

2024 | AERIAL DETECTION SURVEY ACREAGE TABLE

The following table shows agents recorded causing damage on 10 or more acres in the Aerial Detection Survey in 2024, including agent name, the ADS associated code, the agent's primary host(s), the damage type, and total acreage mapped. Agents are organized by acreage. Acreage damaged by fire and root disease are excluded (see wildfire and root disease sections for details).

DAMAGE AGENT (CODE)	HOST(S)	DAMAGE TYPE	ACRES
Fir engraver (4_WA)	True firs (primarily grand, subalpine, silver, and noble)	Mortality	80,510
Mountain pine beetle (6L)	Douglas-fir	Mortality	67,280
Western spruce budworm (BS)	Douglas-fir, true firs, Engelmann spruce, and western larch	Defoliation	63,470
Scattered mortality caused by bear, root disease, and other agents (YCM)	Young conifers	Mortality	53,760
Swiss needle cast (SNC)	Douglas-fir	Defoliation	49,500
Redcedar decline (RCD)	Western redcedar	Crown dieback	45,630
Douglas-fir beetle (1)	Douglas-fir	Mortality	42,780
Western pine beetle (8)	Ponderosa pine	Mortality	32,820
Balsam woolly adelgid (AB)	True firs (primarily grand, Pacific silver, and subalpine)	Defoliation	30,330
Larch casebearer & larch needle blight (CH)	Larch	Defoliation	27,850
Dying hemlock (DH)	Hemlock	Mortality	24,920
Douglas-fir engraver (2)	Douglas-fir	Topkill	12,660
Western balsam bark beetle (5)	Subalpine fir (primarily subalpine fir)	Mortality	12,540
Western blackheaded budworm (BB)	True firs, hemlocks, Douglas-fir, and spruce	Defoliation	9,420
Mountain pine beetle (6B)	Whitebark pine	Mortality	8,780
Mountain pine beetle (6P)	Ponderosa pine	Mortality	7,290
Redcedar mortality (RCM)	Western redcedar	Mortality	6,040
Tent caterpillar (TC)	Hardwoods	Defoliation	4,580
Silver fir beetle (9)	Pacific silver fir	Mortality	2,880
Pine engraver (7)	Ponderosa pine	Mortality	1,850
Unknown defoliation (UNKD_Con)	Conifers	Defoliation	1,790
Lodgepole needle cast (LC)	Lodgepole pine	Defoliation	1,000
Hardwood decline (HDM)	Maples	Crown dieback	820
Hardwood decline (HDA)	Aspen	Crown dieback	560

DAMAGE AGENT (CODE)	HOST(S)	DAMAGE TYPE	ACRES
Pacific madrone decline (PMD)	Pacific madrone	Defoliation	520
Hardwood decline (HD)	All hardwoods	Crown dieback	320
Douglas-fir needle midge (MN)	Douglas-fir	Defoliation	220
Mountain pine beetle (6W)	Western white pine	Mortality	200
Water damage (WATR)	All	Mortality	200
Spruce beetle (3)	Engelmann spruce	Mortality	190
Spruce aphid (AS)	Sitka spruce	Defoliation	160
Unknown defoliation (UNKD_Hwd)	Hardwoods	Defoliation	80
Larch needle cast (RC)	Larch	Defoliation	40
Needle rust (PR)	Poplars	Crown discoloration	30
Winter damage (WNTR)	All	Defoliation	30
Landslide (SLID)	All	Main stem broken or uprooted	30

CREDIT: RACHEL BROOKS / DNR

CREDIT: RACHEL BROOKS / DNR

Spruce broom rust

Biotic Disturbances

Biotic disturbances—disturbances caused by living agents such as insects, fungi, animals, and parasitic dwarf mistletoe plants—can directly cause tree mortality or dieback. These agents can also have an indirect influence on forest health by weakening trees and predisposing them to attacks from other pests or stressors. In Washington, both native and non-native pests and pathogens influence our forest systems.

Unlike abiotic disturbances such as drought and wildfire, forest insects and pathogens typically attack a specific host tree species or narrow range of hosts, so damage may be limited in mixed-species forests. At low levels, native insects and pathogens play important ecological roles in nutrient cycling of dead plant material and removal of weak and suppressed trees, leaving healthier trees with more access to water, light, and nutrients. At high levels, pathogen and pest outbreaks can cause significant changes to stand structure and forest composition over time. Non-native forest insects and diseases, such as the emerald ash borer and sudden oak death *(Phytophthora ramorum)* are major threats to Washington's forests as native trees do not have adequate defense mechanisms and significant impacts are more likely.

The following section is a summary of forest insect and disease damage trends and conditions from 2024 collected through a combination of aerial detection surveys, ground monitoring, and field observations.

INSECTS | BARK BEETLES

CREDIT: GLENN KOHLER / DNR

Pine Bark Beetles

(Dendroctonus ponderosae Hopkins,
Dendroctonus brevicomis LeConte & *Ips* spp.)

NATIVE

The area with mortality caused by all pine bark beetles in 2024 was approximately 118,250 acres, which is above the ten-year average of 110,000 acres but similar to 2023 levels (Fig. 11). Relative to 2023, acres with mortality caused by pine bark beetles decreased for mountain pine beetle (MPB), remained unchanged for western pine beetle (WPB), and increased for Ips pine engravers (Table 2).

MPB damage decreased from 90,200 acres in 2023 to approximately 83,600 acres in 2024. The majority of pine bark beetle mortality recorded each year is in lodgepole pine killed by MPB, which killed lodgepole pine on 67,300 acres in 2024. Recent areas with MPB-killed lodgepole pines totaled 76,100 acres in 2023 and 66,800 acres in 2022.

In 2024, the highest concentrations of MPB mortality in lodgepole were mapped: in the Simcoe Mountains on the Yakama Indian Reservation west of Satus Pass; around the William O. Douglas Wilderness area in Yakima County; in the Manastash Ridge area of southwest Kittitas County; along the Kittitas-Chelan county border including the Colockum Pass area between Wenatchee and Ellensburg; around the Lake Chelan-Sawtooth Wilderness area and the Pasayten Wilderness Area; around Mount Bonaparte in northwest Okanogan County; in the Kettle River Range on the Confederated Tribes of the Colville Reservation and northern Ferry County; and in northern Pend Oreille County.

Some mortality in whitebark pine and western white pine may be due to the non-native white pine blister rust disease

MPB-caused mortality in ponderosa pine was mapped on 7,300 acres in 2024, below the 10-year average of about 17,100 acres. Observers recorded approximately 8,800 acres with MPB-caused mortality of whitebark pine in 2024, the highest level since 2010 (16,200 acres). Areas with high concentrations of whitebark pine mortality included areas on the north side of Mount Adams, the upper Ahtanum and White Pass in Yakima County, around the Manastash Ridge area of southwest Kittitas County, around the Alpine Lakes Wilderness west of Leavenworth, along the Chelan-Okanogan County border, and in western Okanogan County north of Mazama. Observers mapped approximately 200 acres with western white pine mortality in 2024. Some mortality in whitebark pine and western white pine may be due to the non-native white pine blister rust disease directly killing trees or predisposing infected trees to attack by MPB.

Mortality of ponderosa pine due to WPB has increased steadily since 2012. Mapped acreage reached a peak of approximately 44,300 acres in 2022, then decreased to approximately 32,800 acres in both 2023 and 2024, but is still above the 10-year average of 25,700 acres (Fig. 12). The acreage recorded in 2022 marked the highest amount of WPB damage recorded since 2006. WPB damage has been widely reported throughout eastern Washington, resulting in increased requests for information from landowners and land managers. Recent drought conditions are likely an important driver of these increases. Although the trend was down for statewide total acres, there was a marked increase in WPB outbreak activity in lower elevation forested areas of Klickitat County and the eastern portion of the Yakama Indian Reservation. Other concentrations of scattered WPB-caused mortality occurred in central Kittitas County, eastern Okanogan County, the Confederated Tribes of the Colville Reservation, and throughout Stevens and Spokane Counties.

Pine mortality attributed to Ips pine engravers was mapped on approximately 1,850 acres in 2024, doubling the 900 acres mapped in 2023 and similar to the 10-year average of 1,900 acres. Ponderosa pine was the most common species affected. Some of the same areas are also experiencing WPB outbreaks, which have a very similar aerial survey damage signature in young ponderosa pines.

CREDITS: (LEFT) JUSTIN HOF / USFS; (RIGHT) BETSY GOODRICH / USFS

Mountain pine beetle damage on lodgepole and whitebark pine near Lake Chelan in 2024

Mature western white pine killed by mountain pine beetle near Blewett Pass in 2024

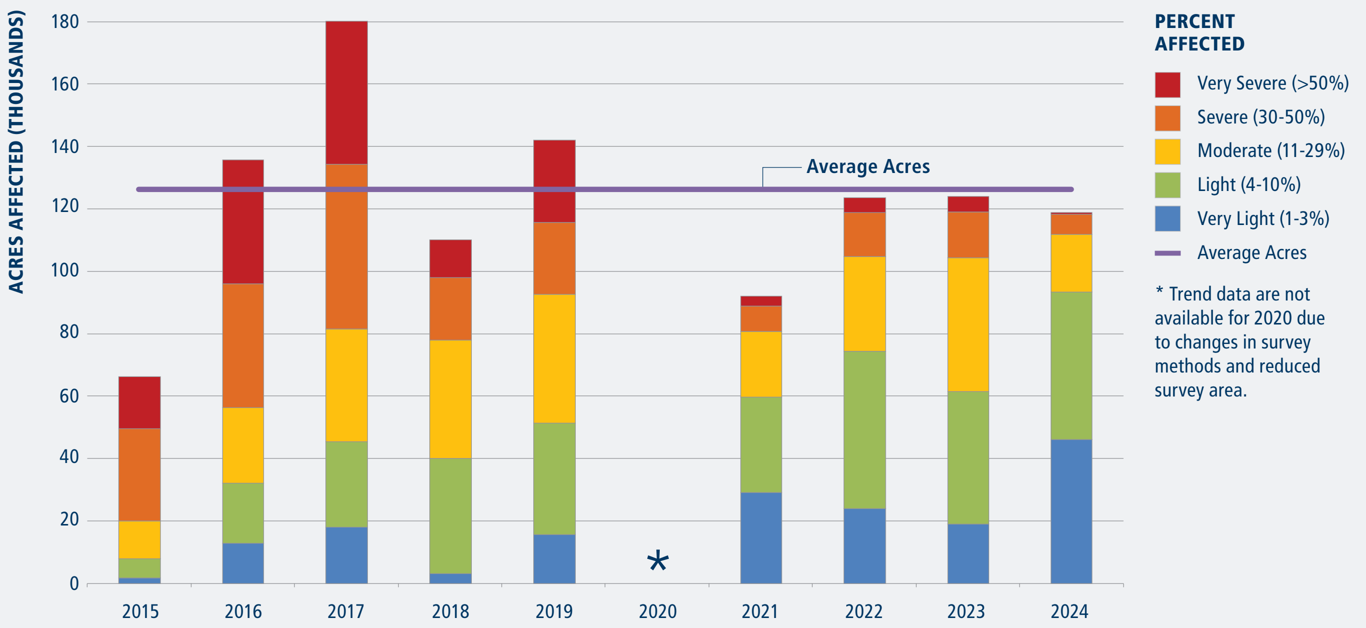
Table 2.

PINE BARK BEETLE DAMAGE IN WASHINGTON OBSERVED IN AERIAL DETECTION SURVEY, IN ACRES

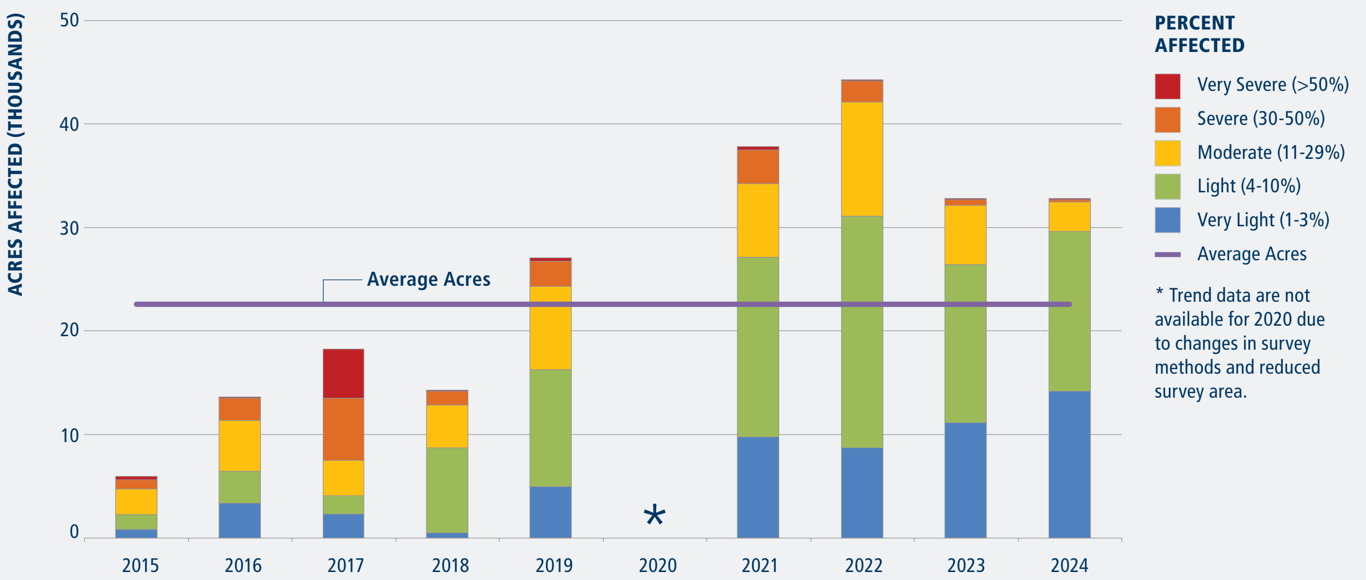
BEETLE SPECIES	HOST(S)	2023 ACRES WITH MORTALITY	2024 ACRES WITH MORTALITY
Mountain Pine Beetle	Lodgepole Pine	76,088	67,285
Mountain Pine Beetle	Ponderosa Pine	6,778	7,286
Mountain Pine Beetle	Whitebark Pine	7,053	8,780
Mountain Pine Beetle	Western White Pine	303	204
Western Pine Beetle	Ponderosa Pine	32,814	32,824
Pine Engravers (*Ips* species)	All Pines	903	1,851
Totals		123,939*	118,230*

*Multiple host species can be recorded in a single area, therefore the sum of acres for all hosts is marginally greater than the total footprint affected.

ALL PINE BARK BEETLES 10-YEAR TREND FOR TOTAL ACRES AFFECTED IN WASHINGTON Figure 11.



WESTERN PINE BEETLE 10-YEAR TREND FOR TOTAL ACRES AFFECTED IN WASHINGTON Figure 12.



INSECTS | BARK BEETLES

CREDIT: PEST AND DISEASES IMAGE LIBRARY / BUGWOOD.ORG

California Fivespined Ips

(*Ips paraconfusus* Lanier)

NATIVE

California fivespined Ips (CFI), a pine engraver beetle native to Oregon and California, was first detected in Washington State in 2010. It has either expanded its range or re-occupied a historic range. Localized outbreaks of CFI continue to cause unusually high levels of ponderosa pine mortality in forested areas along the Columbia River Gorge in Skamania, Klickitat, and Benton counties. Since 2022, localized CFI outbreaks have caused scattered mortality of ponderosa pines, western white pines, shore pines, and ornamental pines (such as Austrian pine) in the Puget Sound area.

The first known occurrence of CFI killing pines in western Washington was in native ponderosa pines at Joint Base Lewis-McChord (JBLM) in 2022, but that outbreak has since subsided. In 2023 and 2024, several locations from Bothell south to Tacoma experienced scattered mortality of pines in urban, park, and roadside settings. Hosts killed include shore pine, western white pine, and Austrian pine. These are new host records for CFI in Washington and likely increase potential for CFI mortality spreading to new areas. To date, CFI has been detected in 14 Washington counties, extending the previously reported range in 1987 by approximately 150 miles to the north and 200 miles to the east.

CREDIT: GLENN KOHLER / DNR

Ornamental pine killed by CFI in University Place, 2024

MONITORING

In 2024, CFI adults collected in a Washington Department of Agriculture (WSDA) trap in Mukilteo (Snohomish County) became the farthest north record of CFI in Washington. Trap sites in northwest Washington (Snohomish, Skagit, and Island counties) and coastal Grays Harbor County were maintained by DNR in 2024 to target stands with shore pine hosts, as well as to determine if CFI is found north of southern Snohomish County (Fig. 13). WSDA is also monitoring for CFI at some survey sites targeting other forest pests. Traps were also maintained by DNR at two sites in northern Yakima County and Kittitas County to monitor for CFI range expansion to the north in eastern Washington.

From 2010 to 2018 and 2022 to 2024, pheromone-baited funnel traps have been used at 63 sites in 29 counties to monitor CFI occurrence and distribution in Washington. Not all sites were trapped each year. Separate traps were also baited for *Ips pini,* the more common native pine engraver in Washington. DNR, USFS, Washington State University (WSU) Extension, and WSDA have collaborated to conduct these surveys.

In 2011 and 2012, only three CFI adults were collected in traps at JBLM, outnumbered by over 200 *Ips pini.* At that time, JBLM was the farthest north CFI had been collected in Washington, with no related mortality reported. In 2018, a trap site near Shelton (Mason County) became the new northern-most record of CFI also with very low numbers (five CFI and over 5,000 *Ips pini*). Prior to 2023, CFI populations at western Washington detection sites north of Vancouver also tended to be low, but CFI trap collections in 2023 at Renton and Bothell sites were in the hundreds.

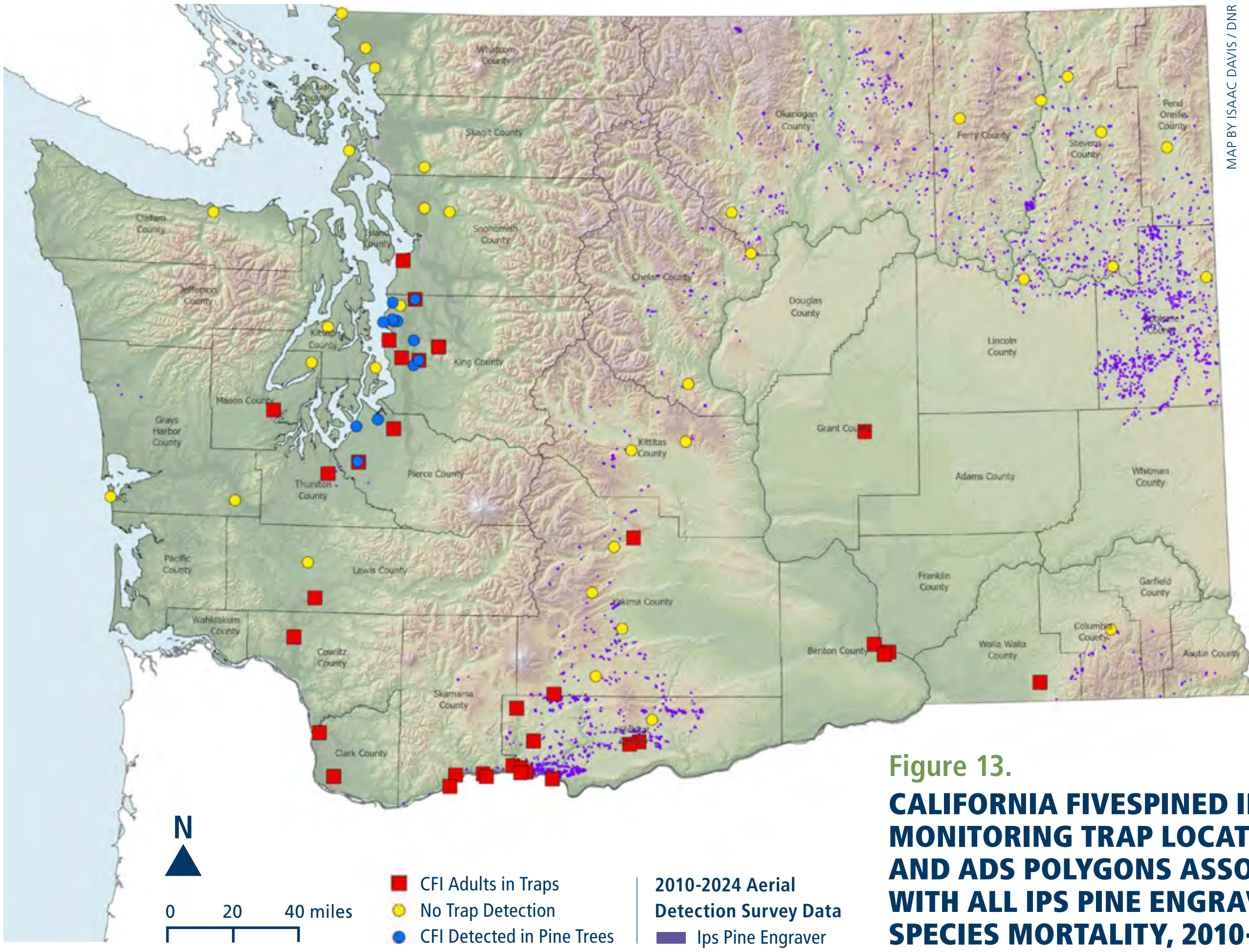


Figure 13.

CALIFORNIA FIVESPINED IPS MONITORING TRAP LOCATIONS AND ADS POLYGONS ASSOCIATED WITH ALL IPS PINE ENGRAVER SPECIES MORTALITY, 2010-2024

IMPACTS AND RANGE EXPANSION

CFI can infest numerous species of pines and has been a serious pest of young ponderosa pine in Oregon's Willamette Valley since it was first reported there in 1999. CFI can rapidly increase its population in small diameter (greater than 3 inches) dead pine slash created by storms, fires, logging, or thinning, and offspring produced the same year can then successfully attack live trees nearby. The risk of outbreak is much higher during drought conditions when live trees are moisture stressed. Ips outbreaks typically subside within a year due to high overwintering mortality. Outbreaks can continue for multiple years if fresh breeding material becomes available each spring. That said, CFI outbreaks in Washington may be lasting longer due to drought stress and more susceptible hosts that haven't been previously exposed to CFI attacks.

CFI outbreaks in the eastern Columbia River Gorge affecting Hood River and Wasco counties in Oregon and Skamania and Klickitat counties in Washington have led to numerous killed and top-killed ponderosa pines most years since 2010. Approximately 2,900 acres with CFI-killed ponderosa pine were recorded in Oregon and Washington during the 2016 ADS, which is the most recent peak of activity. Damage signatures of CFI and *Ips pini* cannot be distinguished from the air, so ground sampling is used to determine which species is the dominant cause of mortality. Outbreaks have been driven by consecutive years of fires, storm damage, and drought conditions. Attacks by western pine beetle, red turpentine beetle, and infections of blue stain fungi may also contribute to mortality of some larger ponderosa pine.

It is unclear why CFI has transitioned in the greater Puget Sound region from low trap catch numbers in 2011 to 2018 to killing pines at several locations from 2022 to 2024. Increased tree stress due to recent droughts and extreme temperatures, such as the 2021 "heat dome" event, are likely contributors. Why CFI seems to be more successful at killing stressed pines than the more abundant *Ips pini* is unknown, but increasing populations and new host species such as shore pine and Austrian pine could be playing a role. Trap survey data indicate that populations of CFI and *Ips pini* do not appear to overlap in high numbers at the same locations. The two species are rarely found in the same tree, which suggests competition may also be a factor.

CREDIT: GLENN KOHLER / DNR

Fork-shaped egg galleries of CFI in ponderosa pine, Seattle

It is difficult to know with just trap data alone whether CFI is actively moving north and east into new areas, or whether it is just being collected more frequently because of increased monitoring efforts. Contents of five regional insect collections indicate that CFI was not likely collected in Washington prior to 2010. While not every trap site is monitored every year, there have been numerous trap sites in northern counties that have not detected CFI, clearly showing the northern edge of its current range. These data can be used as a baseline for continued trapping to the north. The new development of CFI killing pines at several sites in the Puget Sound area suggests that CFI was not well established or killing trees there in the past, otherwise it would have been more likely to have been reported and collected.

DNR and the USFS are partially funding a Washington State University research project in 2025 and 2026 to more closely examine potential relationships between increased CFI activity and drought stress in host trees.

The risk of CFI outbreak is much higher during drought conditions when live trees are moisture stressed

INSECTS | BARK BEETLES

CREDIT: GLENN KOHLER / DNR

Douglas-fir Beetle

(*Dendroctonus pseudotsugae* Hopkins)

NATIVE

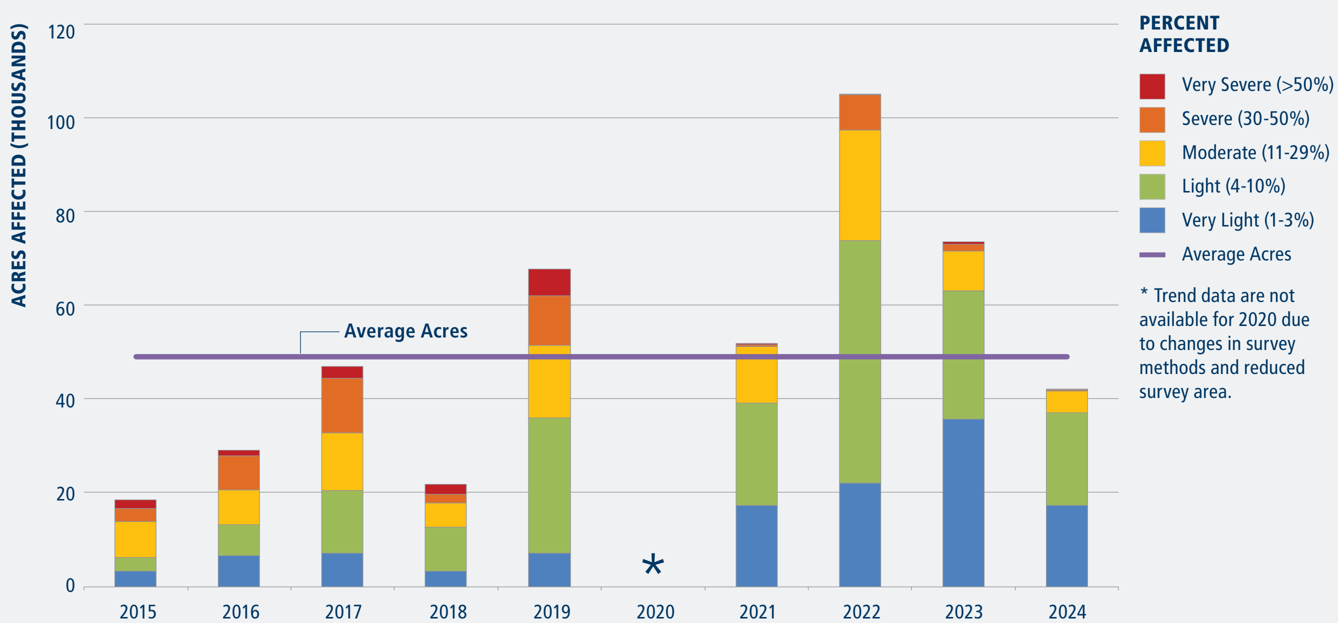
Mortality due to Douglas-fir beetle (DFB) has been increasing in recent years, reaching a peak of 105,000 acres in 2022, the highest level recorded since 2001. The area with DFB damage in 2024 decreased to approximately 42,800 acres, down from 73,500 acres mapped in 2023 and now below the 10-year average of 51,900 acres (Fig. 14). Scattered areas of DFB-caused mortality were detected throughout western Washington, with higher concentrations in Skamania, Lewis, Thurston, King, Whatcom, Mason, Jefferson, and Clallam counties. In eastern Washington, the highest concentrations were in Yakima County on the east side of Mount Adams, central Chelan County around Lake Wenatchee, northwest Okanogan County in the Loomis State Forest and north of Mazama, eastern Ferry County, throughout Stevens and Pend Oreille counties, and in the Blue Mountains in southeast Washington.

Douglas-fir beetle damage in 2024

CREDIT: DANNY DEPINTE / USFS

DOUGLAS-FIR BEETLE 10-YEAR TREND FOR TOTAL ACRES AFFECTED IN WASHINGTON

Figure 14.



INSECTS | BARK BEETLES

Secondary Bark Beetles in Douglas-fir

(*Scolytus monticolae* Swaine, *Scolytus unispinosus* LeConte, and *Pseudohylesinus nebulosus* LeConte)

NATIVE

The aerial survey damage signature of dead tops and branch flagging in Douglas-fir is attributed to Douglas-fir engraver *(Scolytus unispinosus)*. However, this type of damage is also caused by at least two other secondary bark beetle species: Douglas-fir pole beetle *(Pseudohylesinus nebulosus)* and *Scolytus monticolae.* This group of bark beetles is considered "secondary" because they are not typically the primary killers of healthy trees, but tend to attack trees stressed by other factors like drought. All three species can infest the same tree and are difficult to distinguish based on their egg and larval galleries alone.

Observers mapped approximately 12,700 acres of Douglas-fir engraver damage in 2024—a decrease to less than half the 25,600 acres mapped in 2023. 2023 marked the highest level recorded in Washington aerial surveys since 1969. Another recent peak of 20,300 acres with Douglas-fir engraver damage occurred in 2019, well above the 10-year average of 9,500 acres. Decreased activity may be due to some recent reduction in drought conditions. The highest concentrations of damage in western Washington were in eastern Jefferson County, Kitsap County, and scattered throughout the Cascade foothills. In eastern Washington, the highest concentrations of damage were in western Klickitat County, southern Stevens and Ferry counties, and throughout Pend Oreille County.

Attacks by these species usually occur in small diameter Douglas-fir trees or to the tops and branches of larger trees, resulting in a patchy pattern of dieback in mature Douglas-fir tree crowns. Secondary bark beetle species do not typically cause mortality, particularly in mature trees. Stressors such as drought and root disease may predispose Douglas-fir to attack by these species. Attacks during drought are more likely to be successful and cause mortality.

CREDIT: GLENN KOHLER / DNR

CREDIT: GLENN KOHLER / DNR

Above: Douglas-fir damaged by secondary bark beetles in Klickitat County

Right: Secondary bark beetle larval galleries in Douglas-fir

INSECTS | BARK BEETLES

CREDIT: DAVID MCCOMB / USDA FOREST SERVICE, BUGWOOD.ORG

Spruce Beetle

(*Dendroctonus rufipennis* Kirby)

NATIVE

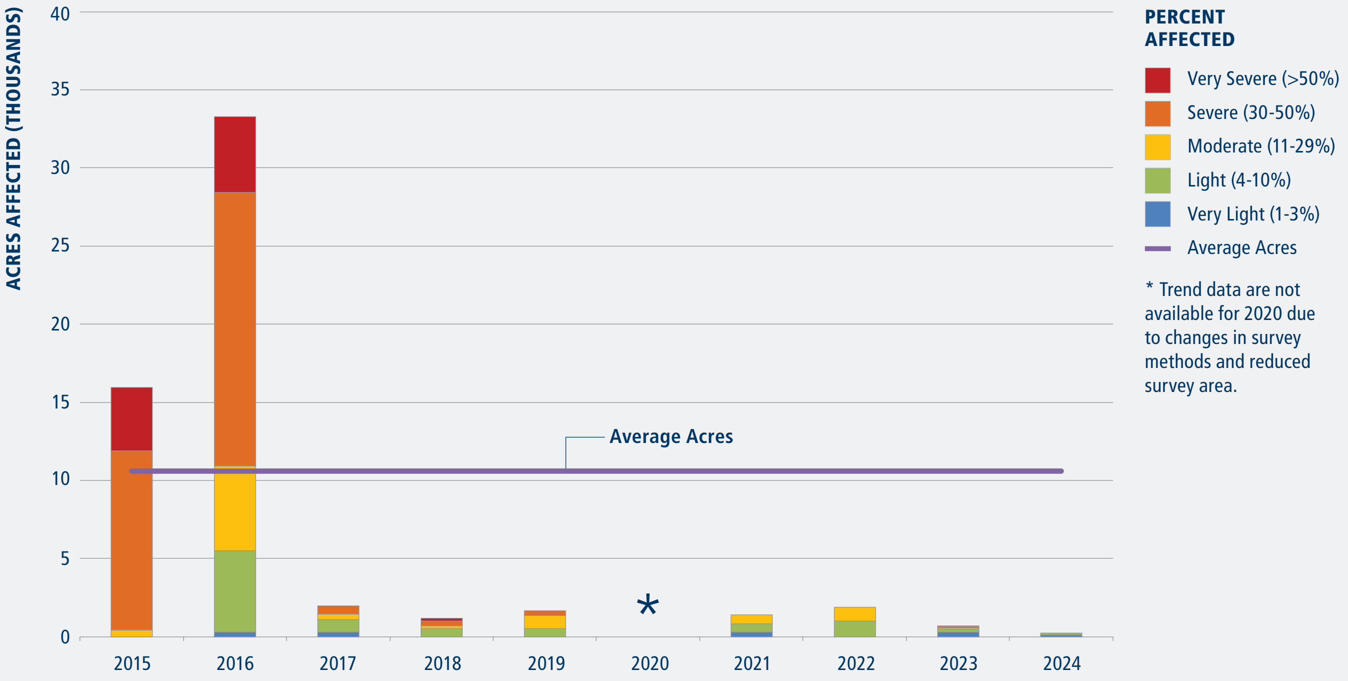
The area of Engelmann spruce affected by spruce beetle in 2024 was approximately 200 acres, a decrease from the 650 acres mapped in 2023, and well below the 10-year average of 7,500 acres (Fig. 15).

The affected areas are near the Cascade crest in Okanogan County. Areas of western Okanogan County around the Pasayten Wilderness experienced a large spruce beetle outbreak until 2017, with a peak in 2012 of over 60,000 acres. Low levels of spruce beetle activity have persisted in this area since 2018.

Spruce beetle pitch tubes in Engelmann spruce in the Little Pend Oreille Forest

CREDIT: DANA BRENNAN / DNR

SPRUCE BEETLE 10-YEAR TREND FOR TOTAL ACRES AFFECTED IN WASHINGTON Figure 15.



INSECTS | BARK BEETLES

CREDIT: DONALD OWEN, CA DEPT. OF FORESTRY AND FIRE PROTECTION, BUGWOOD.ORG

Fir Engraver

(*Scolytus ventralis* LeConte)

NATIVE

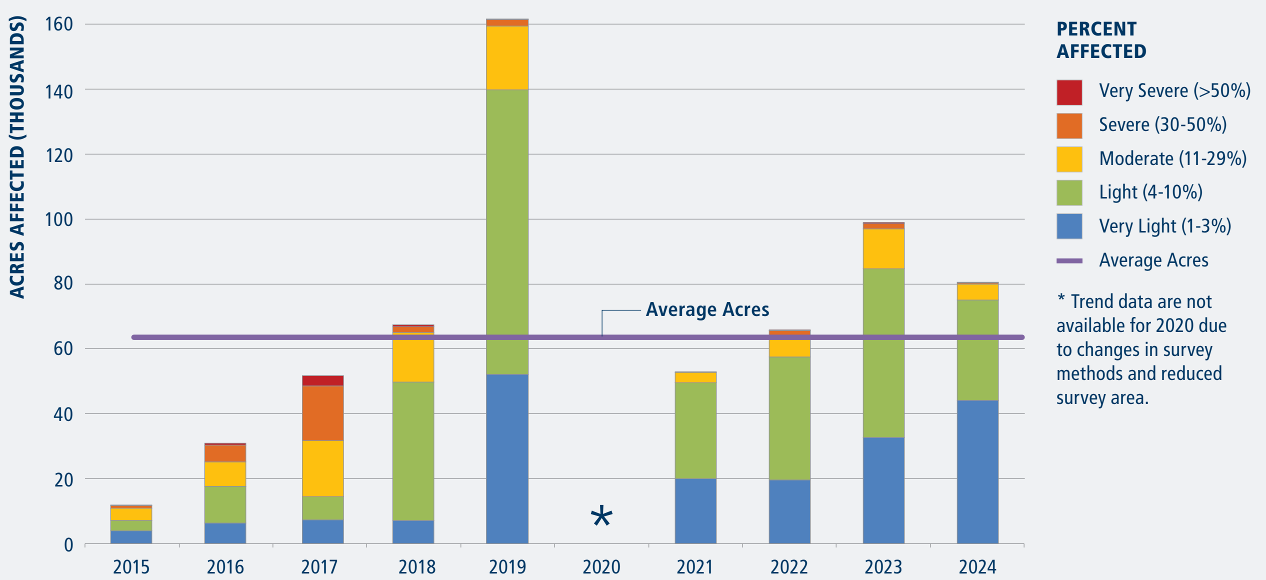
The fir engraver beetle can attack all species of true fir *(Abies)* in Washington, but its primary hosts in Washington are grand fir and noble fir. Fir engraver-caused mortality, primarily in grand fir, has been steadily increasing since 2015 and reached a 10-year high of 166,300 acres in 2019, more than twice the area recorded in 2018 (Fig. 16). Following a drop to 52,500 acres in 2021, the upward trend resumed with an increase in 2023 to 99,000 acres. Acres affected decreased in 2024 to approximately 80,500 but remain above the 10-year average of 69,300 acres.

In eastern Washington, the most concentrated areas of mortality were throughout the Cascade Mountain areas of Klickitat, Yakima, Kittitas, and Chelan counties; in the Kettle River Range and Selkirk Mountains in Ferry, Stevens, and Pend Oreille counties; in northern Spokane County; and in the Blue Mountains in southwest Washington. West of the Cascades, areas with the most damage were scattered throughout the Cascade foothills recorded in Skamania, northeast Cowlitz, Lewis, Pierce, King, Snohomish, Skagit, and Whatcom counties. There were also higher concentrations with mortality on the west slopes of the Olympic Mountains.

CREDIT: RACHEL BROOKS / DNR

Fir engraver galleries in the Olympic National Park in 2024

FIR ENGRAVER 10-YEAR TREND FOR TOTAL ACRES AFFECTED IN WASHINGTON Figure 16.



INSECTS | BARK BEETLES

CREDIT: STEVEN VALLEY / OR DEPT. OF AGRICULTURE, BUGWOOD.ORG

Silver Fir Beetle

(*Pseudohylesinus sericeus* Mannerheim)

NATIVE

The silver fir beetle (SFB) and a related species the fir root bark beetle *(Pseudohylesinus granulatus)* can kill true firs *(Abies)* and other conifer hosts in Washington such as western hemlock and Douglas-fir. The most frequently damaged host is Pacific silver fir. Mortality during a typical year is scattered and attacks are focused on trees weakened by disease or attacked by other fir bark beetles. Outbreaks are rare; however, increases in population can occur following windthrow events that generate abundant breeding material.

Observers mapped approximately 2,900 acres in Washington with mortality caused by SFB in 2024, a marked increase from the 500 acres mapped in 2023. This was the highest level of SFB recorded by aerial survey since 2004, when 6,400 acres were affected. Very low amounts of mortality were recorded from 2005 until 2015, when levels began increasing to a recent peak of 1,700 acres in 2019. Small areas with SFB mortality were mapped in 2024 in the North Cascades National Park area of eastern Whatcom County, near the Cascade crest in northern Celan County, and around Snoqualmie Pass in King County and Alpine Lakes Wilderness in along the Chelan-Kittitas county border.

INSECTS | BARK BEETLES

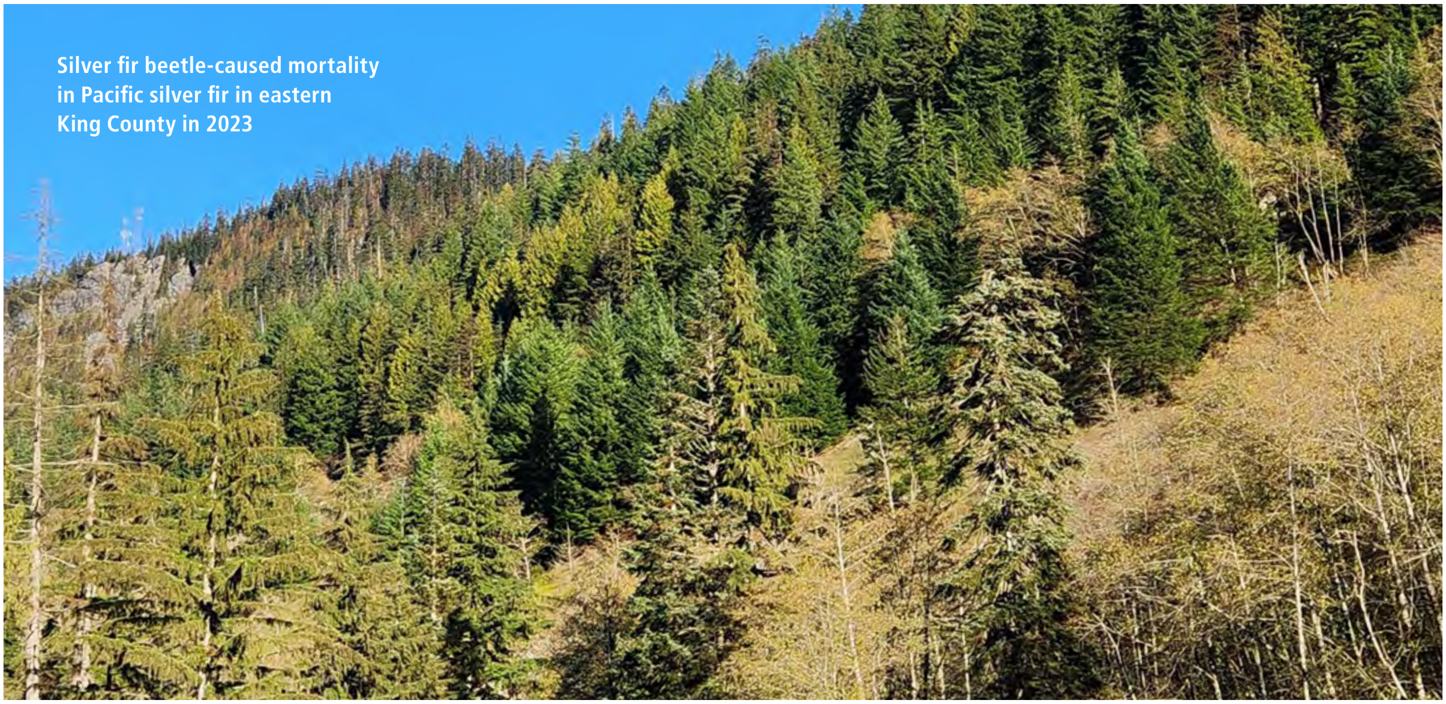
CREDIT: USDA FOREST SERVICE-REGION 2 ROCKY MOUNTAIN REGION, USDA FOREST SERVICE, BUGWOOD.ORG

Western Balsam Bark Beetle

(*Dryocoetes confusus* Swaine)

NATIVE

Western balsam bark beetle (WBBB), often in conjunction with balsam woolly adelgid, is an important driver of subalpine fir mortality in high-elevation Washington forests. Observers mapped approximately 12,500 acres with WBBB-caused mortality in 2024, a marked decrease from 24,900 acres in 2023. The trend in subalpine fir mortality appears to be decreasing from a recent peak of 49,900 acres with damage in 2021, the highest level since 2007. The most concentrated areas with damage were along the Cascade crest in western Okanogan County, eastern Whatcom and Skagit counties, north Chelan County, western Klickitat County, and northwest Yakima County. Areas affected in northeast Washington were throughout high elevations in the Colville National Forest in Ferry, Stevens, and Pend Oreille counties.



Silver fir beetle-caused mortality in Pacific silver fir in eastern King County in 2023

CREDIT: GLENN KOHLER / DNR

INSECTS | AMBROSIA BEETLES

CREDIT: UDO SCHMIDT

Mediterranean Oak Borer

(*Xyleborus monographus* Fabricius)

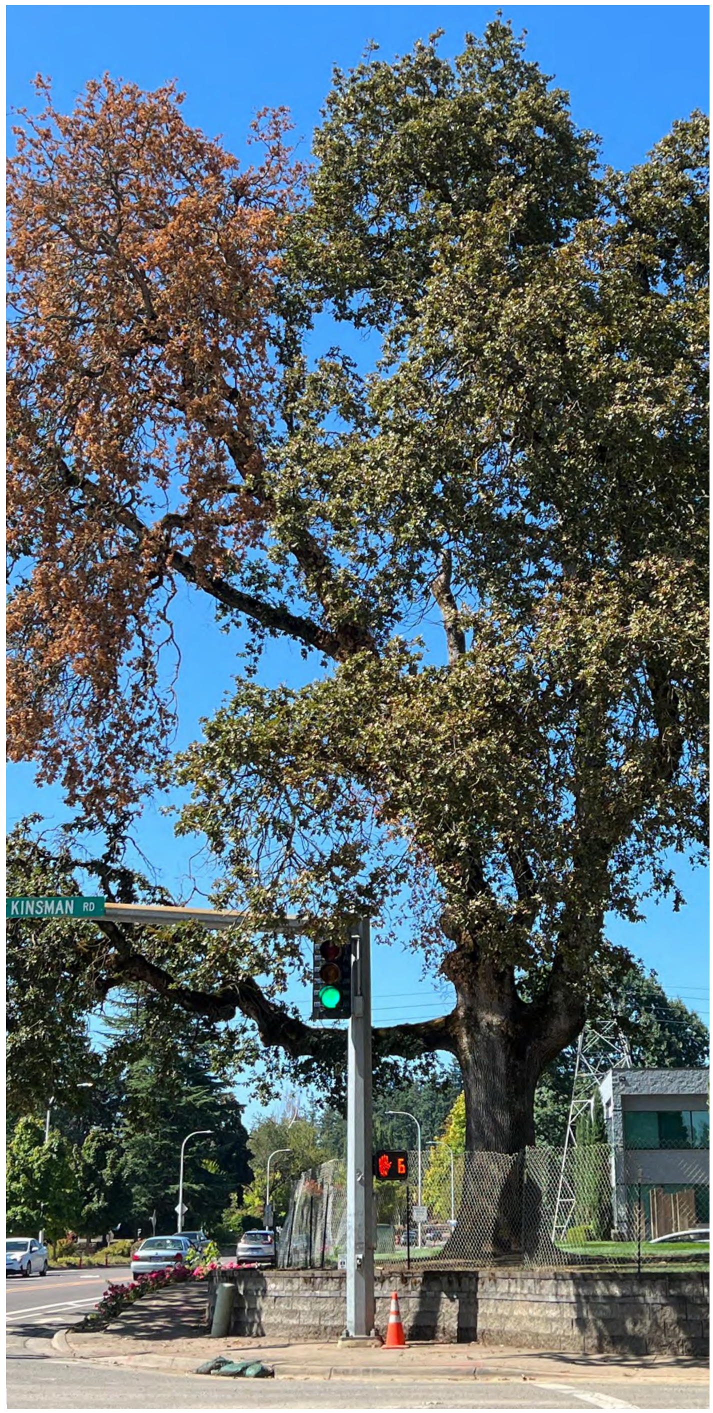
NON-NATIVE

Recent Mediterranean oak borer (MOB) infestations of Oregon white oak *(Quercus garryana)* in northwest Oregon increase the potential of this serious, non-native, forest insect pest moving into Washington. Native to Europe, North Africa, and western Asia, these tiny, one-eighth inch ambrosia beetles can tunnel into wood of several western oak species, including Washington's only native oak: Oregon white oak.

The beetles do not eat wood but use it to grow fungi that is eaten by their young. Unfortunately, two of these fungi, *Raffaelea montetyi* and *Fusarium solani,* can cause wilting diseases that cause branch and crown dieback. Reinfestation over several years can cause a top-down pattern of crown dieback and may eventually result in whole tree mortality.

MOB was likely introduced into central California around 2010 and was reported to be killing valley oaks in Napa and Sonoma counties by 2019. California populations of MOB have spread to nearby Lake and Sacramento counties, where they have also been recorded in blue oak, California black oak, and Oregon white oak. MOB was first detected in traps in northwest Oregon's Multnomah County in 2018 and has since been collected in traps from three other northwest Oregon counties: Clackamas, Marion, and Washington. The first records of MOB infestation resulting in mortality of Oregon white oak occurred in 2022 near Troutdale, Oregon in Multnomah County and Wilsonville in Clackamas County. Additional infested Oregon white oaks have since been found in both Multnomah and Clackamas counties.

CREDIT: CHRISTINE BUHL / OREGON DEPARTMENT OF FORESTRY



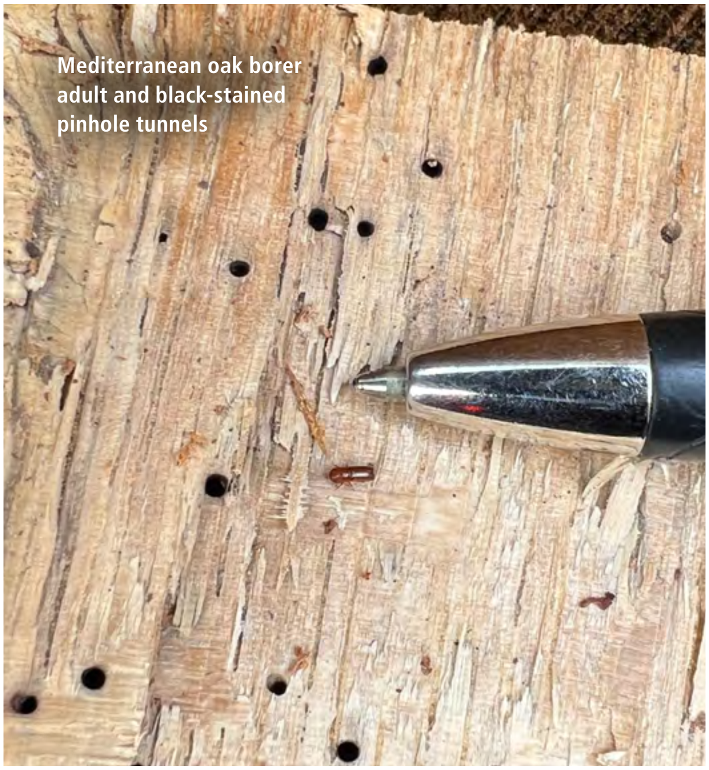
Crown dieback symptoms in Oregon white oak due to Mediterranean oak borer infestation and wilt fungi in Oregon

CREDIT: CHRISTINE BUHL / OREGON DEPARTMENT OF FORESTRY

Powdery frass accumulation typical of ambrosia beetle infestation

Multiple agencies are collaborating to monitor MOB activity in Oregon, determine potential management strategies, and slow its spread. More information about the situation in Oregon can be found in the Oregon Department of Forestry MOB factsheet: https://tinyurl.com/MOB-oregon

MOB has not yet been detected in Washington. DNR and WSDA are using traps to monitor MOB and other invasive insects in Washington. The public is encouraged to report suspected MOB sightings or related damage to oak trees (see **WHAT TO LOOK FOR**) in Washington at https://invasivespecies.wa.gov/report-a-sighting/invasive-insects/



Mediterranean oak borer adult and black-stained pinhole tunnels

CREDIT: CHRISTINE BUHL / OREGON DEPARTMENT OF FORESTRY

CREDIT: CHRISTINE BUHL / OREGON DEPARTMENT OF FORESTRY

Mediterranean oak borer galleries and staining in sapwood

Diligence by the public to avoid moving firewood and other potentially infested oak materials is more important than ever. The spread of MOB over wider areas in California and Oregon raises the concern that it will be difficult to eradicate or contain once established in new areas. The potential impact to Oregon white oak forests in the Pacific Northwest is not well understood. In its native range, oaks attacked by MOB are more likely to be unhealthy or stressed. In California and Oregon, MOB appears more capable of attacking generally healthy oaks.

Diligence by the public to avoid moving firewood and other potentially infested oak materials is more important than ever

WHAT TO LOOK FOR: The most easily spotted symptom of possible MOB infestation is partial crown dieback that proceeds down to lower branches and the main stem over several years (see Page 31). Similar crown dieback symptoms can have other causes, such as drought stress or attack by oak pit scale and carpenterworm. More direct signs of MOB activity include piles of powdery white or tan frass on bark, perfectly round one-sixteenth inch wide entrance/exit holes through bark, and branching black-stained pinhole tunnels in wood that usually don’t enter heartwood (see primary images on Pages 32 and 33, respectively). Other ambrosia beetle species in oak will have similar signs, so adult beetle specimens are needed for positive identification.

INSECTS | DEFOLIATORS

GLENN KOHLER /DNR

Douglas-fir Tussock Moth

(*Orgyia pseudotsugata* McDunnough)

NATIVE

No Douglas-fir tussock moth (DFTM) defoliation was recorded in Washington in 2024. The most recent outbreaks in Kittitas, Chelan, and Okanogan counties defoliated 1,900 acres in 2018 and 5,600 acres in 2019.

Established over 40 years ago, the interagency network of Early Warning System pheromone traps at approximately 240 locations in eastern Washington continues to be monitored annually (Fig. 17). The Early Warning System is a pheromone-based trapping system used to detect outbreaks of Douglas-fir tussock moth in the western United States. Each year, forest health specialists set out sticky traps baited with a synthetic version of the pheromone produced by female moths to attract male moths. These traps are retrieved after the male flight period, and the number of male DFTM moths are recorded. Increases in trap catch numbers may indicate outbreak events in the following years (Fig. 18).

Overall, trap catches across eastern Washington increased in 2024 compared to 2023. Areas with elevated trap catches included western Okanogan, Kittitas, and Klickitat counties. DFTM defoliation has not been recorded in Okanogan and Kittitas counties since 2019. Some trap sites near Trout Lake and Goldendale in Klickitat County have increased recently but this area does not have a recent history of tussock moth defoliation. Two sightings of DFTM larva and egg masses (shown right) were reported in Klickitat County in 2024. High trap-catch numbers do not always correlate with the exact location of future defoliation, and high numbers can be associated with declining outbreak events. Outbreaks of DFTM in the Pacific Northwest are cyclical and occur approximately every 7 to 10 years from the first year with defoliation during the previous outbreak (Fig. 18).

Douglas-fir tussock moth cocoon and egg mass

CREDIT: GLENN KOHLER / DNR

INSECTS | DEFOLIATORS

DOUGLAS-FIR TUSSOCK MOTH TRAP CATCHES AND DEFOLIATION IN WASHINGTON 1988-2024 Figure 17.

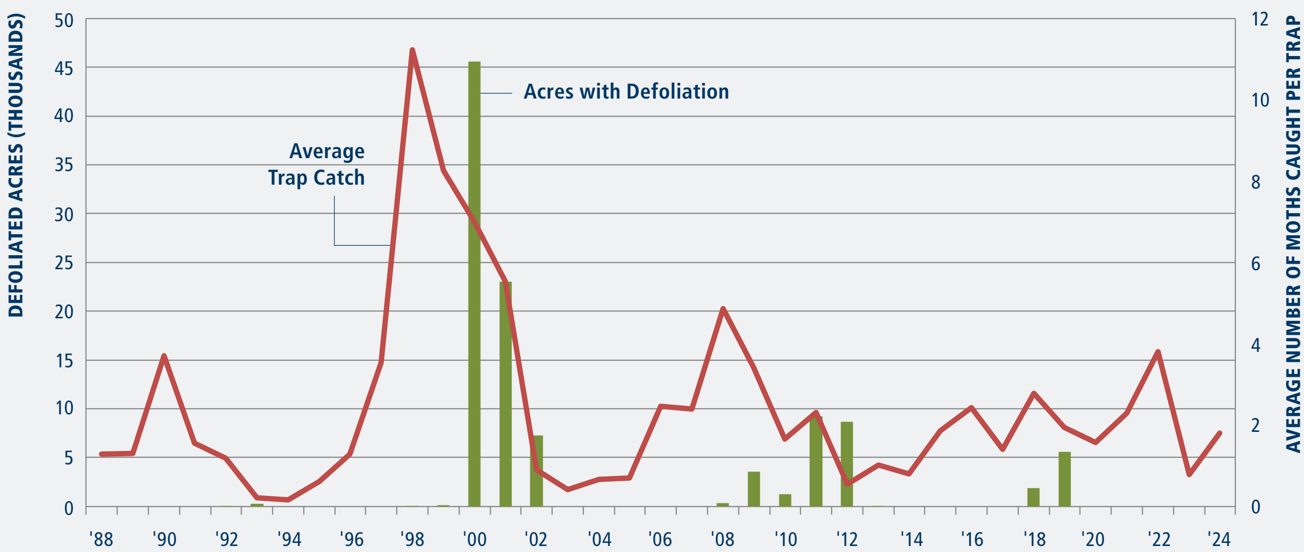
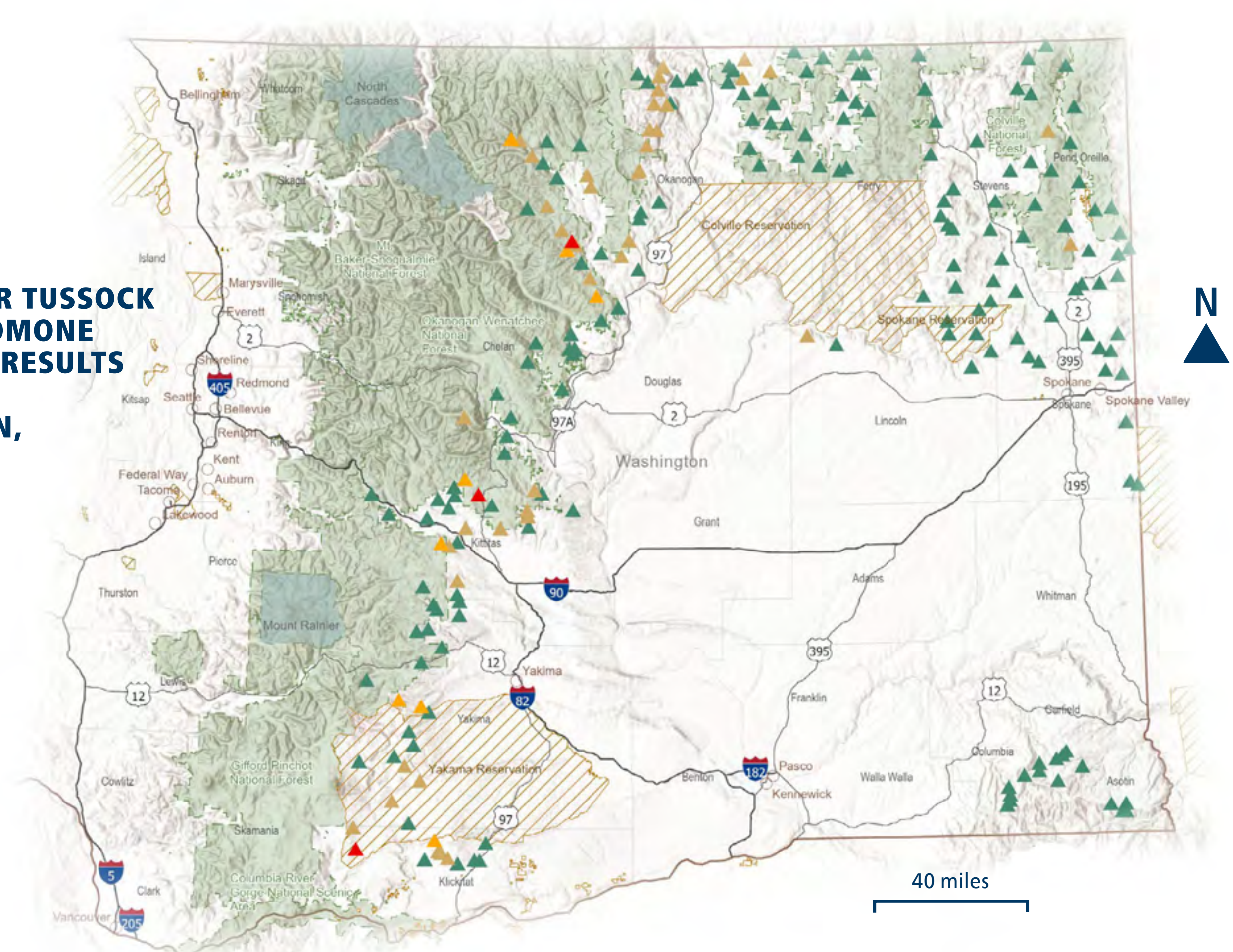


Figure 18.

DOUGLAS-FIR TUSSOCK MOTH PHEROMONE TRAP CATCH RESULTS IN EASTERN WASHINGTON, 2024

SOURCE: USFS

- <1 Moths
- 1 to 10
- 11 to 25
- 26 to 40



INSECTS | DEFOLIATORS

CREDIT: GLENN KOHLER /DNR

Western Spruce Budworm

(*Choristoneura occidentalis* Freeman)

NATIVE

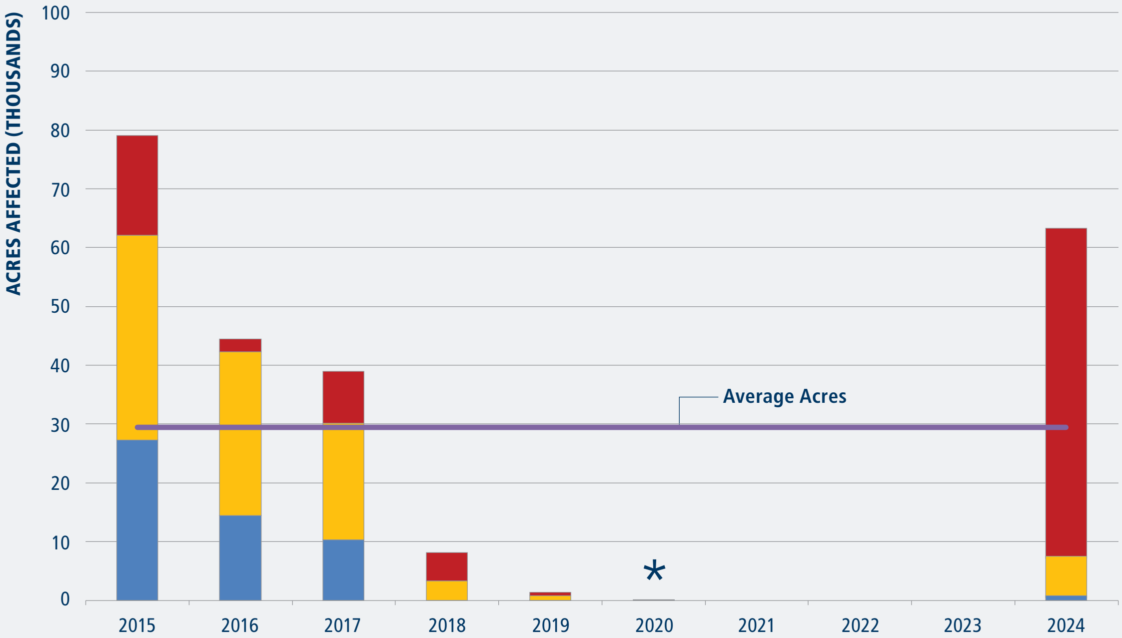
The total acres with western spruce budworm (WSB) defoliation in Washington jumped to over 63,500 acres in 2024, up from zero acres of detectable damage mapped from the air from 2021-2023 (Fig. 19). Outbreak levels of defoliation were mapped east of Ross Lake in Whatcom, Skagit, and Okanogan counties (Fig. 20). Outbreaks of this native defoliator are not unusual in Washington. This outbreak is currently smaller than the over 500,000 acres impacted in 2011 and 2012, when the last major WSB outbreak occurred in the central Washington Cascades. A more recent, shorter-lived, and smaller outbreak in northeast Washington saw a notable decline in defoliated acres by 2019.

WSB pheromone traps were discontinued in 2024. In recent years, traps were placed at over 100 locations in northeast Washington, but trapping efforts were paused after only a few trap sites from 2023 in northern Okanogan County indicated the potential for defoliation in 2024. The purpose of WSB trapping is to predict the next year's defoliation severity in an area that is currently experiencing an outbreak. Due to expense and time commitments, traps may not be placed in 2025. DNR recommends using silvicultural prescriptions for WSB management.

Western spruce budworm adult on grand fir

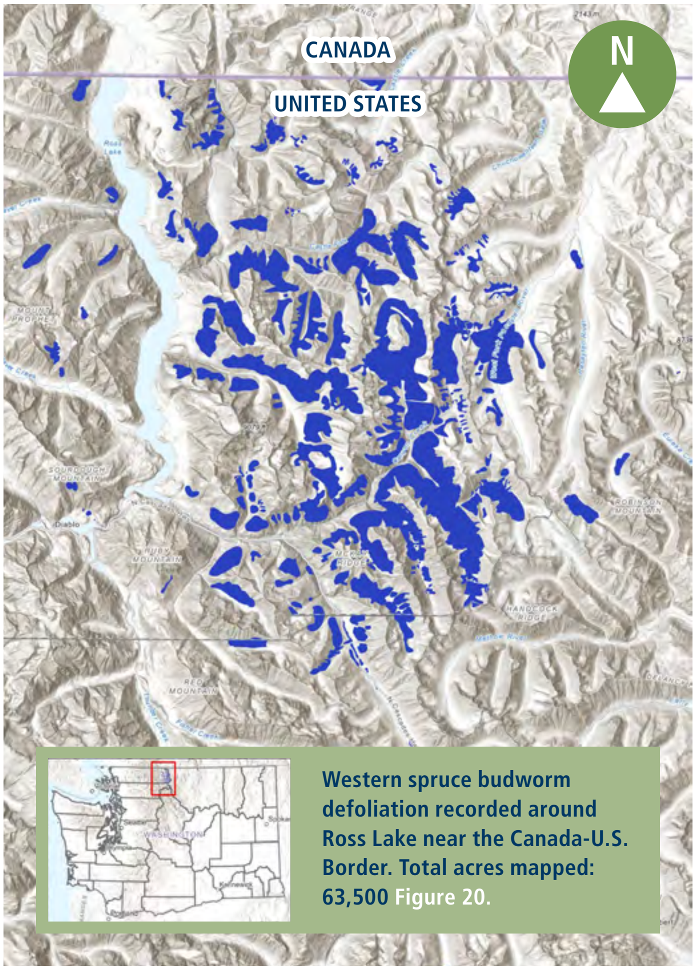
CREDIT: WILLIAM M. CIESLA, FOREST HEALTH MANAGEMENT INT. / BUGWOOD.ORG

WESTERN SPRUCE BUDWORM 10-YEAR TREND FOR TOTAL ACRES AFFECTED IN WASHINGTON Figure 19.



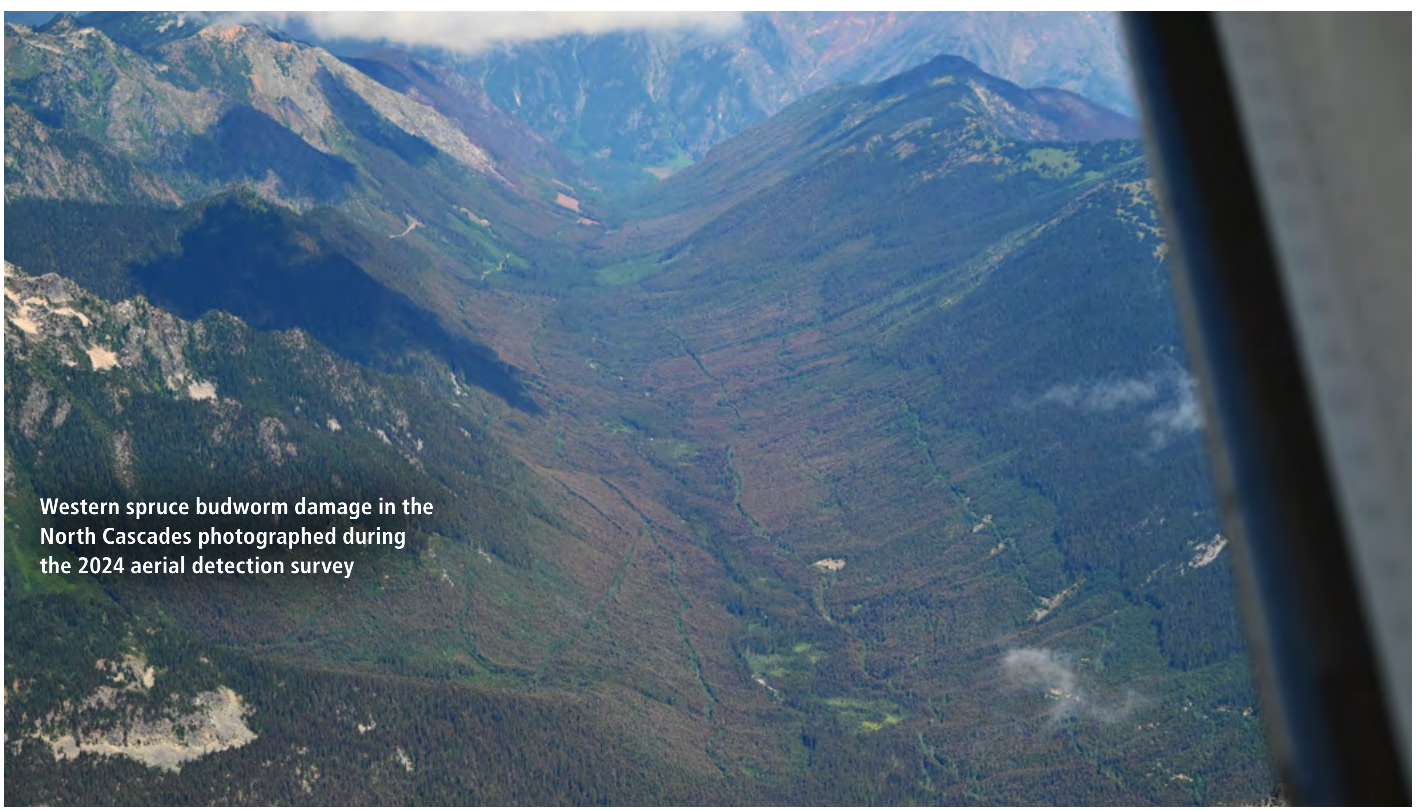
Western spruce budworm 10-year trend for total acres affected in Washington. Historic records of defoliation agents like western spruce budworm are attributed with low, medium, and high severity ratings and differ from the percent-class mortality ratings of current survey methodology.

*Trend data are not available for 2020 due to changes in survey methods and reduced survey area.



Western spruce budworm defoliation recorded around Ross Lake near the Canada-U.S. Border. Total acres mapped: 63,500 Figure 20.

Western spruce budworm damage on a sapling in 2024



Western spruce budworm damage in the North Cascades photographed during the 2024 aerial detection survey

CREDITS: (TOP LEFT) ISAAC DAVIS / DNR; (TOP RIGHT) DANA BRENNAN / DNR; (BOTTOM) JUSTIN HOF / USFS

INSECTS | DEFOLIATORS

CREDIT: ELIZABETH GRAHAM / USDA FOREST SERVICE

Western Blackheaded Budworm

(*Acleris gloverana* Walsingham)

NATIVE

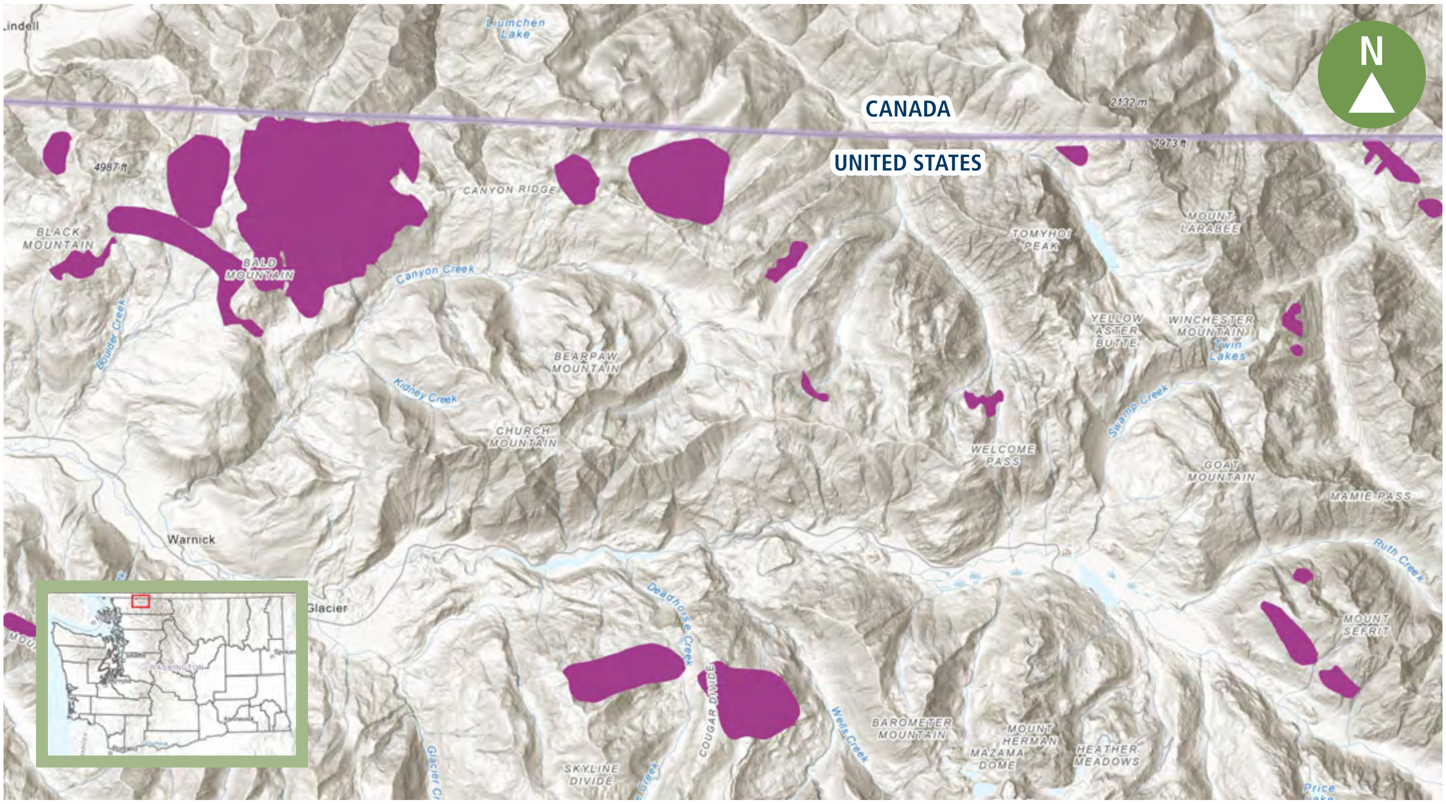
Approximately 9,400 acres with western blackheaded budworm (WBB) defoliation were observed in northwest Washington. The affected area is north of Mount Baker near the Canadian border and west of Ross Lake in Whatcom County (Fig. 21). Defoliation occurred primarily in higher elevations above 3,000 feet and mostly affected Pacific silver fir, with western hemlock and mountain hemlocks also damaged. Intensity of defoliation was light and mostly affecting upper crowns and treetops. WBB were also present in ground checks of a new western spruce budworm (WSB) outbreak in eastern Whatcom County and western Okanogan County between Ross Lake and the Robinson Mountain area north of Mazama. However, WSB appears to be the dominant damaging agent in that area. More ground monitoring of both outbreak areas is planned for 2025.

The last WBB outbreak in Washington occurred from 2013 to 2014 in areas around Baker Lake, the eastern Olympic Peninsula, and west of Mount Rainier. The largest WBB outbreak recorded in Washington affected over 450,000 acres from 1970 to 1973.

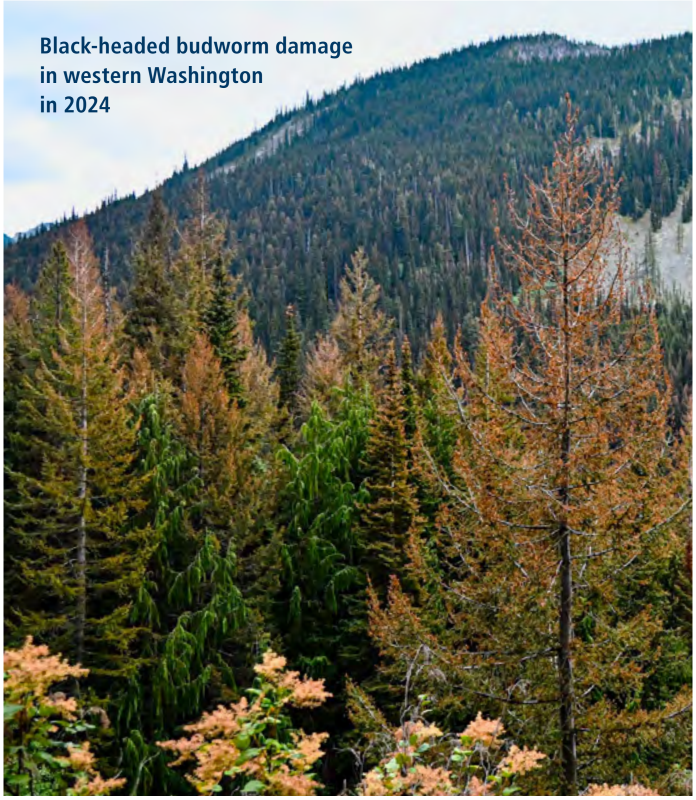
Black-headed budworm damage in western Washington on fir in 2024

CREDIT: JUSTIN HOF / USFS

Western blackheaded budworm defoliation recorded in 2024 Figure 21.



Dingy-red colored trees damaged by the black-headed budworm in western Washington in 2024 (lower left of the photo)



Black-headed budworm damage in western Washington in 2024

Black-headed budworm damage in western Washington on western hemlock in 2024

CREDITS: JUSTIN HOF / USFS

INSECTS | DEFOLIATORS

CREDIT: FRANCO FOLINI

Western Tent Caterpillar

(*Malacosoma californicum* Packard)

NATIVE

Isolated outbreaks of western tent caterpillar (WTC) developed in areas of northwest Washington in 2023 and continue to affect the same areas in 2024. Approximately 4,600 acres with defoliation were observed in western Skagit County around Anacortes and Guemes Island, the San Juan Islands; and western Whatcom County around Bellingham and Lummi Island. The last major WTC outbreak in western Washington occurred from 2012 to 2014. WTC outbreaks are cyclical and rarely last more than a few years.

Western tent caterpillar (WTC) outbreaks are cyclical and rarely last more than a few years

Western tent caterpillar larvae on Guemes Island, 2023

CREDIT: JAKE WHITTENBERG / KING 5 NEWS

CREDIT: JUSTIN HOF / USFS

Defoliated hardwoods in the San Juan Islands caused by western tent caterpillar as seen in 2024

INSECTS | BARK BEETLES

JON YUSCHOCK / BUGWOOD.ORG

Spongy Moth

(*Lymantria dispar* Linnaeus)

NON-NATIVE

Washington State Department of Agriculture (WSDA), the USDA Animal and Plant Health Inspection Service (APHIS), and the USFS continue to work cooperatively to eradicate introduced populations of spongy moth. Two eradication projects were completed in May with 1,383 acres in Thurston County and 920 acres in Skagit County aerially treated with three applications of the biological insecticide *Bacillus thuringiensis* var. *kurstaki* in a formulation approved for organic agriculture.

Post-treatment high-density delimitation traps were placed in and around the treated areas, but no moths were trapped in the treatment areas in 2024. WSDA will continue to survey for two years to ensure the eradication effort was successful.

WSDA deployed nearly 21,000 detection traps statewide to survey for the presence of all species and subspecies of spongy moth and the flighted spongy moth complex in 2024. Thirty-two adult male moths were collected in western Washington. Molecular diagnostics confirmed all were the non-flighted subspecies of spongy moth, *Lymantria dispar dispar.*

No eradications are planned in response to moth detections for 2025. In addition to post-treatment trapping, WSDA will implement high density delimitation trapping to monitor all 2024 detection sites in Clark, Pierce, King, Snohomish, Thurston, and Whatcom counties to determine the extent of possible spongy moth infestations in these areas, allowing for the implementation of an eradication project in 2026.

More information about spongy moth in Washington can be found at www.agr.wa.gov/moths.

Spongy moth monitoring trap

CREDIT: CHRIS EVANS / UNIVERSITY OF ILLINIOS, BUGWOOD.ORG

INSECTS | DEFOLIATORS

CREDIT: FRANCO FOLINI

Douglas-fir Needle Midge

(*Contarinia pseudotsugae* Condrashoff and other *Contarinia* species)

NATIVE

Over 200 acres of Douglas-fir needle midge defoliation was mapped south of Danville during the 2024 aerial survey. Significant defoliation was also noted on the ground along US Route 395 between Boyds and Laurier. The damage was evident in all Douglas-fir on infested sites, regardless of size or age. Douglas-fir needle midge is a native fly whose larvae feed in current year Douglas-fir needles. Defoliation results in discoloration, distortion, and slight swelling of affected needles. Although Douglas-fir needle midge is not typically a mortality agent, several consecutive years of defoliation can result in twig dieback and reduced tree vigor.

CREDIT: DANA BRENNAN / DNR

CREDIT: DANA BRENNAN / DNR

Left: Douglas-fir needle midge damage on a sapling in 2024

Above: (Detail) Douglas-fir needle midge damage on a sapling in 2024

INSECTS | BRANCH AND TERMINAL INSECTS

CREDIT: GILLES SAN MARTIN

Balsam Woolly Adelgid

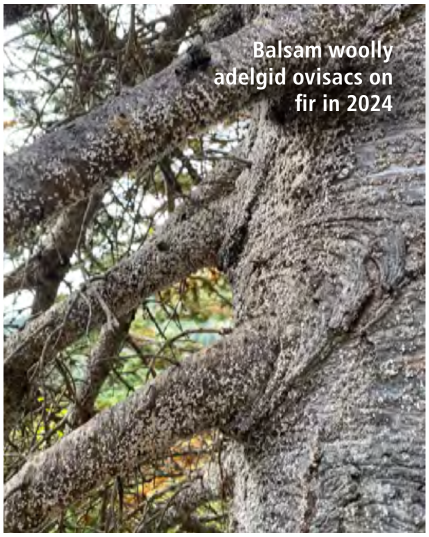
(*Adelges piceae* Ratzeburg)

NON-NATIVE

Balsam woolly adelgid (BWA) is a non-native sucking insect that continues to be widespread in Washington and causes mortality to subalpine fir, Pacific silver fir, and grand fir. The most significant BWA damage is in subalpine fir stands at high elevation. Observers mapped approximately 30,300 acres with damage in 2024, more than double the 14,400 acres mapped in 2023 but closer to the 10-year average of 31,900 acres (Fig. 22). The majority of BWA damage occurs on federal land.

BWA damage, primarily to subalpine fir and Pacific silver fir, was recorded at high elevations in the eastern Olympic Mountains and in scattered high elevation areas east of the Cascades. BWA infestations are often chronic, and cumulative effects may result in mortality. BWA damage levels included approximately 3,600 acres with some host mortality in 2024.

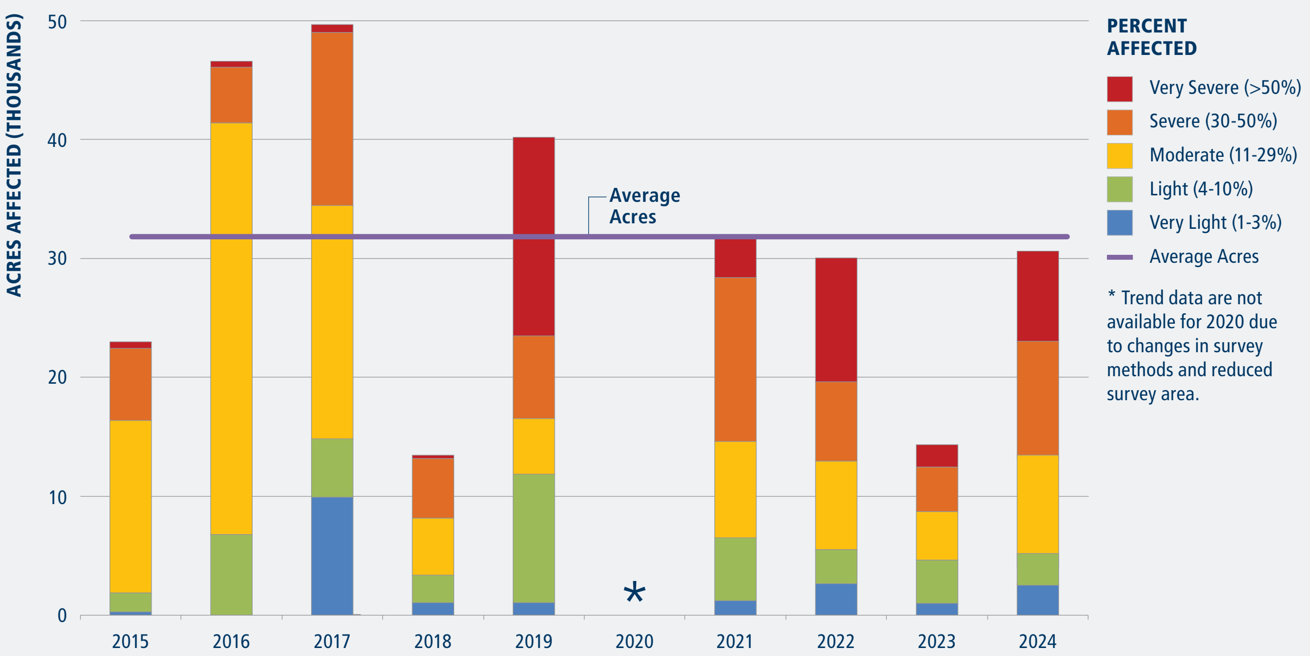
Western balsam bark beetle (page 34) is another important mortality agent in subalpine fir stands that may attack trees weakened by BWA infestation. Approximately 12,500 acres in these same high elevation areas were mapped with some subalpine fir mortality caused by western balsam bark beetle. BWA infestation can be a predisposing factor to western balsam bark beetle attack.



Balsam woolly adelgid ovisacs on fir in 2024

CREDIT: RACHEL BROOKS / DNR

BALSAM WOOLLY ADELGID 10-YEAR TREND FOR TOTAL ACRES AFFECTED IN WASHINGTON Figure 22.



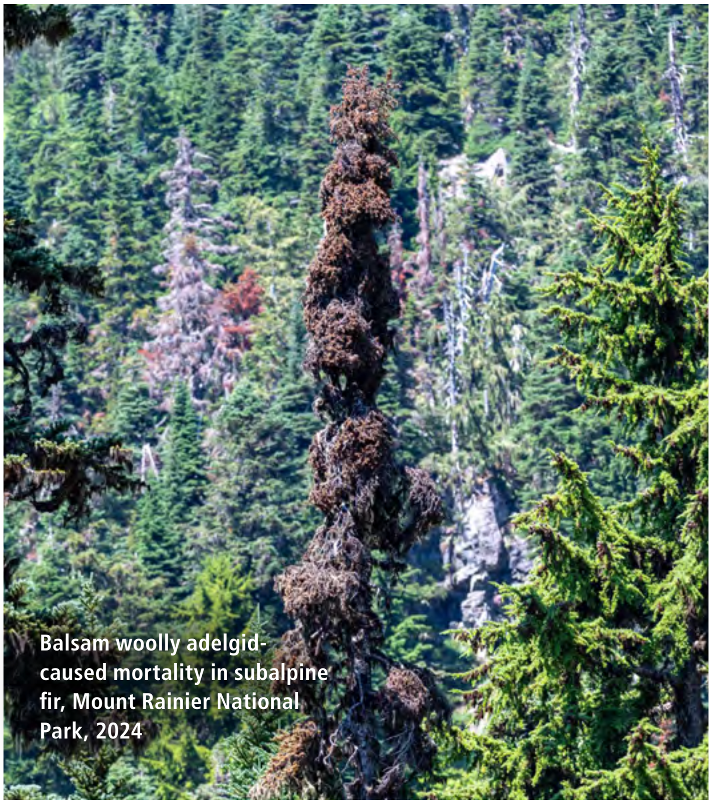
CREDIT: RACHEL BROOKS / DNR

Balsam woolly adelgid ovisacs on fir in 2024

CREDIT: RACHEL BROOKS / DNR

Gouting and deformation on fir branches caused by the balsam woolly adelgid in 2024

CREDIT: GLENN KOHLER / DNR



Balsam woolly adelgid-caused mortality in subalpine fir, Mount Rainier National Park, 2024

INSECTS | WOOD BORERS

CREDIT: USDA FOREST SERVICE

Flatheaded Fir Borer

(*Phaenops drummondi* Kirby)

NATIVE

There are many different native wood borer species in the families Cerambycidae (longhorned wood borers), Buprestidae (metallic wood borers), and Siricidae (woodwasps) that will attack already dead or dying trees afflicted with other mortality agents. Some species can be more aggressive, especially during droughts or on drier sites. The flatheaded fir borer (FFB) is known to kill Douglas-fir on dry sites in southwest Oregon. Recently, there have been reports of FFB killing green trees in Idaho, southern British Columbia, and northeast Washington.

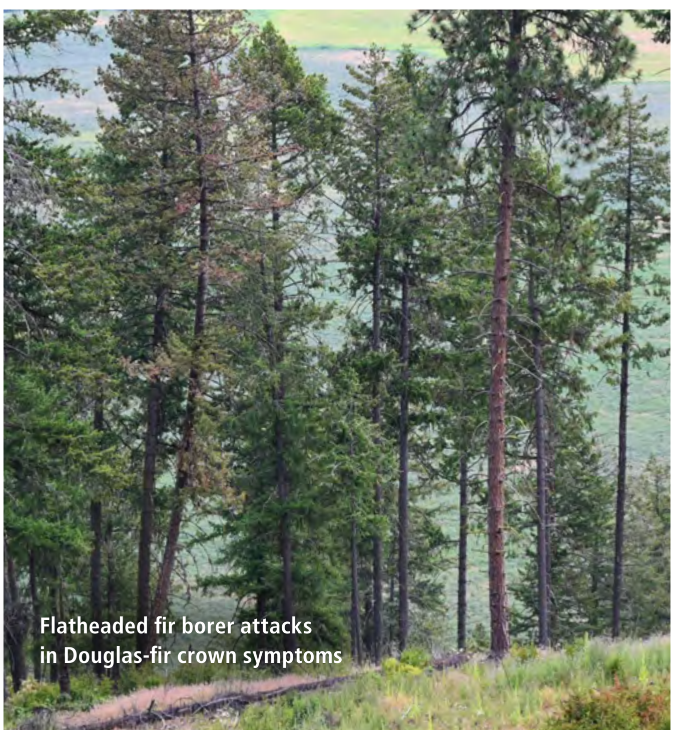
Symptoms associated with FFB attack in live Douglas-fir include: woodpecker holes and removal of outer bark, discoloration and loss of older foliage, clear "pitch pearls" in bark crevices, one-eighth inch, oval-shaped exit holes, and fine tunneling tracks in live inner bark. This combination of symptoms and absence of bark beetle activity may indicate FFB is killing Douglas-fir, with drought being the most likely inciting factor. Adult beetles are needed for positive identification but are rarely found in trees as FFB cannot be identified from gallery patterns and larvae alone.

In 2023 and 2024, several declining Douglas-fir with signs and symptoms of more aggressive tree-killing FFB attacks were observed at sites near Cle Elum (Kittitas County), Mazama (Okanogan County), and Colville (Stevens County). Based on reports from early 2025, there's also likely an increase in FFB damage in eastern Klickitat County.

The FFB damage signature is unfortunately difficult to see from the air because FFB-attacked trees decline slowly and often retain some green foliage. Unless the damage becomes more severe and widespread, it may be challenging to capture its extent in an aerial survey. FFB damage can also occur in Douglas-fir stands affected by secondary bark beetle attacks, which have a more distinct aerial signature of top-kill and branch flagging (see page 31 for more information).

FFB may become a wider emerging issue for some lower elevation Douglas-fir stands under hotter and more intense drought conditions. FFB-caused mortality tends to be worse on stand edges, in more open stands, south or west-facing slopes, and ridges. These sites all receive more heat, often retain less moisture, and can desiccate needles.

CREDITS: GLENN KOHLER / DNR



Flatheaded fir borer attacks in Douglas-fir crown symptoms

Woodpecker removal of outer bark

INSECTS | WOOD BORERS

CREDIT: BENJAMIN SMITH

Emerald Ash Borer

(*Agrilus planipennis* Fairmaire)

NON-NATIVE

The emerald ash borer (EAB; *Agrilus planipennis*), a small metallic green wood boring beetle native to Asia, continues to pose severe threats to ash trees (*Fraxinus* spp.) across the United States. First discovered in southeastern Michigan in 2002, the beetle burrows beneath the bark of ash trees to consume the phloem layer, leaving serpentine galleries that girdle and eventually kill trees. Common symptoms of infestation include crown and branch dieback, galleries under tree bark, and one-eight-inch-wide D-shaped exit holes through the bark.

With no successful eradication examples in the U.S., modern management efforts focus on removal, replacement, and chemical treatments for significant or historic trees. Research is underway to develop EAB-resistant ash trees using the genetics of "lingering ash" that survive infestations. EAB has expanded its presence in western US since its initial detection on the West Coast in 2022 in Forest Grove, Oregon.

CREDITS: GLENN KOHLER / DNR

D-shaped exit holes of EAB from the Vancouver, BC detection

A city park in Camas, WA with a mature Oregon ash canopy

NEW DETECTIONS IN 2024

- Vancouver, British Columbia: In May 2024, the Canadian Food Inspection Agency confirmed the presence of EAB in Vancouver. This marks the first detection of EAB in British Columbia, prompting Canadian officials to implement movement restrictions on ash materials and firewood to prevent further spread. The city of Vancouver continues to monitor the spread of EAB using branch sampling protocols with park, public, and street trees.

- North Dakota: In late August 2024, adult EAB specimens were collected from a trap in LaMoure County, near Edgeley, North Dakota. This detection signifies the first occurrence of EAB in the state, leading to the implementation of quarantines to restrict the movement of ash materials and firewood from infested areas.

EXPANSION IN OREGON

- EAB has been found in three additional Oregon counties* since its detection in Forest Grove: Clackamas, Yamhill, and Marion. The Oregon Department of Agriculture, Oregon Department of Forestry and the state's Interagency EAB Task Force are working to slow its spread through quarantines, trapping, providing technical assistance to land managers and urban foresters and implementing mitigation programing.

WASHINGTON DNR PREPAREDNESS INITIATIVES. Recognizing the imminent threat EAB poses to Washington, DNR has proactively undertaken several initiatives within the last year to help partners prepare for its eventual detection and spread:

* https://experience.arcgis.com/experience/9f29b1860cb04d36ad71b122148277f3/page/Page

- Trap Tree Creation Workshop: In the fall of 2024, staff from the Urban & Community Forestry Program hosted a workshop in Vancouver, Washington to educate and engage southwestern communities in creating trap trees, a method used to monitor EAB populations and locate initial infestations.

- Preparedness Support: DNR also funded EAB preparedness activities for the City of Vancouver including the acquisition of treatment equipment, initial ash tree removals and replacements in park properties, and the creation of outreach materials to inform the public about EAB identification and impacts.

- Resource Planning: DNR secured federal funding for the development of the Washington Resources and Management Guide for EAB. This guide will provide Washington landowners and land managers with resources to support decisions around ash treatment, removal, replacement and biological control. The Washington Invasive Species Council is slated to receive federal funding to help develop the guide.

- Pest Readiness Project Outreach: DNR and the Washington Invasive Species Council hosted three regional pest readiness workshops for municipal tree care staff. These workshops had large components focused on EAB preparedness using inventories and the Pest Readiness Playbook (https://invasivespecies.wa.gov/wp-content/uploads/2020/01/UrbanForestPestReadinessPlaybook.pdf).

- Urban Tree Inventories: Numerous urban tree inventories funded by DNR's Community Forestry Assistance Grant Program have been completed throughout the state. These inventories are crucial for identifying existing ash trees, preparing for potential EAB invasions, and enabling targeted management and conservation efforts by city staff.

Emerald ash borer symptoms in Vancouver, British Columbia

An ash tree is intentionally girdled by removing a ring of bark, stressing the tree and attracting EAB in search of weakened hosts

CONTINUED VIGILANCE AND PUBLIC PARTICIPATION. The spread of EAB underscores the importance of public diligence in preventing the movement of firewood and other potentially infested ash materials. Everyone is encouraged to:

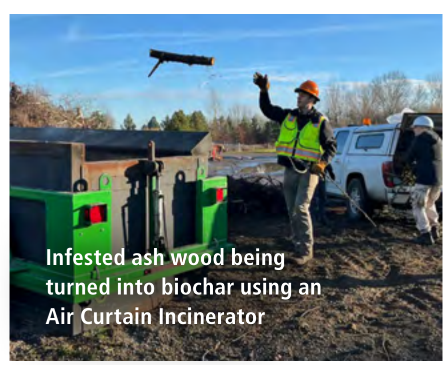
- Recognize Symptoms: Common signs of EAB infestation include crown and branch dieback, unusual leaf sprouting from trunks, serpentine galleries under the bark, and D-shaped exit holes.

- Report Sightings: In Washington state, suspected EAB sightings or ash tree damage can be reported through the Washington Invasive Species Council's online portal: https://invasivespecies.wa.gov/report-a-sighting/

- Avoid Planting Ash: Land managers and homeowners alike should avoid planting new ash trees.

- Avoid Transporting Wood: Firewood used for camping is a significant vector for spreading invasive pests across the state. When possible, purchase wood and firewood close to where you will burn it.

- Prepare Your Community: Help your community develop an EAB preparedness strategy using the Pest Readiness Playbook: https://invasivespecies.wa.gov/projects/pest-ready/



Infested ash wood being turned into biochar using an Air Curtain Incinerator

CREDITS: (TOP LEFT) ADAM AIROLDI / WA STATE PARKS; (TOP RIGHT) ZEIMA KASSAHUN / DNR; (BOTTOM) KAT BETHEA / OREGON DOF

DISEASES | ROOT ROTS

Root Rot Diseases

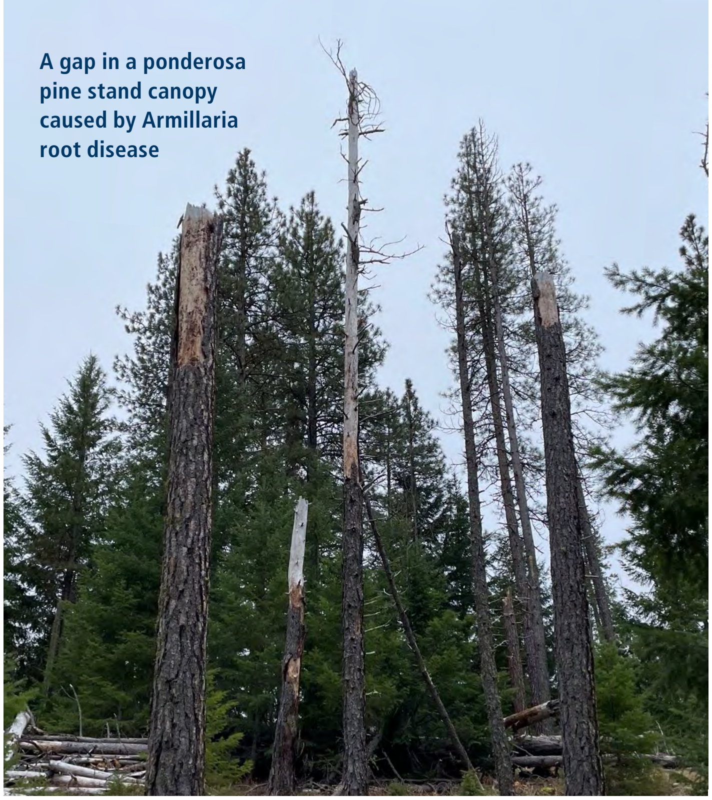
Variety of fungi

NATIVE

A handful of root diseases impact forests throughout Washington. These include Armillaria root disease (*Armillaria solidipes*, formerly North American A. *ostoyae*); Heterobasidion root diseases (*Heterobasidion irregulare* and *H. occidentale*); and laminated root rot (*Coniferiporia sulphurascens*). These pathogens are the most common and destructive of the root disease pathogens in Washington.

Root diseases that occur within Washington forests are caused by native fungi and are a well-established part of our forested systems. Root rot diseases are persistent in forests, where they may affect tree growth and cause tree mortality, but may also help diversify forest structure and tree species composition. Root rot diseases are very challenging to manage and are typically considered "diseases of the site." Correct identification of the specific pathogen is important for determining management response. In general, early seral species like pines and larches are more tolerant to root pathogens compared to late seral species like true firs and hemlocks.

Root rots are difficult to map during the aerial detection survey, as their signature is not easily seen from above. If mapped at all, they are often classified under associated categories, such as "young conifer damage" or "Douglas-fir beetle" and not under root disease. For example, in 2024 only 200 acres of root disease was mapped during the aerial detection survey, despite estimates that almost 2.8 million acres in Washington and Oregon combined are at risk of losing 15% or more of total basal area due to root disease between 2013 and 2027 (Krist et al. 2014, Lockman and Kearns 2016). Root rot diseases continue to represent a large portion of site visits and questions DNR's forest pathologists respond to and will stay a common management concern for Washington's forests.



A gap in a ponderosa pine stand canopy caused by Armillaria root disease

CREDITS: RACHEL BROOKS / DNR

DNR pathogists collect bark samples to identify and catalogue root diseases in Washington forests

Bark removed from a ponderosa pine base exposing the white mycelial fan of the Armillaria fungus

DISEASES | CANKERS

CREDIT: USDA FOREST SERVICE

White Pine Blister Rust

(Cronartium ribicola)

NON-NATIVE

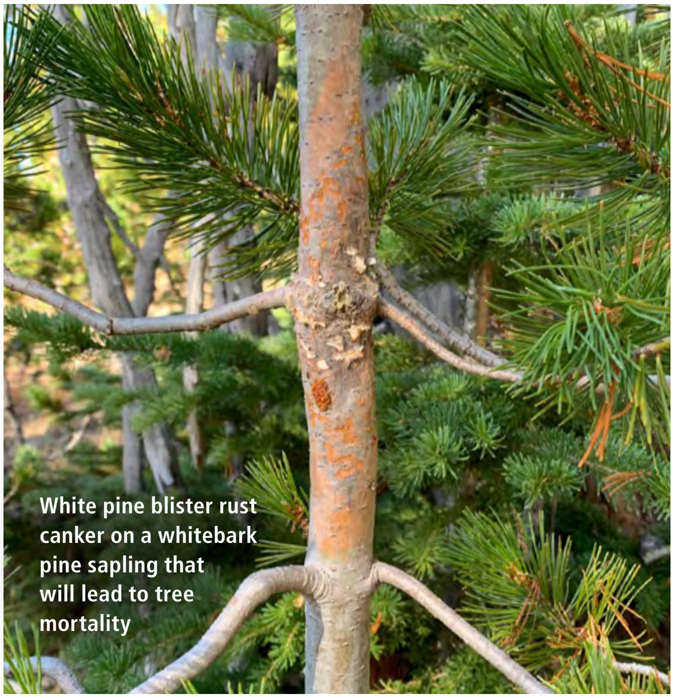
The non-native fungal pathogen *Cronartium ribicola,* the cause of white pine blister rust (WPBR) was accidently introduced to North America more than 100 years ago. All nine species of white pine (five-needle pines) native to the US are highly susceptible to the disease, with mortality rates surpassing 90% in some areas. Today, this pathogen is found throughout Washington where it has caused widespread mortality of our native western white pine (*Pinus monticola*) and whitebark pine (*Pinus albicaulis*).

Western white pine is an important economic and ecologic tree species in the Pacific Northwest as it once was a major timber tree and dominated many forest stands prior to being devastated by WPBR. Whitebark pine is considered a keystone species in high alpine ecosystems and is now listed as threatened under the US Endangered Species Act due to mortality caused by WPBR and increasing pressures from mountain pine beetle, wildfire, and weather extremes.

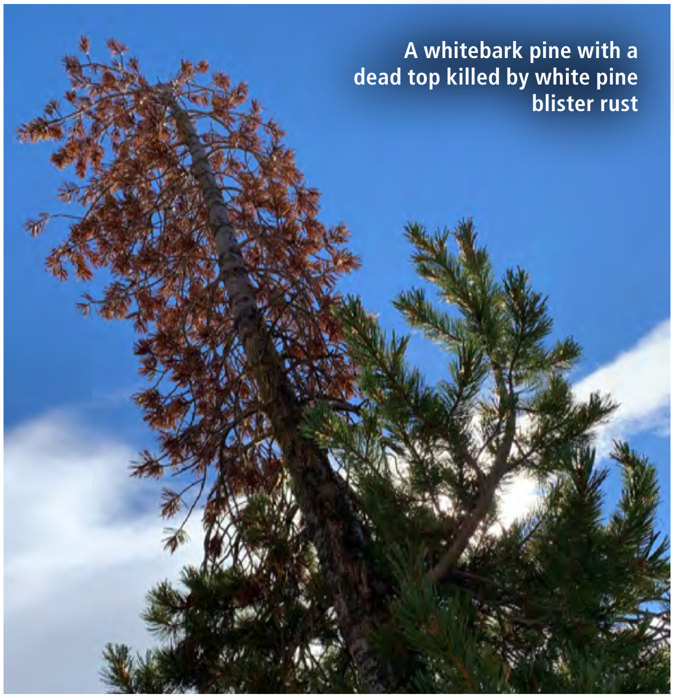
WPBR is difficult to map during aerial detection surveys, as cankers can cause slow branch and top dieback for many years before a tree succumbs to the disease, and full crowns may or may not turn red in one year. If damage is mapped, it is often included with the mountain pine beetle codes for western white pine and whitebark pine. This is because WPBR killed trees can turn red when they are killed by a low basal canker, similar to the symptom caused by mountain pine beetles. In total, 200 acres of western white pine and 8,780 acres of whitebark pine were mapped containing damaged trees in 2024 and coded for mountain pine beetle. WPBR and mountain pine beetle can occur in the same stand and even on the same tree. Ground checks confirmed the majority of mortality was driven by mountain pine beetle, though WPBR is likely present and causing branch/top dieback, reductions in cone crops, and delayed mortality in most places.

Natural genetic variation has fortunately provided some individual western white pine and whitebark pine lineages with varying degrees of resistance to the pathogen that causes WPBR. Breeding programs have been active for decades in efforts to take advantage of those variations. DNR, in collaboration with USFS, local tribes, and British Columbia, maintains 16 long-term research field sites focused on understanding the natural genetic variation found within western white pine and whitebark pine.

CREDITS: RACHEL BROOKS / DNR



White pine blister rust canker on a whitebark pine sapling that will lead to tree mortality



A whitebark pine with a dead top killed by white pine blister rust

DISEASES | CANKERS

JOSEPH OBRIEN / USDA
FOREST SERVICE, BUGWOOD.ORG

Sudden Oak Death

(*Phytophthora ramorum* Werres et al.)

NON-NATIVE

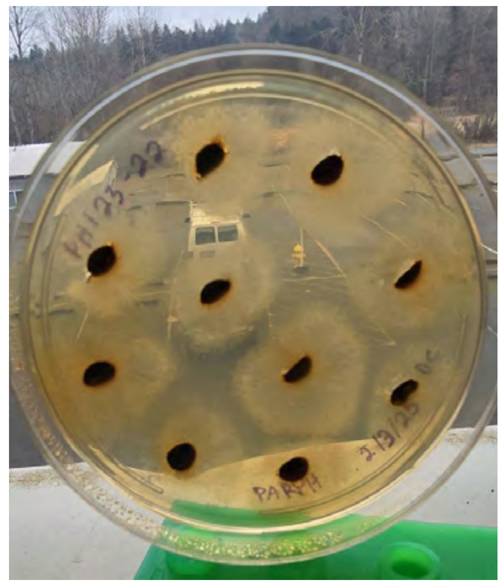
Phytophthora ramorum (Pr) is the causal agent of sudden oak death, ramorum leaf blight, and ramorum dieback. This water mold is invasive in North America and has caused extensive mortality of tanoaks and several oak species in southwestern Oregon and California. Luckily, Oregon white oak, the oak native to Washington, is not considered susceptible. Unfortunately, other native Washington plants and trees are susceptible, including western larch.

This pathogen can move short distances via wind and wind-driven rain and can move long distances on nursery plant materials transported by humans. Due to the presence of susceptible hosts, suitable climatic conditions, and plant nurseries with Pr-infected stock, Washington's forests remain at risk for Pr spread and Pr-caused disease. However, to date, damage like that caused by Pr in forests of Oregon and California has not been observed in Washington.

In 2024, 11 waterways in eastern Washington and one in western Washington were bait sampled for Pr using fresh rhododendron leaves. Selected eastern sites (five sites in Yakima County, three sites in Pend Oreille County, two sites in Stevens County, and one site in Okanogan County) were in watersheds that contained large numbers of western larch. The western Washington site in Mason County was in an area with no known Pr presence in which rhododendron leaves for sampling were collected. Sites were sampled six times from March through June.

No sampling location tested positive for Pr in 2024. Overall, most sampled waterways in Washington are free from Pr and there has been no indication to date that the pathogen is leaving waterways, as all vegetation samples collected in the woodlands bordering previously positive waterways have been negative for Pr.

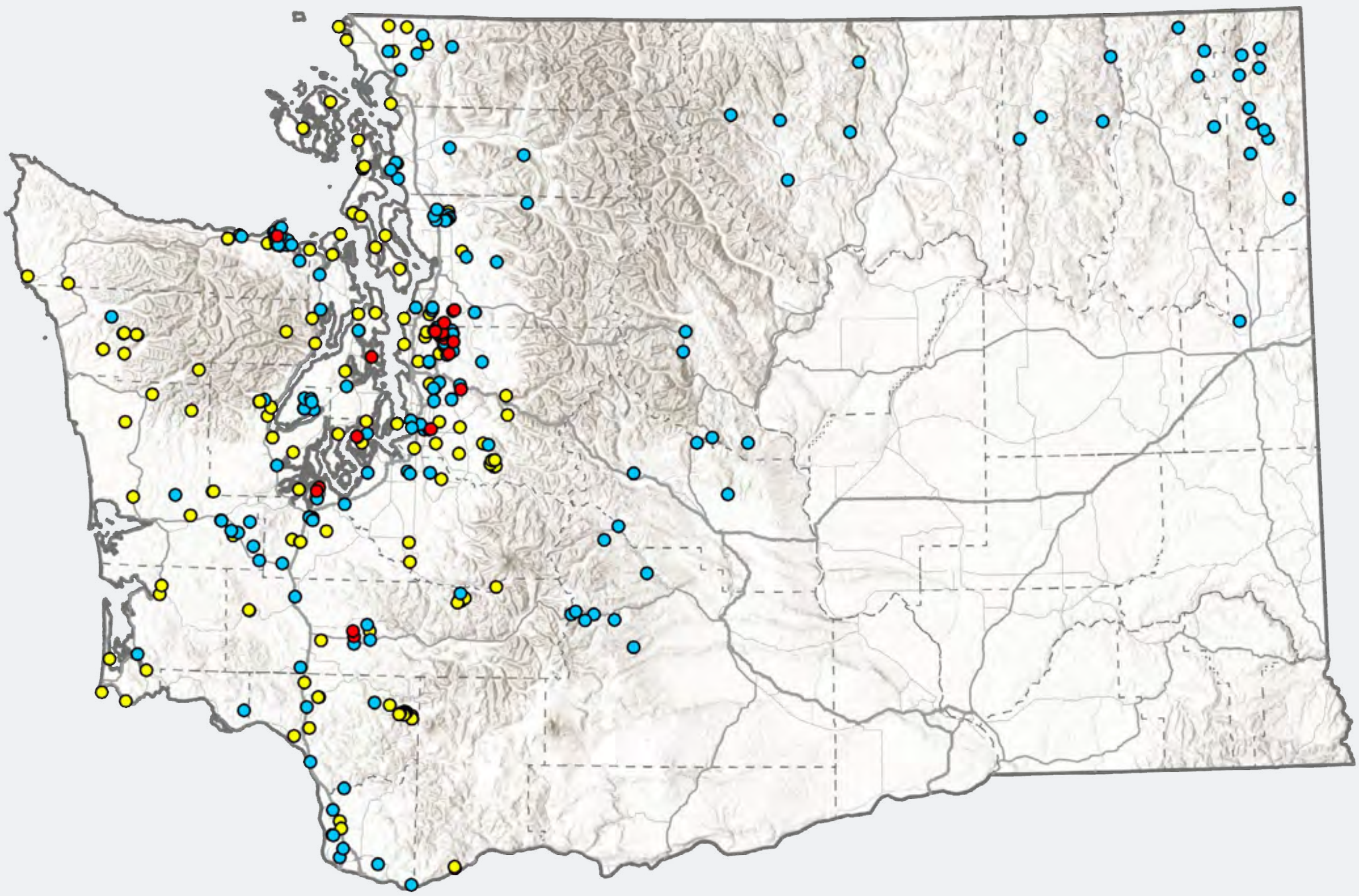
In collaboration with WSDA and WSU, next generation sequencing laboratory techniques were used in 2024 to identify other Phytophthora species collected from streams during the 2023 survey. Several other Phytophthora species (not including *P. ramorum*) as well as other Oomycete genera, were identified. While the absence of *P. ramorum* in these samples is welcome news, more research is needed to understand the roles and effects of other species identified. The results of this work demonstrate the value of these surveys, not only as a method of early detection, but also as a method to advance baseline understanding about the diversity of *Phytophthora* species in our watersheds.



CREDITS: MARIANNE ELLIOT / WSU

Top: Petri plate with Phytophthora colonies growing from symptomatic rhododendron leaf baits from a previous year

Right: *Phytophthora ramorum* chlamydospores in culture



No sampling locations tested positive for Pr in 2024. However, Washington's forests remain at risk for Pr spread and Pr-caused disease

Figure 23.

DNR *PHYTOPHTHORA RAMORUM* MONITORING, DETECTION, AND SURVEY SITES, 2003-2024

SOURCE: DNR

KEY

- **Positive** Aquatic Baiting Location
- **Negative** Aquatic Baiting Location
- **Negative** Wildland Survey Location

DISEASES | CANKERS

Table 3. Monitoring history of waterways that have tested positive for *Phytophthora ramorum* (Pr).
Years with positive detections are indicated with a green square and a plus sign. Years with no detection are indicated with a blue square and a minus sign. White squares indicate years the waterway was not surveyed. No positive detections occurred in 2024, and no sampling was done in previously positive waterways.

COUNTY	WATERWAY	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Clallam	Dungeness River & Canals								+	+	–	–								
King	Bear Creek						+	–												
King	Cottage Lake Creek							+	–											
King	Issaquah Creek									–	–	–	+							
King	Little Bear Creek						+	–								+				
King	Mill Creek																+			
King	Sammamish River		+	+	+	+	+	+	+	+	+	+	+	+	+				–	
King	Woodin Creek					+	+	+												
Kitsap	Issel Creek									+	+									
Lewis	Mill Creek						+	+			–	–								
Pierce	Unnamed stream, Rosedale	+	–	+																
Snohomish	Evans Creek															+				
Thurston	Woodard Creek							–	+	–	+									
TOTAL POSITIVE WATERWAYS		1	1	2	1	2	5	4	3	3	3	1	2	1	1	2	1	0	0	0

+ Year with positive detection
– Year with no detection
Year not surveyed

DISEASES | CANKERS

Phytophthora austrocedri

NON-NATIVE

(Not currently present in Washington)

Austrocedrus (*Austrocedrus chilensis*) trees killed by *Phytophthora austrocedri* in Argentina

CREDIT: EVERETT HANSEN / OSU

Phytophthora austrocedri is an aggressive soilborne plant pathogen of unknown origin that was identified on symptomatic common juniper plants at two Oregon nurseries in late 2023 and 2024. This is the first report of this plant pathogen in North America, and it has never been identified in Washington. USDA Animal Plant Health Inspection Service, Oregon Department of Agriculture, and the two nurseries are cooperating to destroy infected plant material and monitor the areas. However, based on surveys and interviews of both nurseries, it is likely that the pathogen has been present for many years prior to the recent detections and may be present elsewhere.

In forests of southern Argentina, the disease known as mal del ciprés, or cypress sickness, began causing stand-level mortality of Chilean cypress in the late 1940s. In 2007, *Phytophthora austrocedri* was identified as the cause of the disease. By 2010, it was found on dying common juniper in northern England and is now confirmed at over one hundred locations across England and Scotland. Impacted species in Europe include yellow-cedar and Port-Orford-cedar.

Yellow-cedar is an economically, culturally, and ecologically valuable native tree throughout its range, which includes the Cascade Range in Washington. Port-Orford cedar is native to parts of California and Oregon and found as an ornamental in Washington. Based on the locations where the pathogen has established and its affinity for sites with high soil moisture, it is likely to be able to survive well in the wet, mild climates of the Pacific Northwest where susceptible hosts occur.

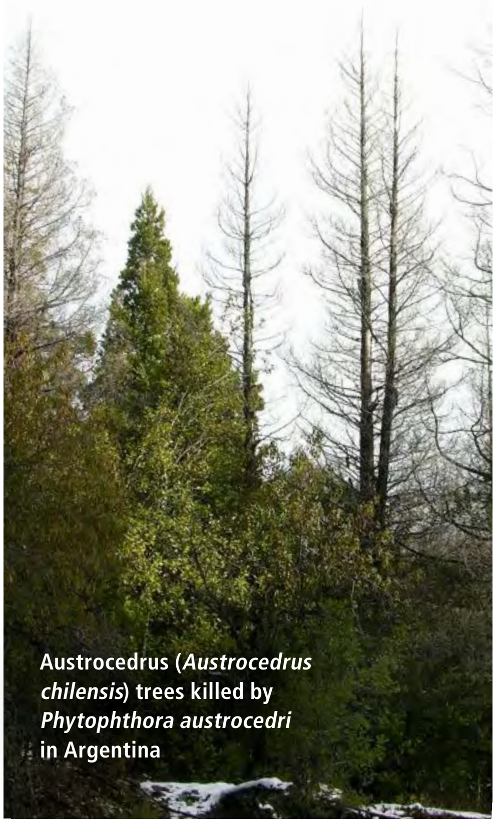
Phytophthora austrocedri can kill several juniper and cypress species in the family Cupressaceae, though its impact to most North American plant species is unknown or unconfirmed. Researchers at Oregon State University, with funding from the USFS, are evaluating the susceptibility of Pacific Northwest conifers. Understanding the susceptibility of our native species and partnering across agencies will give us the best chance to prevent the introduction of this disease into nurseries, ornamental plantings, managed landscapes, and natural forests. This pathogen attacks roots and stem bases, causing discoloration and death of the tree crown. The pathogen is primarily spread over long distances via human transport of infected plant material or locally through water and soil movement.

CREDITS: CROWN COPYRIGHT / FOREST RESEARCH

A juniper in the UK killed by *P. austrocedri*

Preventing unintentional spread and eradicating infected plant material are critical steps to ensure this pathogen does not impact Pacific Northwest forests. Movement of live plants is the most likely method of disease introduction, so care must be taken to prevent unintentional planting of infected seedlings. Oregon State University Extension Service has compiled best practices guidelines available online at https://extension.oregonstate.edu/catalog/pub/em-9330-preventing-phytophthora-infestations-restoration-nurseries. Building awareness of this new disease threat, promoting early detection, and preventing introduction can help us to safeguard our forests.

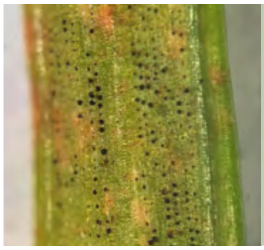
Middle Bottom: Typical basal stem lesion caused by *P. austrocedri* as seen on juniper in the UK



Austrocedrus (*Austrocedrus chilensis*) trees killed by *Phytophthora austrocedri* in Argentina

DISEASES | FOLIAR DISEASES

CREDIT: RACHEL BROOKS / DNR



Swiss Needle Cast

(*Nothophaeocryptopus gaeumanni*)

NATIVE

Swiss needle cast disease (SNC) is caused by the native fungus *Nothophaeocryptopus gaeumanni,* which is found everywhere its only host Douglas-fir is grown. This foliar disease can cause premature needle loss and foliar discoloration resulting in reduced tree growth, as the pathogen produces fruiting bodies that black stomates (pores in the needle) where gas exchange occurs. This pathogen became a priority in the coastal forests of Washington and Oregon in the 1990s and has more recently become a concern in areas of British Columbia. These areas have likely seen high SNC levels due to fungi-favorable topographic and climatic conditions (including mild winters and wet springs), historical plantings using off-site Douglas-fir seed sources, and increases in Douglas-fir densities due to forest management practices. Monitoring SNC and its symptoms along the Pacific Northwest coast from the air and on the ground have become common practice in Washington and Oregon.

An aerial survey covering 2.1 million acres of land along the Pacific coast in April and May 2024 mapped the distribution of discolored Douglas-fir trees typically associated with SNC (see below). Observers mapped just under 50,000 acres with Douglas-fir displaying yellow-brown foliage, representing about 2.4% of the total area surveyed. Severely symptomatic stands were generally located between Westport and Ilwaco, while moderately symptomatic stands were found scattered throughout the region (see following page). The total symptomatic acreage mapped is lower than the range of previous measurements.

To support the aerial survey, 44 ground locations across the same coastal area were also assessed in spring 2024. SNC fungal counts (percentage of fungal fruiting bodies visible in a subset of stomata) and needle retention (number of years with needles retained on a secondary lateral branch) were estimated within Douglas-fir dominated stands. An average of 14.1% SNC fungal counts and 2.3 years of needle retention was measured at these coastal plots.

Additionally, 17 ground plots were surveyed in Whatcom and Skagit counties during the same time in an area only monitored by ground surveys since 2021 (referred to as the NW region). This area was included due to its proximity to British Columbia, where SNC has been reported as a growing concern. An average of 17.1% SNC fungal counts and 2.5 years of needle retention were measured. These numbers are both higher than those measured along the coast during the same period. This is of note, because while the amount of blocked stomates was higher in the NW region compared to the coastal region, the trees retained needles longer.

These ground surveys found that SNC fungal counts and needle retention varied between site, regions, and by year. In 2024, correlation between SNC fungal counts and needle retention was significant in both regions, displaying the expected relationship between high fungal counts and low needle retention. This correlation is expected because as fungal counts increase, the function of stomata which are responsible for gas and water exchange is expected to decrease, possibly causing needle loss.

CREDITS: GLENN KOHLER / DNR

Douglas-fir stands displaying yellow-brown discoloration and thin crowns associated with high SNC disease near South Bend, WA in 2024

As this correlation does not explain all the recorded variation, this indicates that other factors besides SNC are contributing to needle loss in Douglas-fir, such as weather, site quality, tree genetics, or other diseases and pests. For example, elevation was significantly correlated with needle retention in the NW region, but not in the coastal region.

Overall, fungal counts and needle retention numbers from both ground and aerial surveys indicate that there has been no substantial increase in the severity of SNC or the effect on Douglas-fir needle retention, or crown health, over the past decade in coastal Washington. Results from the NW region are inconclusive, as ground measurements do not exist prior to 2021.

Caution is advised when interpreting these data. The SNC aerial survey detects tree crown symptoms (discoloration and thinning) visible from the air. As aerial observers can only map areas where symptoms are visible from more than 1,000 feet above, aerial survey data can only be used to coarsely document symptom distribution. Additionally, although correlation between fungal counts and needle retention can be seen to some degree, correlation does not confirm causation. Therefore, while the aerial survey and randomly selected ground points can be used as a guide for identifying areas impacted by SNC, site-specific ground surveys should be conducted in stands of interest before SNC mitigating management decisions are made. Given that Douglas-fir is the only host of this pathogen, forest managers with sites impacted by SNC may select for or plant other tree species. For a more detailed management discussion, refer to the "Silvicultural decision guide for Swiss needle cast in coastal Oregon and Washington" (Ritóková et al. 2022) available online at: extension.oregonstate.edu/pub/em-9352

The survey was conducted by the DNR Forest Resilience Division and Wildland Fire Management Division, the WDFW Aviation Section, and the USFS Forest Health Protection Group.

Washington 2024 Swiss Needle Cast Aerial Survey Map ▶

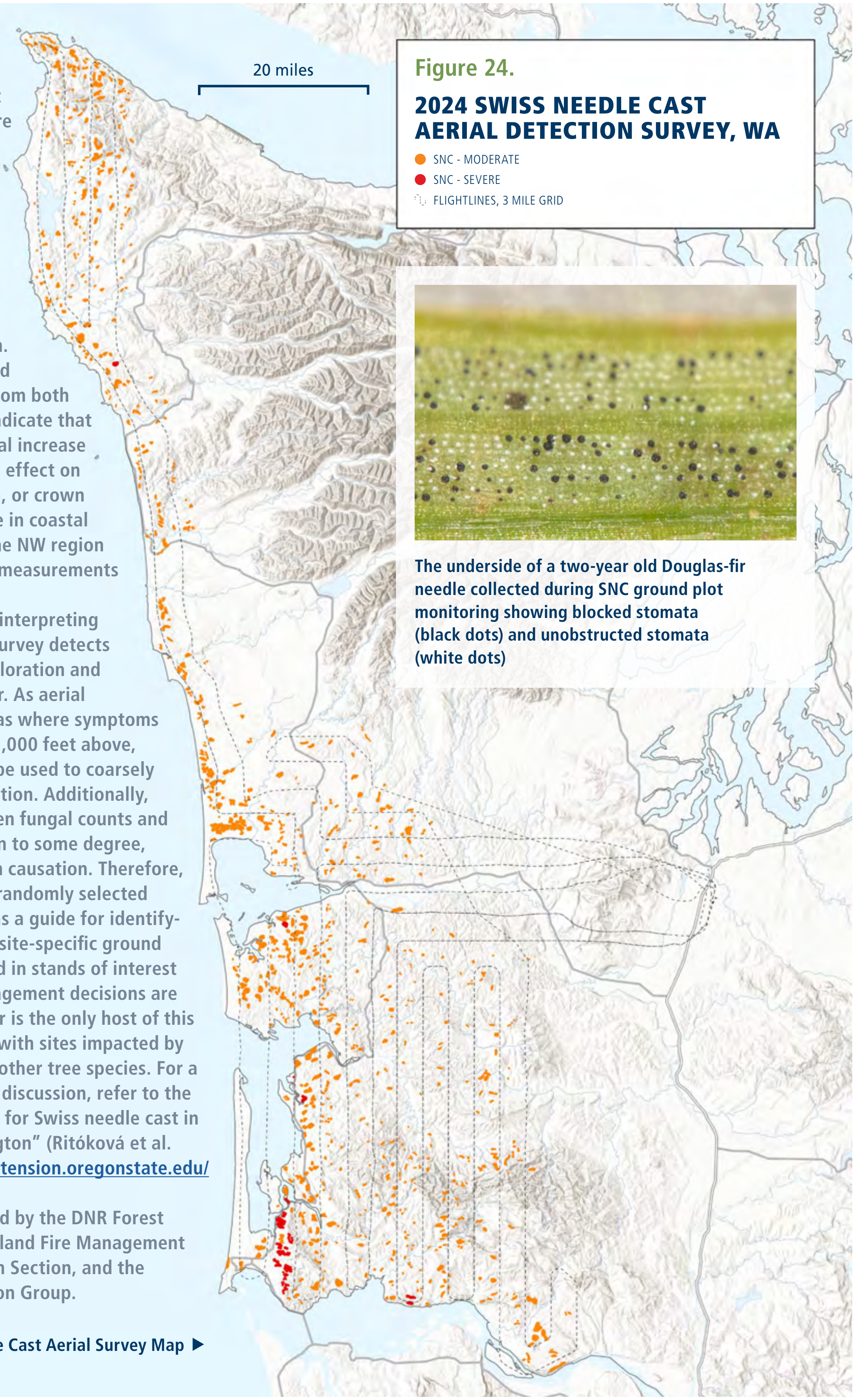


Figure 24.

2024 SWISS NEEDLE CAST AERIAL DETECTION SURVEY, WA

CREDIT: ISAAC DAVIS / DNR

The underside of a two-year old Douglas-fir needle collected during SNC ground plot monitoring showing blocked stomata (black dots) and unobstructed stomata (white dots)

CREDIT: DNR

DISEASES | FOLIAR DISEASES | LARCH DEFOLIATION

CREDITS: (TOP AND MIDDLE) USDA; (BOTTOM) CONNECTICUT AGRICULTURAL EXPERIMENT STATION

Larch Needle Cast

(*Rhabdocline laricis*)

NATIVE

Larch Needle Blight

(*Hypodermella laricis*)

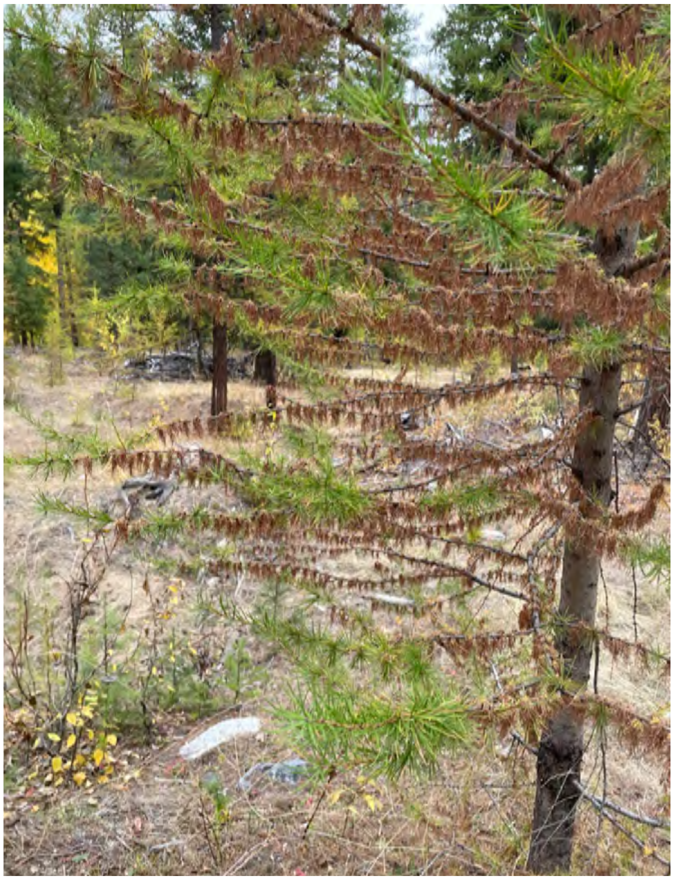
NATIVE

Larch Casebearer

(*Coleophora laricella*)

NON-NATIVE

A variety of fungi and insects impact larch foliage. Aerial detection survey observers mapped larch defoliation on approximately 28,000 acres in eastern Washington, an increase from the 3,200 acres mapped in 2023 but similar to the 27,500 acres mapped in 2022. Based on patterns of discoloration observed from the air and ground checks, the majority (over 95%) of the defoliation was due to the native fungus *Hypodermella laricis* that causes larch needle blight, a disease that kills foliage in the spring which is then retained throughout the season. Black elliptical fruiting bodies can be observed on the needles (see top photo) later in the season. Additionally, the native fungus *Rhabdocline laricis* which causes larch needle cast and the invasive larch casebearer insect (*Coleophora laricella*), were also likely present in some places. The amount of impacted acreage was likely driven by cool moist spring weather conditions during larch bud break that favors fungal infections. Long-term impacts on forest stands from foliar damage are minimal, even in years with high levels of discoloration observed.



CREDITS: RACHEL BROOKS / DNR

Top: Retained dead larch needles on a branch killed by larch needle blight with small black fungal fruiting bodies visible on the dead needles

Right: Retained dead needles killed by larch needle blight

DISEASES | FOLIAR DISEASES

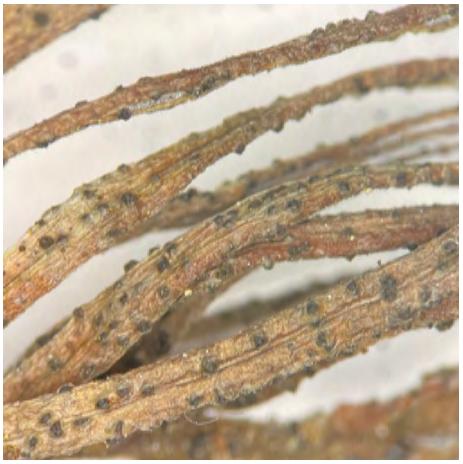
Delphinella Shoot Blight

(*Delphinella* spp.)

NATIVE

A suspected small outbreak of Delphinella shoot blight on grand fir near Port Angeles was observed during 2024. This native pathogen can damage true firs, especially in years with exceptionally cool and wet springs conducive to disease development and spread. Infected needles will first turn red then a gray black. On older dead foliage small black fungal fruiting bodies may be visible with the help of a hand lens. Retained foliage and any killed branch tips often droop. The amount of branch tips and associated buds killed will determine the pathogen's impact. Damage can look similar to that caused by a late spring frost or by certain pesticides. To differentiate this disease from frost or herbicide damage, look for damage confined to true firs and for small black fruiting bodies.

Retained dead drooping needles and branch tips on a grand fir near Port Angeles mid-summer in 2024



Above: Fruiting bodies (raised black specs) of *Delphinella* spp.

Right: Recently killed red foliage, previously killed gray foliage with tiny black fruiting bodies visible, and uninfected green foliage in the background

Current year foliage killed by a suspected *Delphinella* spp. on grand fir near Port Angeles in November 2024 that has turned dark gray

CREDITS: RACHEL BROOKS / DNR

DISEASES | FOLIAR DISEASES

Needle Casts of Ponderosa Pine

(including *Elytroderma deformans* and *Lophodermella* spp.)

NATIVE

A variety of native fungi can cause needle cast diseases on ponderosa pine in Washington. These fungi typically infect needles via airborne spores during the growing season. These infected needles later turn red or tan and may be startling to observe. Later in the season, tiny black fungal fruiting bodies may become visible on the foliage or other infected tissues.

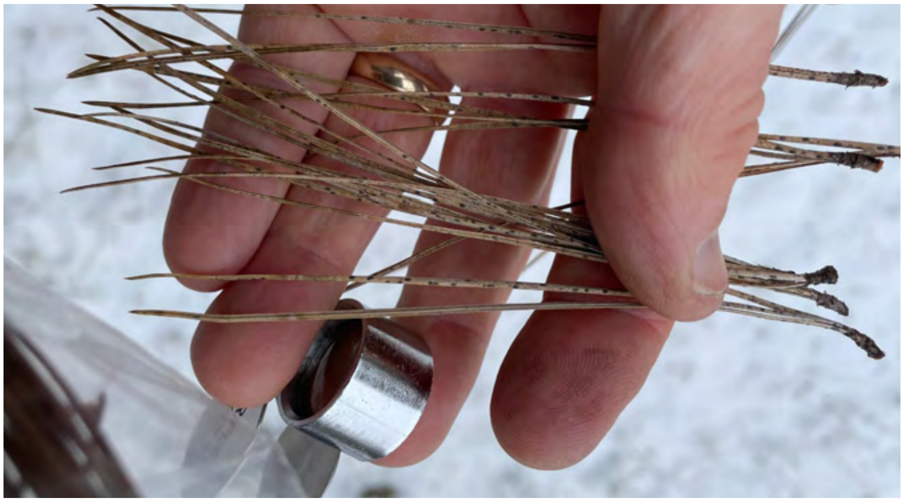
In most cases, needle casts cause little damage to forest stands other than possibly reducing tree growth, though impacts may be significant in some scenarios. These scenarios often include off-site plantings (planting seed sources not local to the area), repeated years of severe infections, or impacts to small seedlings. Foliar diseases are a good reminder to use the principles of seed zones to select appropriate planting stock for a site.

Lophodermella spp., which cause Lophodermella needle casts of ponderosa pine, result in the reddening and then loss of previous year's needles. Short elliptical fungal fruiting bodies can be seen on killed foliage later in the season. Somewhat similarly, *Elytroderma deformans,* which causes Elytroderma needle blight, also causes conspicuous reddened foliage and needle loss on ponderosa pines, with black fruiting bodies also forming on older killed foliage. *Elytroderma deformans,* which impacts the current year's foliage, can spread down the needle into the stem, becoming locally systemic. Much like dwarf mistletoes, these systemic infections cause a clustering of branches called witches' brooms. While most reports consider Elytroderma needle cast not to be very damaging and mortality of infected trees is rare, chronic infections can result in growth loss and predispose trees to attacks by bark beetles. There are areas where chronic Elytroderma needle cast is locally severe.

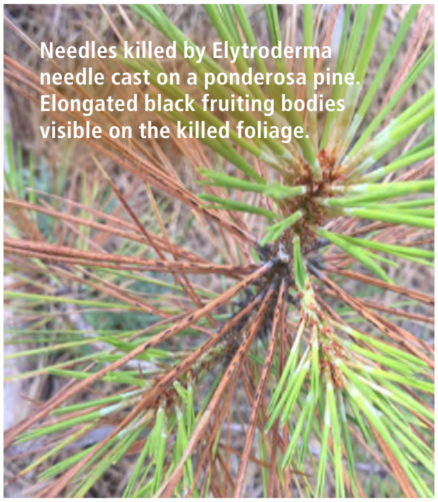
Ponderosa pine displaying low needle retention and broom formation caused by Elytroderma needle cast

CREDITS: BETSY GOODRICH / USFS

Ponderosa pine foliage killed by a needle cast disease with small black fruiting bodies



CREDIT: DAN OMDAL / DNR



Needles killed by Elytroderma needle cast on a ponderosa pine. Elongated black fruiting bodies visible on the killed foliage.

MISCELLANEOUS

Western Redcedar Dieback

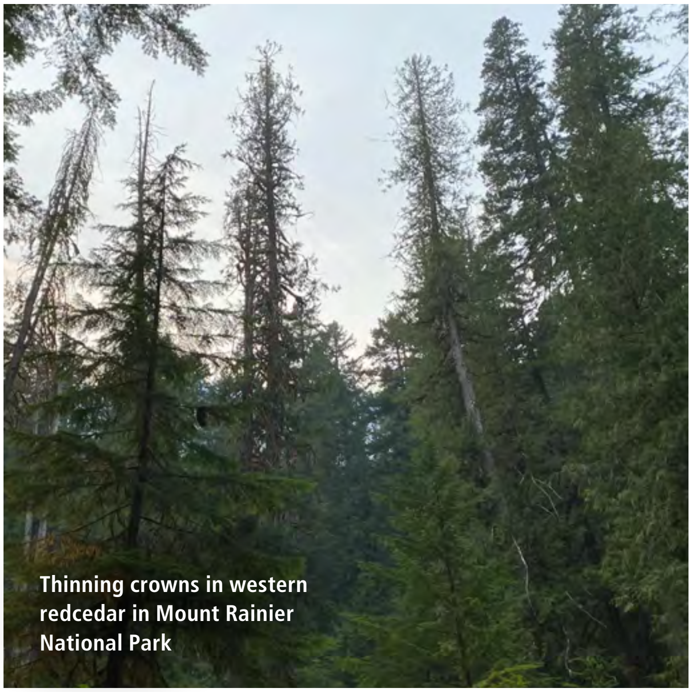
Approximately 51,700 acres with western redcedar (WRC) dieback and mortality were observed throughout Washington in 2024, an increase from the 47,000 acres observed in 2023. Since aerial mapping of WRC dieback began in 2017, the affected area had increased every year until 2023, when it reverted to about 46,000 acres mapped.

Symptoms of dieback include: thinning crowns, discoloration (yellowing or browning) of the needles, heavy cone crops, branch dieback and flagging, topkill, and mortality. The highest concentrations of damage in western Washington were in the Olympic National Forest, the Olympic National Park, the north coast of the Olympic Peninsula in Callam and Jefferson counties, the San Juan Islands, Kitsap County, western Mason County, northern Thurston County, and the foothills and mountain valley areas in Whatcom, Skagit, Snohomish, and King counties. In northeast Washington, there were a few scattered areas with damage in northern Ferry, Stevens, and Pend Oreille counties.

Ground observations of WRC damage agents include cedar bark beetles (*Phloeosinus* species), wood-boring beetles, and root diseases, but these are typically secondary damage agents taking advantage of trees stressed by other inciting factors. Recent research on WRC dieback in the Pacific Northwest found that affected cedars experienced reduced growth for several years prior to dying or thinning. This indicates cumulative stress brought on by warmer and drier conditions in late spring and early summer, resulting in a longer-than-normal dry season, may be a factor and that changing climatic conditions likely account for the wide range of damage observed throughout the region. Not all forests with WRC have experienced the same impacts and many healthy WRC remain, but future drought and higher temperature events may lead to more dieback. More information on this research can be found here: https://labs.wsu.edu/meddenslab/projects/western-redcedar-mortality

More information on WRC dieback cooperative monitoring work is available in this online story map: https://storymaps.arcgis.com/stories/1405dab5f59246aa83849ec43f72b15a


Thinning crown, branch dieback, and top-kill symptoms in western redcedar in western Washington


Thinning crowns in western redcedar in Mount Rainier National Park

CREDITS: BETSY GOODRICH / USFS

MISCELLANEOUS

Young Conifer Mortality

Aerial surveys record scattered, pole-sized, newly dead trees of all conifer species as "young conifer mortality." Based on ground checks, bear girdling and root disease are the primary causes of this distinct damage pattern. Drought, secondary bark beetles, or other cambium-feeding animals such as porcupines and mountain beavers, may also play a role. This damage signature is commonly identified in young timber stands in western Washington but can be present throughout all forest types.

When bears emerge from hibernation in spring, they strip bark from trees and feed on the sugary wood beneath (Fig. 25). Trees are either entirely girdled (growth tissue damaged around the entire circumference of the tree) and killed, or they become weakened and vulnerable to secondary damage agents. While this behavior is quite common, our ability to detect and record the resulting mortality varies. In normal conditions, it can take more than a year for the girdled tree to die, its needles to turn red, and the damage to become recognizable from the air. Alternatively, in drought conditions, girdled trees may become visible from the air the same year they are injured. In years with wet and cool spring conditions, the berries that bears feed on mature later, so bears are more likely to exploit more trees as an alternative source of food. Above-average amounts of spring precipitation may also delay the reddening of bear damaged trees, which may result in less observed damage that year. Other factors that may influence fluctuation in bear damage are the local bear populations and tree age.

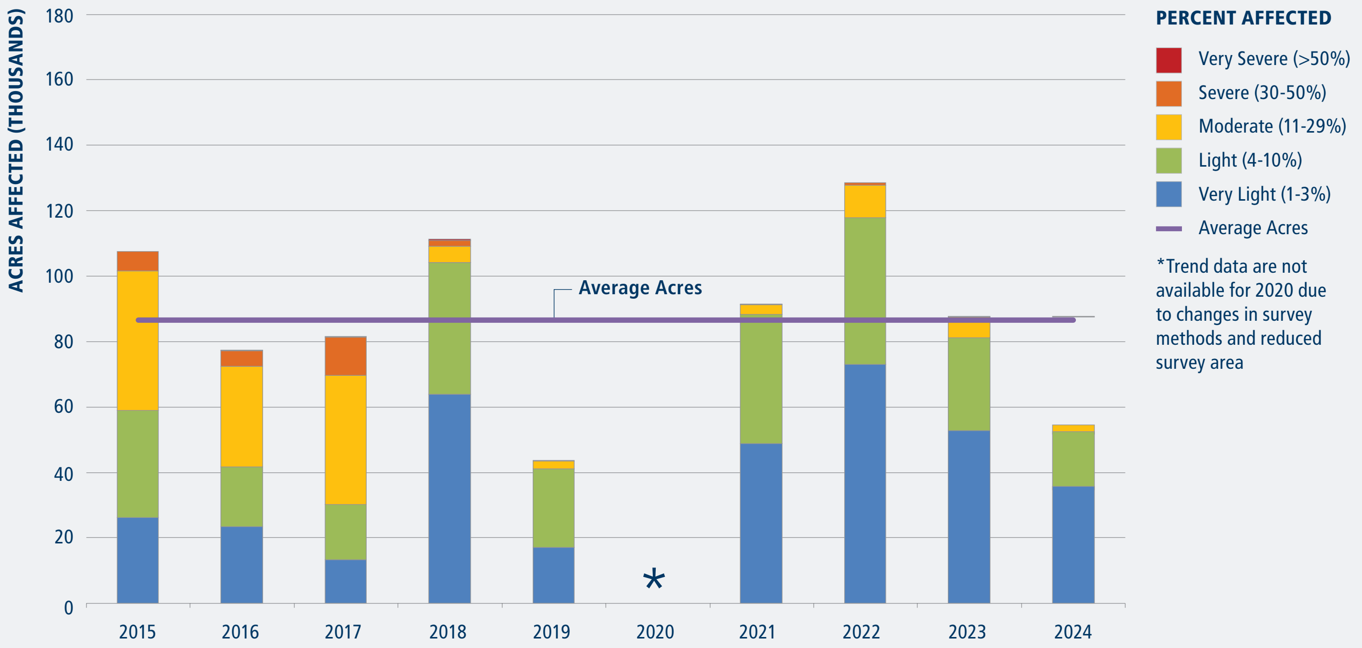
Root disease damage (see root disease section for more details) manifests in a similar pattern in young conifer stands, with scattered newly dead trees. Ground inspection of trees can easily determine if the bark has been stripped by bear or if additional investigation into root rot or other stressors should be completed.

Approximately 53,800 acres with young conifer mortality were observed in 2024, a decrease from the 87,700 observed in 2023 and the 99,600 acres in 2022. This acreage is within previous recorded ranges and is not unusual.

CREDIT: RACHEL BROOKS / DNR

Right: Typical bear girdling damage on a Douglas-fir

YOUNG CONIFER MORTALITY 10-YEAR TREND FOR TOTAL ACRES AFFECTED IN WASHINGTON Figure 25.



*Trend data are not available for 2020 due to changes in survey methods and reduced survey area

CREDIT: JUSTIN HOF / USFS

Aerial Detection Survey Methodology

Disclaimer: *To accurately identify and record damage observations on a statewide scale from an aircraft is a challenging task that takes years to master and mistakes are expected to occur. Occasionally, the wrong damage agent is designated or the marking on the map is geographically incorrect. The aircraft used in aerial survey travels at great speeds across the landscape and varying altitudes to ensure the safety of ADS personnel. Forest damage can be overlooked due to subtlety, particularly in areas of diverse, congested damage. The overarching goal of the program is to correctly identify and accurately map forest damage within ¼ mile of its precise location 70% of the time.*

Since 1947, the USFS Pacific Northwest Region (Region 6) has led a cooperative effort with the DNR to systematically monitor forest health conditions across the state of Washington, documenting tree mortality and defoliation by aircraft. The insect and disease aerial detection survey (ADS) is conducted from a small, fixed-wing aircraft flying between 500 and 3,500 feet above the forest canopy in a 4-mile grid pattern (see Figure 8, page 15) at an average velocity of 120 mph. Two highly trained forest health specialists positioned on either side of the plane work in tandem scanning the forest for areas of dead and defoliated trees.

Evident damage is documented in real time on tablet computers equipped with a proprietary software developed by the USFS called digital mobile sketch-mapping (DMSM) that allows the user to cross-reference satellite and topographic imagery displayed on the device with the landscape below. Observed damage is recorded on the tablet using points for small clusters of trees less than 2 acres in size and polygons for large swaths, or multiple groupings, of trees greater than 2 acres (Tables 4 & 5). Aerial sketch-mappers scan forests directly below the plane and up to 2 miles beyond the wing to ensure all land between each 4-mile flight path is surveyed. Because the survey is performed annually, careful measure is made to map new or active forest damage exclusively, disregarding old dead trees mapped the previous year and beyond. Considering the speed at which the survey aircraft is travelling, efficiently mapping large-scale insect outbreaks or areas of congested, varying damage types is a demanding task. Specialized training, skilled pattern recognition, and experience allow observers to assign each point and polygon with both a causal agent and a metric for damage intensity (see "Methods for recording damage activity" below for more detail). Tree size and species, location, the presence of thin or faded foliage, and nuanced patterns of mortality or decline indicate the most likely cause of visible forest damage. Collectively, these categories of classification are referred to as "damage signatures." Both surveyors maintain constant communication throughout each flight mission discussing observations and geographically relevant damage signatures to ensure the data recorded is accurate with a high degree of certainty and consistent on both sides of the plane across all landscapes.

ADS specialists are trained to identify tree species and damage signatures quickly and confidently with respect to color, crown shape, damage pattern, and stand composition, which varies greatly across Washington's diverse ecological zones. The DMSM software used in aerial survey can display satellite imagery, sectional aeronautical charts, spatial and topographic information, historical wildfire data, and past ADS damage. Together these tools guide decision making and promote geographical accuracy when recording forest damage. ADS protocol specifies at least one of the two observers have a minimum of three years of sketch-mapping experience in a geographical region or state, further supporting the integrity of the data collected and published. For users of this report and/or published ADS datasets, it would be incorrect to assume all trees within a damage polygon are dead or declining when interpreting the information provided. Polygon size strictly represents the distribution, or extent, of damage agent activity. Tree mortality and decline are defined by a range of intensity modifiers and recently killed or damaged trees only make up a fraction of the forestland mapped within a given polygon.

Table 4. Percent of treed area affected classes used for ADS damage polygons

PERCENT-CLASS CODE	NAME (VALUE RANGE)
1	Very Light (1-3%)
2	Light (4-10%)
3	Moderate (11-29%)
4	Severe (30-50%)
5	Very Severe (>50%)

Table 5. Range classes of individual affected tree counts used for ADS damage points

POINT-CLASS CODE	NUMBER OF TREES AFFECTED (VALUE RANGE)
1	1
2	2 – 5
3	6 – 15
4	16 – 30
5	>30

Unmanned aircraft system used for aerial survey ground checks and other forest health monitoring missions

CREDIT: ZACK ADAMS / USFS

Trees affected by wildfire closely mimic the damage caused by forest pests and disease when viewed from above. Forest damage is virtually indistinguishable from fire damage up to two years after a wildfire event. It is standard ADS protocol to disregard areas affected by wildfire when sketch-mapping until three years after a given event. Only then will existing damage signatures be attributed to forest pests or disease and represented in ADS damage totals. To aid surveyors in this effort, fire perimeters from one and two years prior to the active survey year are displayed on DMSM tablets for reference in flight.

METHODS FOR RECORDING DAMAGE INTENSITY

Damage polygons are assigned a "percent-class" value representing one of five incremental ranges of percent of treed area affected (Table 4, p.67). Observers assign a percent-class value by estimating the canopy area with recent damage and visually dividing it by the canopy area of all trees within the polygon, including currently damaged, live, and dead trees as well as non-host trees.

For forestland affected by defoliating agents, polygons are assigned intensity values of within-crown defoliation (L-Light, M-Moderate, H-Heavy). When observers record points of damage in areas less than two acres, they assign a range estimate of the number of trees affected by a given agent (Table 5, p.67).

Adoption of the percent-class/point-range method presents challenges for trend analysis and cumulative mortality assessments when compared to the trees per acre (TPA) method used prior to 2018. Summary statistics of approximate number of trees killed, such as totals and averages by agent, cannot be derived directly from percent-class data. In the USFS Pacific Northwest Region (Washington and Oregon), percent-class polygons are converted to a calculated TPA value using a "histogram matching" method. This method separates several recent years of historical TPA data into five categories similar in range to the percent-class categories, then calculates a derived TPA value for each percent-class polygon based on the midpoint of each TPA category and the relative polygon size. Point-range categories are converted to TPA values based on the upper range of each point-class code.

All 2024 ADS mortality polygons in DNR's downloadable GIS datasets use calculated TPA values as intensity modifiers. USFS Pacific Northwest Region (Region 6) quadrangle reporting maps available in PDF format use percent treed area affected classes and damaged tree ranges as label modifiers. See the "Data and Services" section on the following page for more information on accessing these distinct datasets.

Together these tools guide decision making and promote geo-graphical accuracy when recording forest damage

Data and Services

Tree mortality, defoliation, and statewide forest health conditions are documented annually across all 22 million acres of Washington's diverse forestland by aircraft. The aerial detection survey (ADS) is performed cooperatively by DNR and the USFS and provides a comprehensive overview of insect and disease activity throughout the state. The data produced is used by federal, state, private, and tribal organizations to guide contemporary forest management practices. Compared to alternative survey methods that require considerably more time and labor, ADS remains the most cost-effective approach to gather regional and statewide forest health information. All electronic resources and raw datasets produced by aerial survey specialists are available for public use and serve as valuable tools for evaluating local forest disturbance events and informing responsible treatment of compromised trees. The interagency ADS program also hosts an archive of data dating back to 1947, allowing users to analyze historical trends of forest damage throughout Washington.

INTERACTIVE MAP TOOLS

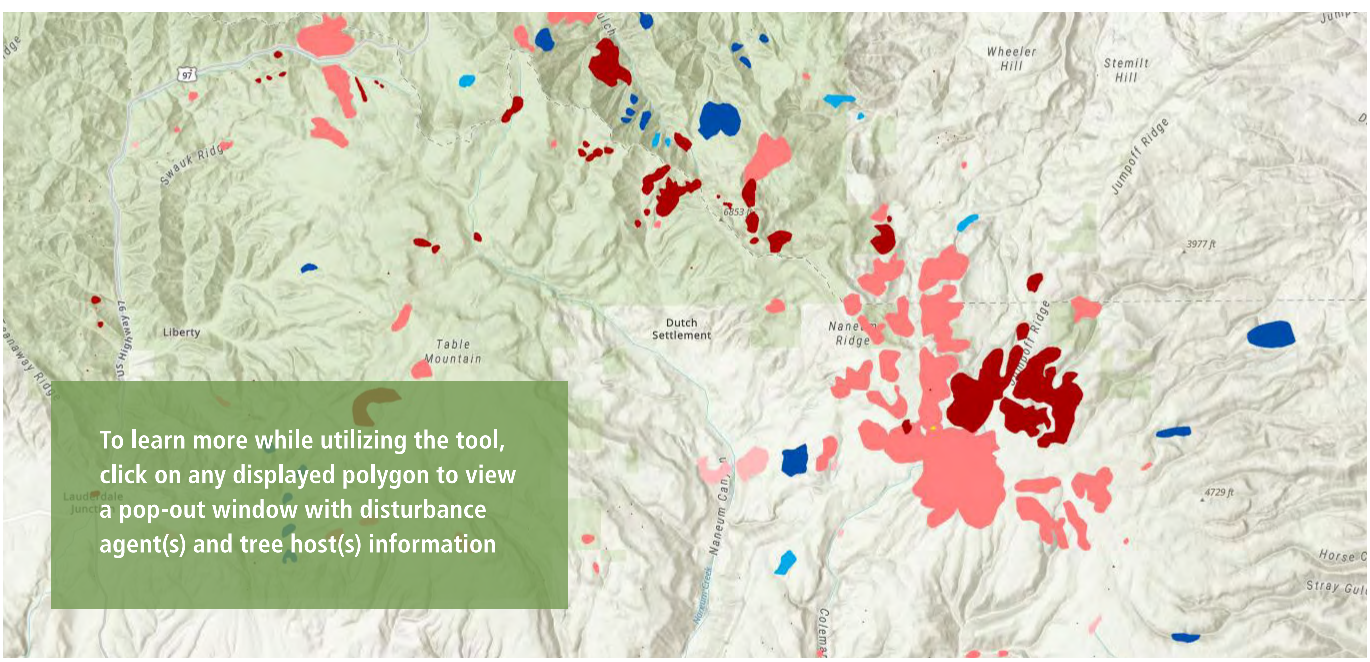
There are a few locations where you can access aerial survey data online in interactive maps, both through DNR and USFS websites:

- **DNR data access (2015-2024).** Aerial survey data is available on DNR's interactive, web-based mapping service: "Forest Resilience Data and Mapping System" at: https://experience.arcgis.com/experience/4f3323f1a82b418d9dbf16faf32dd9f2/. To access these datasets, navigate to the blue icons on the lefthand side of the webpage and select "Map Layers" (top icon). Hover the cursor over the top layer. When the eye icon (visibility) appears, unselect it. Do this for each layer in the dropdown list except for the one titled "Monitoring." This will prevent non-ADS datasets from generating in the output and improve the functionality of the webmap service. Click the angle bracket symbol (">") next to the "Monitoring" tab to expand the list of contents. Unselect or select the eye icon on each layer within the "Monitoring" tab to make "Forest Health Aerial Survey" the only visible layer on the map. Click the angle bracket on the "Forest Health Aerial Survey" tab to view all selectable aerial survey data layers, 2015 through 2024.

- **USFS current year draft data.** The USFS offers interactive web-based services for accessing aerial survey data and visualizing forest health trends in the Pacific Northwest at: https://www.fs.usda.gov/r06/natural-resources/forest-health/aerial-detection-survey. To view current-year, draft aerial survey data in an interactive web-based map, click the "Current Year Data Viewer." Read and agree to the terms and select "OK." This tool allows the user to visualize recent aerial survey data, flightlines, and create customized maps with a collection of background layers. Damage points and polygons are color-coded as *Mortality, Defoliation, or Other Damage* and are superficially labeled with a shorthand code used by aerial surveyors. Select a polygon of interest to reveal a popup dialog box containing information on damage causal agent (i.e., DCA), host group, and percent-affected range.

For questions on how to use these interactive map products or any other related inquiries, please contact Isaac Davis listed in the Forest Health Contacts section on page 71.

Sample of the aerial detection survey DNR interactive map tool



GIS DATA AVAILABLE FOR DOWNLOAD

The USFS maintains an archive of downloadable ADS data for Washington and Oregon from 1947 through 2024. These data can be reached by navigating to https://www.fs.usda.gov/r06/natural-resources/forest-health/aerial-detection-survey and clicking the link titled "Aerial Detection Survey Data Download." Select a year of interest in the main body of the website. This will open a webpage with the option to download a zipped geodatabase (.gdb) folder containing a list of shapefiles (.shp) of ADS data collected that year. Note: USFS credentials or an approved cooperator login may be required to access and download these datasets.

FOREST HEALTH WEBSITES

The latest information on exotic pests, insect and disease outbreaks, and forest health trends in Washington are published annually in these Washington Forest Health Highlights reports. Supplementary reports, Washington DNR research and programs, and other forest health information are available at http://www.dnr.wa.gov/ForestHealth. Click the link titled "Insects and Disease Monitoring" under the "Assistance and Information" heading in the main body of the webpage for more detail on current forest health monitoring efforts and reporting. Additional forest health resources can be found online in DNR's Forest Resilience Library at https://www.dnr.wa.gov/DigitalLibrary

Historic Forest Health Highlights reports for Alaska, California, Oregon, Washington, and Hawaii and the Pacific Islands are available at: https://www.fs.usda.gov/science-technology/forest-health-protection/publications-reports/forest-health-monitoring-publications/forest-health-highlights

Updates to the USFS ADS website are ongoing. Visit https://www.fs.usda.gov/r06/natural-resources/forest-health/aerial-detection-survey to discover new tools and resources not currently mentioned here.

The USFS Pacific Northwest Region (Region 6) Forest Health Protection (FHP) program has a shared mission to monitor and improve the health of forests in Washington and Oregon. It provides technical and financial assistance to federal resource managers managing pest insects, tree diseases, and harmful vegetation in forest ecosystems. Assistance to state and private resource managers is provided through state forestry agencies (Washington DNR, Oregon Department of Forestry). Learn more about USFS Region 6 FHP programs and resources at: https://www.fs.usda.gov/r06/natural-resources/forest-health

CREDIT: DANA BRENNAN / DNR

Larch casebearer damage near Northport

Forest Health Contacts

WASHINGTON DEPARTMENT OF NATURAL RESOURCES

Forest Resilience Division

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USDA FOREST SERVICE | Forest Health Protection & Monitoring Program

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Vacant	GIS Analyst		

If you have questions about forest insect and disease activity in Washington, please contact one of these regional or field offices on the previous page or below.

USDA FOREST SERVICE | Wenatchee Service Center

Forestry Sciences Laboratory, 1133 N. Western Avenue, Wenatchee, WA 98801

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Vacant	Forest Entomologist		
Vacant	Forest Pathologist		

USDA FOREST SERVICE | Westside Service Center

Mount Hood National Forest, 16400 Champion Way, Sandy, OR 97055

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Holly Kearns	Forest Pathologist	(503) 668-1475	holly.kearns@usda.gov

USDA FOREST SERVICE | Blue Mountains Forest Insect and Disease Service Center

Wallowa-Whitman National Forest, 3502 Highway 30, La Grande, OR 97850

NAME	TITLE	PHONE	EMAIL
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Vacant	Forest Entomologist		

Blotch mine defoliation by a *Phyllonorycter* moth in Cottonwood at Camp Growden CCC Camp

South Gifford Pinchot Forest Collaborative testing the DNR stand-level monitoring protocol in the Little White Priority Planning Area

CREDITS: (BACKGROUND) DANA BRENNAN / DNR; (INSET) ANDREW SPAETH / DNR

Notes

dnr.wa.gov/foresthealth