Forest Service
Pacific Northwest Region
Forest Health Protection

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

Forest Health Highlights in Washington—2012

Washington State Department of Natural Resources
Forest Health Program
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Front cover: *Porodaedalea pini* (Brot.) Murrill. (Syn. *Phellinus pini* (Brot.) Bondartsev & Singer) conks on Douglas-fir. Photo: Daniel Omdal, Washington Department of Natural Resources (WDNR).

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Summary

Washington has 22.4 million acres of forestland. In 2012 approximately 1,080,000 acres of this land contained some level of tree mortality, tree defoliation, or foliar diseases. This is a slight increase from the 950,000 acres reported in 2011. Acres with mortality from bark beetles increased for most hosts in 2012, with the largest increases in mountain pine beetle, Douglas-fir beetle, and spruce beetle damage. The area with conifer defoliation by western spruce budworm and Douglas-fir tussock moth in 2012 remained similar to 2011. Defoliation damage by balsam woolly adelgid, hemlock looper, and western tent caterpillar increased in 2012. Previous annual totals were:

2010: 937,000 acres **2009**: 1.73 million acres **2008**: 1.36 million acres

Drought conditions and warm, dry spring weather tend to increase tree stress and insect success, driving acres of damage up. Wet spring weather tends to increase acres affected by foliage diseases and bear damage. 2012 spring precipitation was above average for all forested regions of Washington. In spite of extra spring rainfall, abnormally dry and moderate drought conditions existed in most of eastern Washington from January through July 2012. The Seattle area went 82 days without rain from July 23 until October 12, resulting in an abnormally dry condition by October throughout Washington.

Approximately 2.8 million trees were recorded as recently killed.

Pine bark beetle activity recorded by aerial survey in Washington increased in 2012 to almost 156,000 acres, compared to 111,000 acres in 2011. **Mountain pine beetle** (MPB) damage increased in all hosts except whitebark pine. The largest increases in MPB affected acres were in Yakima County, especially around Mt. Adams, eastern Okanogan County, and Ferry County.

Approximately 26,000 acres with **Douglas-fir beetle** (DFB) caused mortality were observed statewide in 2012, up from 16,000 acres in 2011. Over 17,000 acres with DFB caused mortality were recorded in western Okanogan County alone in 2012, a significant increase from approximately 2,400 acres mapped there in 2011.

The east slopes of the Washington Cascade Mountains and mountains of northeastern Washington continue to experience an outbreak of **western spruce budworm** (WSBW). The area affected continues to expand in northeastern Washington and severity of defoliation is increasing in parts of the Cascades. Areas with WSBW defoliation recorded in the 2012 aerial survey have decreased slightly to 511,000 acres, but the acres with highest intensity increased.

Defoliation by the **Douglas-fir tussock moth** (DFTM) decreased to approximately 8,700 acres, down slightly from 9,400 acres in 2011. 2012 was the second year with widespread DFTM defoliation in the Blue Mountains of Washington, totaling approximately 8,600 acres. The Blue Mountains outbreak is likely to collapse in 2013.

An outbreak of **hemlock loopers** continues to expand and cause some mortality to western hemlocks around Baker Lake in the North Cascades. Approximately 1,400 acres of hemlock looper defoliation were recorded in the 2012 aerial survey.

Needlecast diseases in eastern Washington affecting larch and pine increased significantly in 2012, likely due to above normal spring rainfall. Approximately 38,800 acres of needlecast symptoms were observed in western larch, 10,500 acres in lodgepole pine, and 7,200 acres in ponderosa pine.

Bear (animal damage) activity recorded by aerial survey continued to rise slightly in 2012 to approximately 200,000 acres, up from 180,000 recorded in 2011.

Weather and Forest Health

Severe weather events that injure or kill trees often make them more susceptible to attack by insects and pathogens. Examples include windthrow, winter damage (defoliation, cracks or breakage from cold, snow or ice), heat stress, flooding, landslides and hail. Many insects and pathogens use weakened or dead trees to maintain and sometimes increase their populations. Injuries can be vulnerable to infection by fungi. Outbreaks of certain bark beetle species, such as Douglas-fir beetle, follow weather or fire events that kill or injure numerous trees. Unusually wet spring weather can increase the incidence of foliar diseases. In years like 2012, when summer precipitation was at or below average, the number of bark beetle-killed trees may increase the following year. This increase in beetle-kill may not be apparent until the 2014 aerial survey.

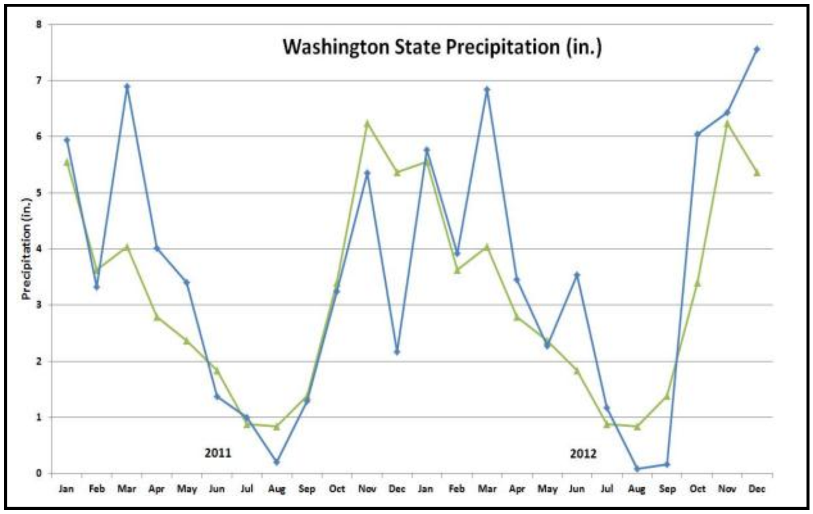

Figure 1. *Average monthly precipitation and 30-year average (green line) for Washington. Source: National Climatic Data Center (http://www.ncdc.noaa.gov/oa/climate/research/cag3/cag3.html).*

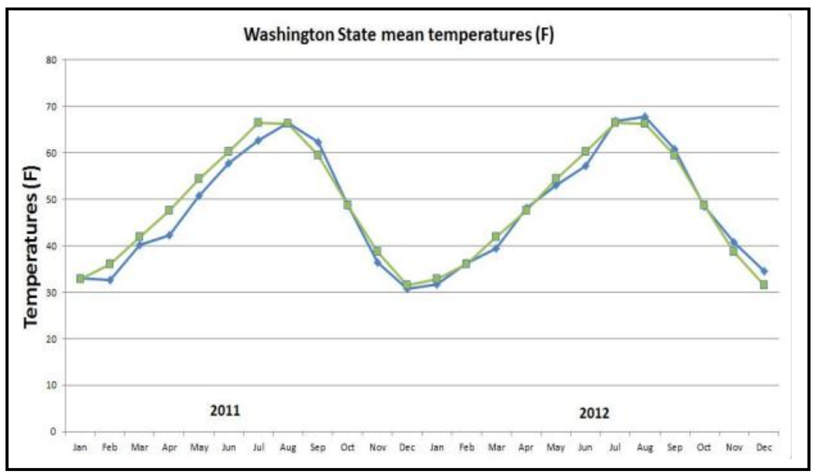

Figure 2. *Monthly mean temperature and 30-year average (green line) for Washington. Source: National Climatic Data Center (http://www.ncdc.noaa.gov/oa/climate/research/cag3/cag3.html).*

Aerial surveys also aim to record the location and severity of certain weather related events like flooding or tree blowdown, giving landowners and managers warning to take appropriate action, such as salvaging weakened or dead material.

Vigor and resilience to adverse weather can be increased by ensuring that trees have room to grow and are appropriate species for the site. For example, forests in eastern Washington are generally overstocked with too much fir and not enough drought tolerant pine and larch. These conditions favor defoliators such as the western spruce budworm and perpetuate root disease and bark beetle activity. In western Washington, Swiss needle cast disease affects Douglas-fir growing on coastal sites that may be more suited to western hemlock and Sitka spruce.

2012 Weather Events

Figure 3. *2012 winter damage near Galvin in Lewis County.*

Winter storm damage: In late January 2012, heavy snowfall followed by an ice storm in western Oregon and Washington caused injuries, at least two deaths, property damage, power outages, and widespread tree damage. The Puget Sound area had wide areas with tree branch and top breakage, especially in hardwoods, and some scattered areas where whole trees were knocked down (Fig. 3). Future deformities and decay will likely result in economic loss for forestry in the area. Dead wood was primarily small diameter, so increased bark beetle activity was not expected. The same storm resulted in whole tree blowdown in some areas of Klickitat and Skamania Counties. This may increase attacks by Douglas-fir beetle in 2013, but mortality may not be evident until summer 2014. Storm damage in the Columbia River Gorge area of Klickitat and Skamania Counties will likely contribute to damage from California fivespined Ips actively killing ponderosa pines in that area since 2010. A severe snowstorm near Leavenworth east of Stevens Pass in December 2012 caused tree damage that will likely be mapped in 2013.

Severe thunderstorm damage: On July 20, 2012 a severe "blow echo type" thunderstorm in Ferry County generated downdraft and microburst winds that caused property damage, power outages, and breakage of thousands of trees (Figs. 4 & 5). Areas around Republic and Keller were especially hard hit. Damage was worst where winds were magnified by terrain. The timing of the storm was after peak flights of bark beetles, such as pine engravers, so it is unlikely to lead to outbreaks. The Washington Department of Natural Resources (WDNR) and the US Forest Service (USFS) conducted a special aerial survey of Ferry County storm damage on July 25th. Due to the scattered nature of damage, it was challenging to map. 50 polygons with damage totaling 1,065 acres were recorded, but this is likely an underestimate. Total forest damage was estimated to be 14,543 acres as the result of ground and special aerial survey.

Figure 4. *Entire stands toppled by high winds during July 20, 2012 storm in Ferry County.*

Figure 5. *Property damage from severe thunderstorms in Ferry County.*

Drought

2012 spring precipitation was above average for all forested regions of Washington State. Wet spring conditions contributed to an increase in the incidence of foliage diseases in 2012. However, summer precipitation critical to tree health was well below average. Statewide average rainfall was near zero in August and September. Parts of eastern Washington experienced abnormally dry to moderate drought conditions from January through July 2012. By October 2012, western Washington was in an abnormally dry condition after more than two months with little to no rainfall. Average 2012 summer temperatures were slightly above normal across the state. Trees experiencing drought stress can become more susceptible to insect and disease attacks and are less likely to recover from damage. In eastern Washington, trees growing in dense or overstocked stands have a higher likelihood of experiencing drought stress.

Fire

The beginning of the 2012 fire season was delayed several weeks because of wet and cold spring weather caused by El Niño. By the middle of summer the situation drastically changed because of lack of precipitation for almost two months across the entire state. With 324,000 acres burned, the 2012 fire season turned out to be the second worst (after 2006) fire season in the past two decades. The aerial survey team finished the insect and disease survey in early September, a few weeks before many large fires in East Washington were ignited by lightning on September 8th. During the 2012 fire season, approximately 14,000 acres of polygons mapped in 2012 with various types of damage and intensity were subsequently burned.

Dennis Carlson, Washington DNR, retired

Figure 6. *The Cascade Creek Wildfire was ignited by lightning on September 8, 2012. It burned over 20,000 acres on the south and east flanks of Mt. Adams.*

Aerial Survey

The annual insect and disease aerial survey in Washington was conducted by the USDA Forest Service (USFS) in cooperation with the Washington Department of Natural Resources (WDNR). The survey is flown at 90-120 mph at approximately 1,500 feet above ground level. Two observers (one on each side of the airplane) look out over a two-mile swath of forestland and mark on a digital sketchmapping computer any recently killed or defoliated trees they see. They then code the agent that likely caused the damage (inferred from the size and species of trees and the pattern or “signature” of the damage) and the number of trees affected. Photos are rarely taken. It is very challenging to accurately identify and record damage observations at this large scale. Mistakes occur. Sometimes the wrong pest is identified. Sometimes the mark on the map is off target. Sometimes damage is missed. Our goal is to correctly identify and accurately map within ¼ mile of the actual location at least 70% of the time. In areas with heavy mortality, our ground truth of trees per acre (TPA) killed can be up to 2-3 times greater than estimates from the air. In a comparison of ground based estimates to ADS cumulative mortality data for mountain pine beetle, Meigs et al. (2011) found ADS underestimated the TPA intensity by about one order of magnitude.

Newer satellite photography showing recent management activity allows observers to place the damage polygons more accurately. In addition, aerial observers are familiar with forestry and forest pests and are trained to recognize various pest signatures. There is always at least one observer in the plane who has three or more years of sketchmapping experience.

Aleksandar Dozic, Washington DNR

Figure 7. *Partenavia aircraft used for aerial survey in Washington State.*

Each damage area (polygon) is assigned a code for the damage agent. These codes are defined in the legend of the aerial survey maps. The agent code is followed by number of trees affected; number of trees per acre affected; or intensity of damage (L-Light, M-Moderate, H-Heavy). If more than one agent is present in a polygon, codes are separated by an exclamation point (!). When interpreting data and maps, do not assume that the mortality agent polygons indicate every tree is dead within the area. Depending on the agent code modifier, only a small proportion of trees in the polygon may actually be recently killed.

The perimeters of areas burned by wildfire are added to aerial survey maps the year of the fire. The year following the fire, dead trees are not recorded within the fire perimeter. This is because from the air it can be difficult to distinguish mortality caused by the fire from mortality caused by insects or disease. The second summer after the fire, direct effects of the burn have mostly subsided and pests are credited with the newest tree damage.

Reference:

Meigs, G.W., R.E. Kennedy, and W.B. Cohen. 2011. A Landsat time series approach to characterize bark beetle and defoliator impacts on tree mortality and surface fuels in conifer forests. Remote Sensing of Environment 115: 3707-3718.

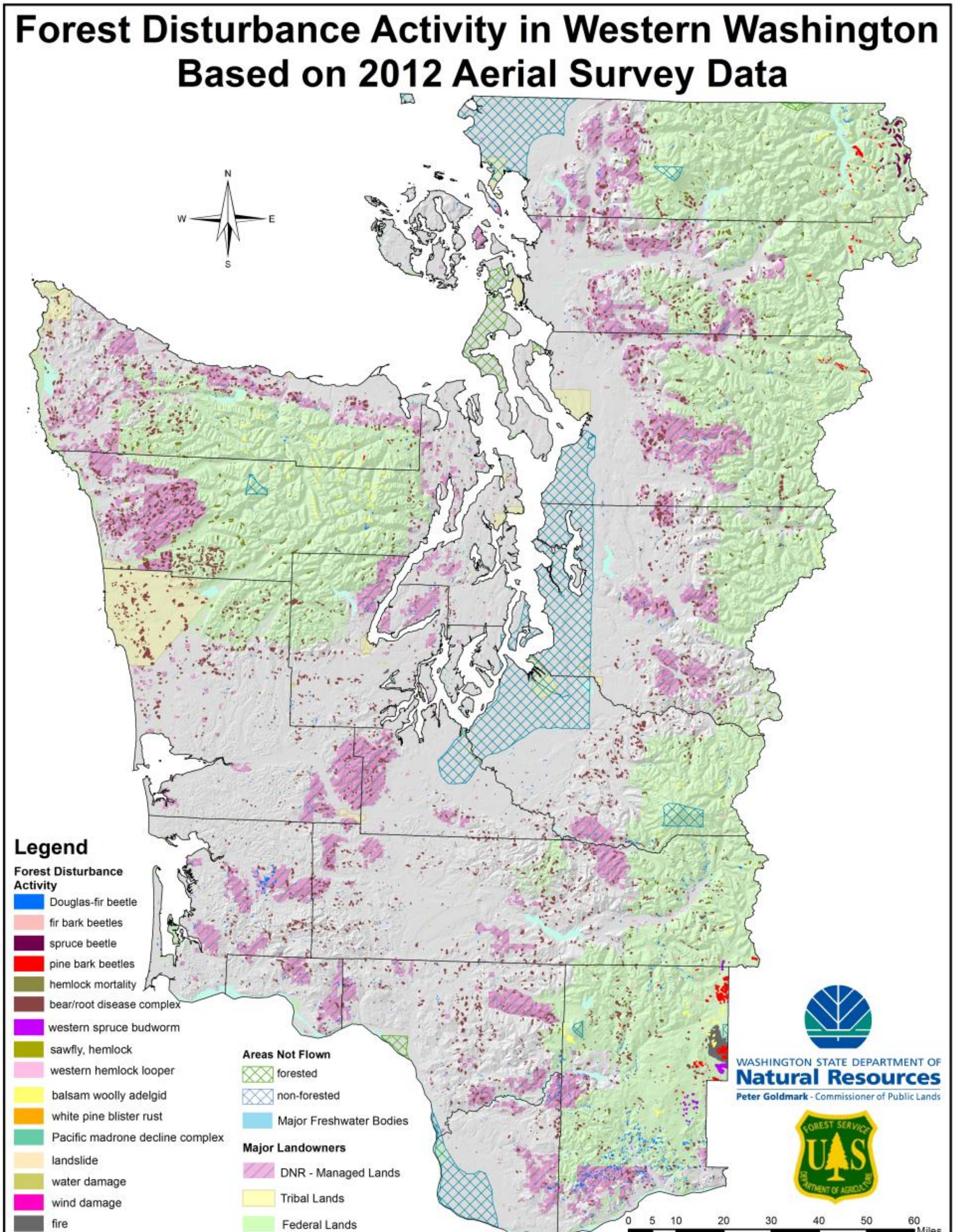

Figure 8. *Forest disturbance map of Western Washington composed from 2012 aerial survey data.*
Map by: Aleksandar Dozic, Washington DNR

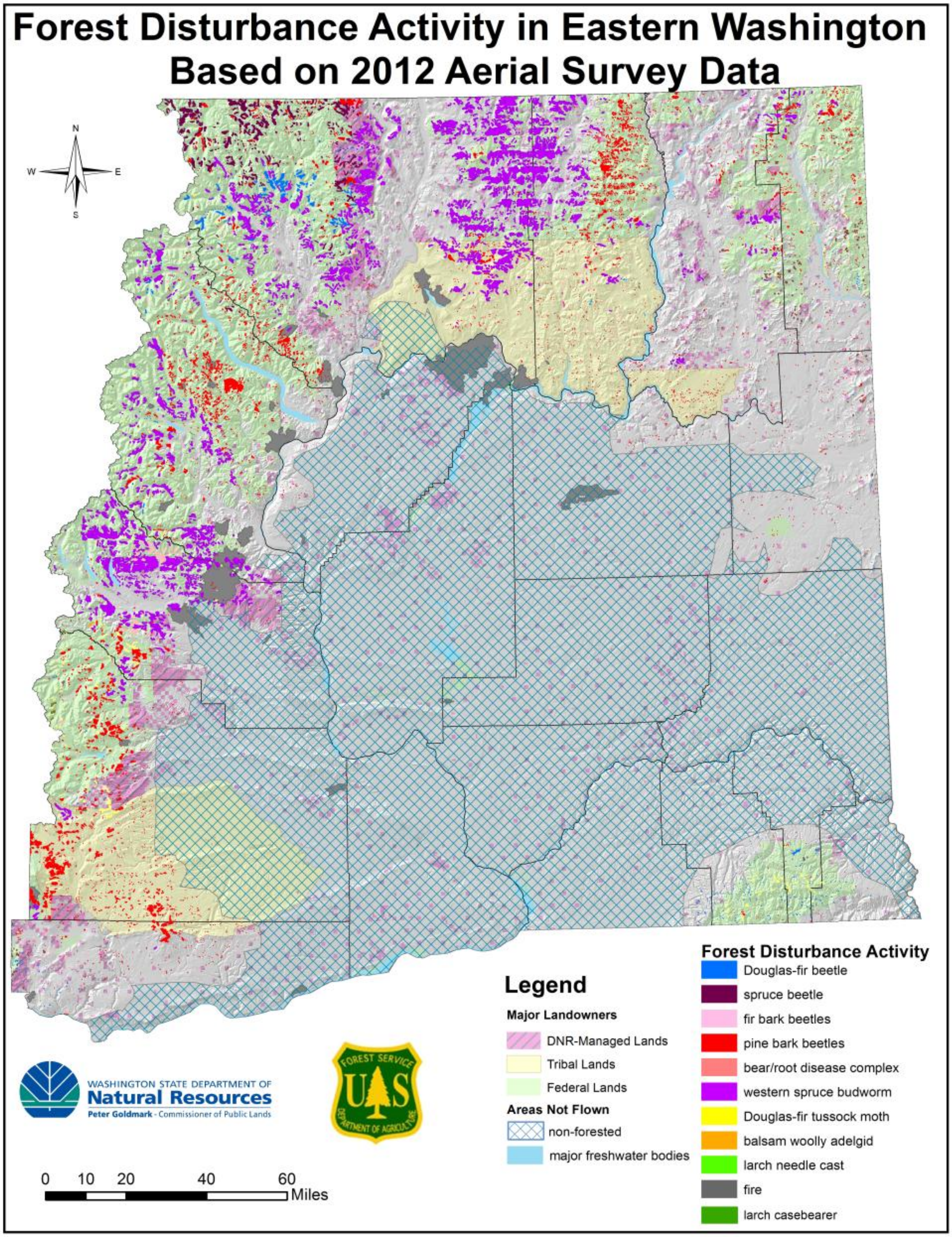

Figure 9. *Forest disturbance map of Eastern Washington composed from 2012 aerial survey data.*
Map by: Aleksandar Dozic, Washington DNR

Forest Health Hazard Warning

Moving Towards Resilient Forests in Eastern Washington

The Washington State Legislature has established that the state faces serious forest health problems, primarily in eastern Washington, where forests are overcrowded and species composition has been greatly altered compared to historical reference conditions. Insect outbreaks and wildfires are more severe and extensive than would have occurred historically due to the altered structure and composition of eastern Washington forests. The level of insect and disease damage in Washington's forests has doubled from 600,000 acres per year in the 1980s to over 1.2 million acres in the 2000s. In 2007, the legislature amended the forest health law (RCW 76.06) to initiate a more pro-active response to emerging forest health threats in eastern Washington.

Figure 10. *Eastern Washington Forest Health Hazard Warning Areas.*
Map by: Chuck Hersey, Washington DNR

In November of 2011, Commissioner of Public Lands Peter Goldmark initiated the state's Forest Health Hazard Warning system found in RCW 76.06, marking the first-ever use of the authority. The Commissioner appointed a nine member technical advisory committee of foresters, scientists and other experts to assess the nature and extent of forest health threats in eastern Washington and recommend areas for further actions under the forest health law. The committee's analysis focused on recent and current insect damage, projected future damage, forest structure and species composition, and potential for on-the-ground action. Based on the findings and recommendations of the technical advisory committee, Commissioner Goldmark issued a Forest Health Hazard Warning for portions of Okanogan, Ferry, Klickitat and Yakima counties in August 2012.

A complete description of the committee's recommendations and evaluation process can be viewed here: http://www.dnr.wa.gov/foresthealth

Forest Health Hazard Warning Area Maps and Damage Agents

Major Damage Agents in Warning Areas

The subjects of the Okanogan and Ferry Counties Forest Health Hazard Warning are western spruce budworm in dry, mixed conifer forests, pine bark beetles in dry, mixed conifer and ponderosa pine forests and mountain pine beetle in lodgepole pine in the Loomis State Forest.

A western spruce budworm outbreak has been active in portions of Okanogan and Ferry Counties for the last two to five years. Moderate defoliation is expected to continue in 2013.

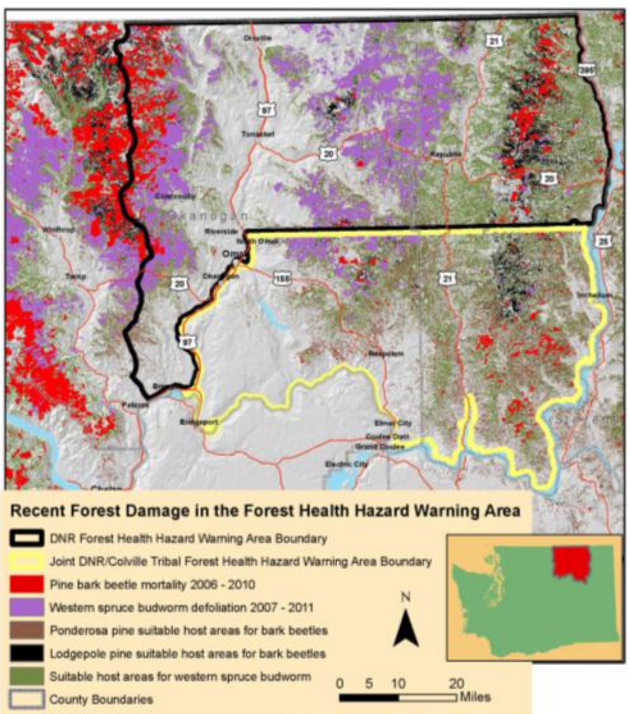

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Figure 11. *Recent forest insect damage in the Okanogan and Ferry Counties Forest Health Hazard Warning Area.*
Map by: Chuck Hersey, Washington DNR

The subject of the Forest Health Hazard Warning in Klickitat and Yakima Counties is pine bark beetles in ponderosa pine.

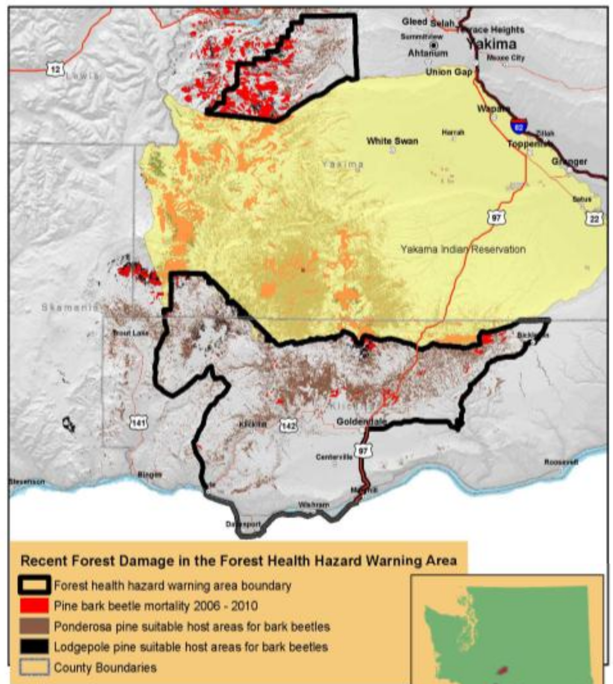

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Figure 12. *Recent forest insect damage in the Klickitat and Yakima Counties Forest Health Hazard Warning Area.*
Map by: Chuck Hersey, Washington DNR

Chuck Hersey, Washington DNR

Figure 13. *Western spruce budworm defoliation of Douglas-fir understory trees for second year near Republic, WA.*

Forest Health Hazard Warning Landowner Outreach

WDNR is committed to raising awareness of the critical health issues facing eastern Washington forests and improving forest resiliency across all ownerships. The objective of a warning is to focus attention and voluntary actions by forest landowners on severe or emerging forest health concerns. Western spruce budworm and pine bark beetles are the subject of the warnings.

Chuck Hersey, Washington DNR

Figure 14. *Landowner forest health workshop in Goldendale, WA.*

Following the issuance of the Forest Health Hazard Warnings, WDNR initiated a public outreach effort to notify landowners in the Warning Areas about forest health concerns in their area and resources available to address the concerns. These efforts included:

•10,517 notices mailed to forest landowners in the Forest Health Hazard Warning Areas

•Toll free number and website created to help landowners learn more about western spruce budworm and pine bark beetles, recommended actions to reduce risk and request assistance from a WDNR forester in their region. To view the Forest Health Hazard Warning website go to: http://www.dnr.wa.gov/foresthealth

•WDNR and WSU Extension sponsored a series of forest health workshops for landowners in the Warning Areas. Three evening workshops and two intensive hands-on field workshops were held in Goldendale, Tonasket and Republic. A total of 207 landowners participated in the workshops.

•WDNR foresters provided technical assistance to 317 landowners that manage over 68,000 acres as a direct result of the Forest Health Hazard Warning outreach efforts.

Mike Johnson, Washington DNR

Figure 15. *Historically there were about 820,000 acres of large diameter, low density mixed conifer and ponderosa pine forests (see photo above) in the Forest Health Hazard Warning Areas. Today only about 170,000 acres of this forest structure exists in the Warning Areas. There are hundreds of thousands of acres of overstocked mixed conifer and pine forests in the Warning Areas susceptible to budworm and bark beetles.*

Insects

Bark Beetles

Fir Engraver
(*Scolytus ventralis* LeConte)

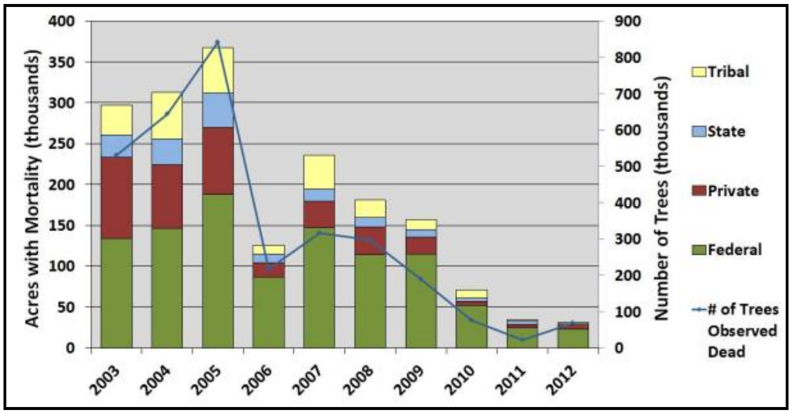


Figure 16. *Ten year trend for total acres and number of trees affected by fir engraver in Washington.*

Fir engraver can attack all species of true fir (*Abies* species) in Washington, but the primary hosts in Washington are grand fir and noble fir. The 31,500 acres with fir engraver caused mortality in 2012 were the lowest level observed in the past decade. The area with mortality from fir engraver has steadily fallen from a recent high of 236,000 acres in 2007. However, the number of trees killed in 2012 was nearly double the number in 2011. The average intensity was just over two trees killed per acre. Areas with scattered individual fir engraver-killed trees were common throughout the range of grand fir. The highest concentration was in areas of Kittitas County where western spruce budworm has defoliated hosts for at least seven consecutive years.

Glenn Kohler, Washington DNR

Figure 17. *Subalpine fir killed by western balsam bark beetle.*

Western Balsam Bark Beetle
(*Dryocoetes confusus* Swaine)

Western balsam bark beetle (WBBB), often in conjunction with balsam woolly adelgid, is an important driver of subalpine fir mortality in Washington's high elevation forests. The 6,500 acres with WBBB caused mortality in 2012 was the lowest amount seen in a decade. The area with subalpine fir mortality from WBBB has steadily fallen from a recent high of 56,000 acres in 2007.

Previous annual total acres with mortality from western balsam bark beetle:

- 2011: 8,100
- 2010: 16,000
- 2009: 16,000
- 2008: 32,000
- 2007: 56,000

Douglas-fir Beetle (*Dendroctonus pseudotsugae* Hopkins)

Approximately 26,000 acres with Douglas-fir beetle (DFB) caused mortality were observed statewide in 2012, up from 16,000 acres in 2011. The most dramatic increase in DFB activity was in western Okanogan County, primarily north of Highway 20. Acres with mortality in this area increased to approximately 17,000 acres in 2012, up from 2,400 acres in 2011. The increase in DFB-killed trees occurs in the same area that has been defoliated by western spruce budworm for at least six consecutive years. Trees stressed by defoliation are more likely to be attacked by bark beetles.

Figure 18. *Red boring dust on windthrown Douglas -fir, indicating Douglas-fir beetle attacks.*

Other areas with concentrated DFB activity include southern Skamania County, Pacific County and the Blue Mountains. However, only 1,000 acres with DFB mortality were observed in the Blue Mountains in 2012, continuing a downward trend from a peak of 20,000 acres in 2008.

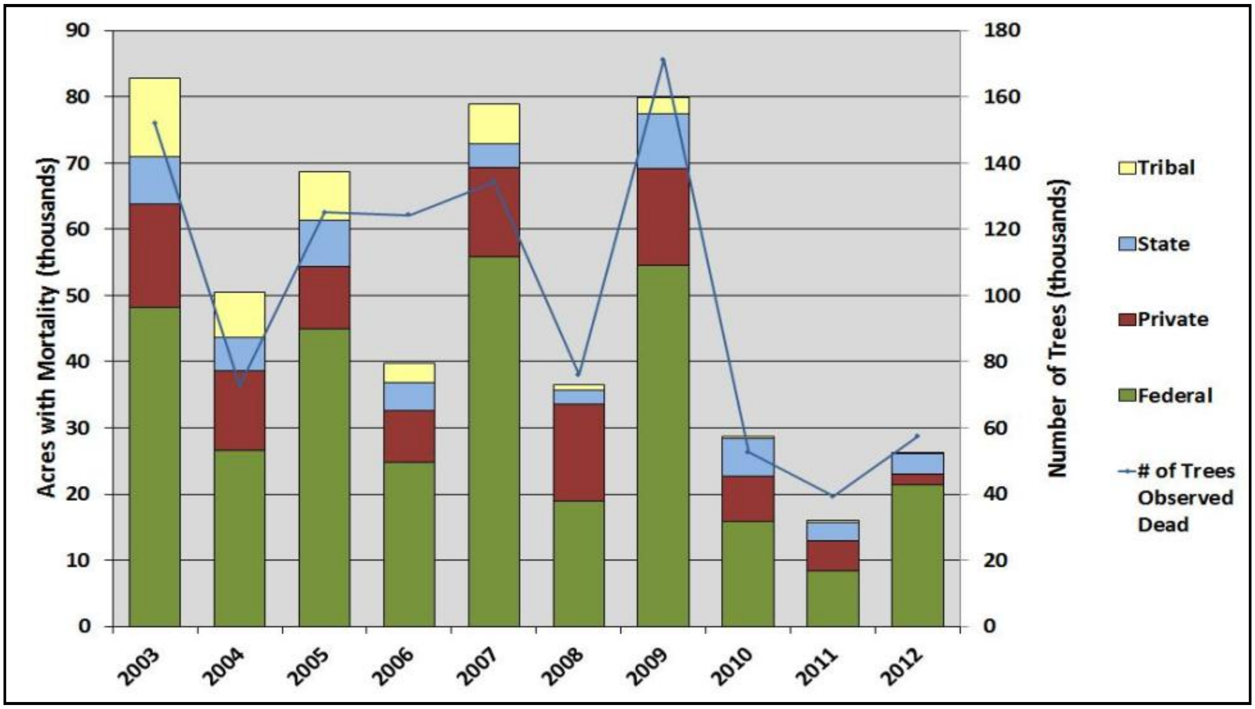


Figure 19. *Ten year trend for total acres and number of trees affected by Douglas-fir beetle in Washington.*

Spruce Beetle (*Dendroctonus rufipennis* Kirby)

62,000 acres with some spruce beetle-kill were observed in 2012 near the Cascade crest in western Okanogan and eastern Whatcom Counties. In this area spruce beetle impacts high elevation stream bottom stands of Engelmann spruce. This outbreak began in 1999 following winter damage to host trees. 2012 marks the highest annual acreage recorded in this outbreak in past decade, a significant increase from the record lows of 15,000 acres in 2010 and 2011. The reduction in mapped acres in 2010 and 2011 may have been due to unusually cool and wet springs delaying onset of red crowns. Precipitation in spring 2012 was also above normal but there was a month-long period with no rain preceding the flight over this area.

Glenn Kohler, Washington DNR

Figure 20. *Engelmann spruce mortality caused by spruce beetle in western Okanogan County.*

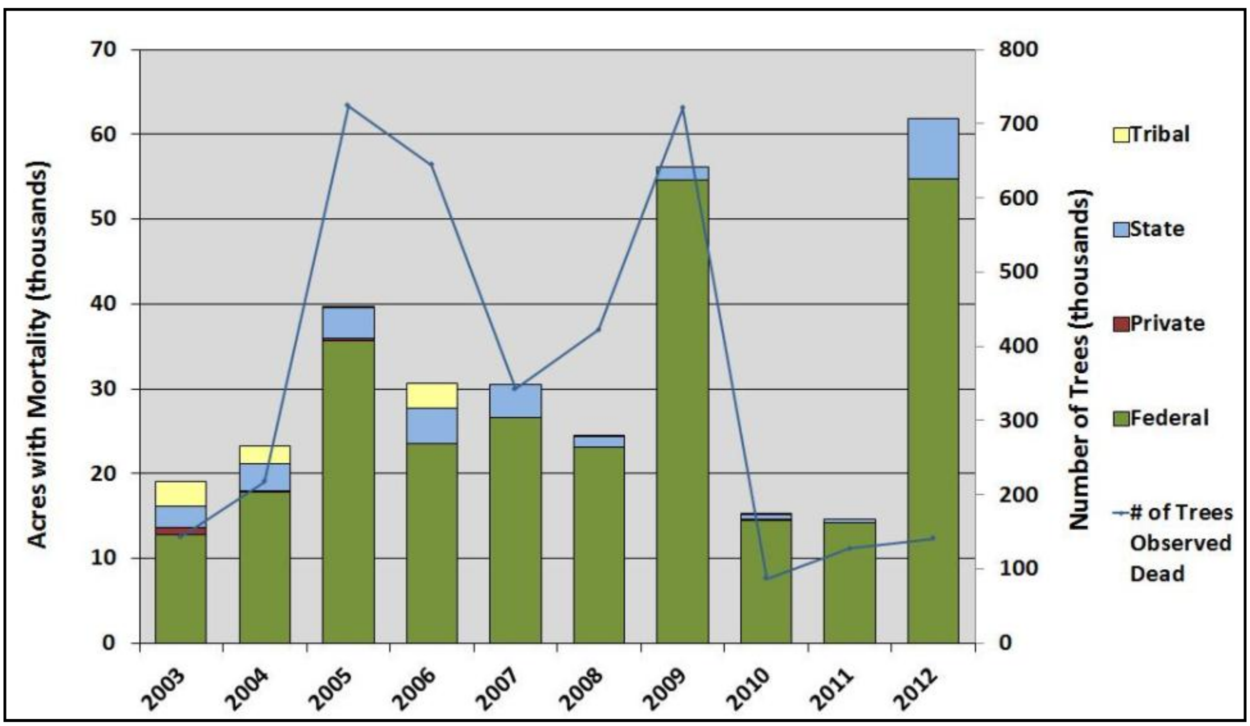


Figure 21. *Ten year trend for total acres and number of trees affected by spruce beetle in Washington.*

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

The number of acres with pine trees killed by bark beetles increased in 2012 to approximately 156,000 acres, up from 111,000 acres in 2011. Mountain pine beetle (MPB) damage increased in all hosts except whitebark pine (Table 1). The largest increases in MPB affected acres were in Yakima County, especially around Mt. Adams, eastern Okanogan County, and Ferry County. The overall number of lodgepole pines killed by MPB within affected areas of eastern Washington more than doubled since 2011 to nearly 2 million trees. The proportion of lodgepole mortality was especially high in Chelan and Yakima Counties. The largest increase in area affected by all pine bark beetles occurred in the Cascade Mountains of Kittitas, Yakima and Klickitat Counties. Approximately 62,000 acres with mortality were recorded in 2012, up from 30,000 acres in 2011. Other areas with increased pine bark beetle activity include Chelan, Okanogan, Ferry, Stevens, Pend Oreille, and Spokane counties.

Aleksandar Dozic, Washington DNR

Figure 22. *Mountain pine beetle-killed lodgepole pine at Shady Pass near Chelan, Washington.*

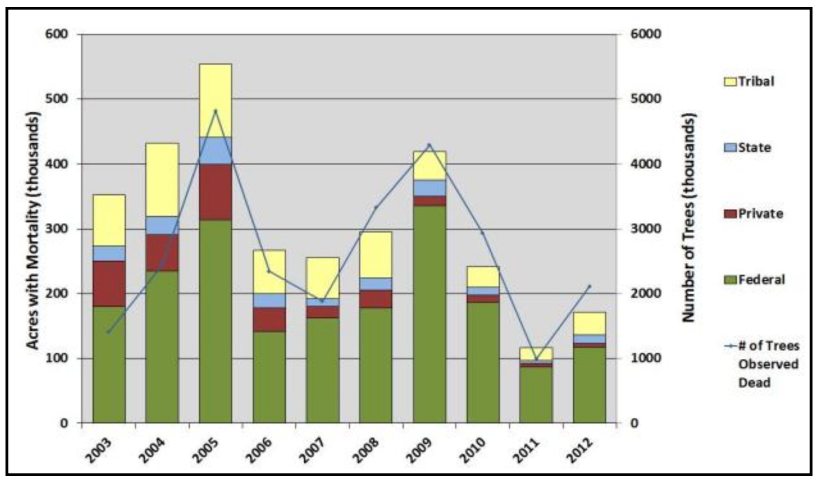


Figure 23. *Ten year trend for total acres and number of trees affected by pine bark beetles in Washington.*

Table 1. 2012 statewide acres affected and estimated number of pine bark beetle-killed trees.

Beetle species	Host(s)	Acres with mortality*	Estimated number trees killed
mountain pine beetle	lodgepole pine	141,000	1,993,000
mountain pine beetle	ponderosa pine	23,000	104,000
mountain pine beetle	whitebark pine	4,100	8,600
mountain pine beetle	western white pine	1,000	900
western pine beetle	ponderosa pine	1,800	2,200
pine engravers (*Ips* species)	all pines	402	3,300

*Multiple host species can be recorded in a single damage area, therefor total footprint of pine bark beetles is greater than total of all hosts.

California Fivespined Ips (*Ips paraconfusus* Lanier)

Todd Murray, WSU Extension

Figure 24. *Ponderosa pine mortality caused by California fivespined Ips near White Salmon, Washington.*

The California fivespined *Ips* (CFI), *Ips paraconfusus*, a pine engraver beetle native to California and Oregon, has been a serious pest of young ponderosa pine plantations in the Willamette Valley in Oregon. CFI was recorded for the first time in Washington State in 2010. 2012 was the third year of CFI outbreaks in the eastern Columbia River Gorge in Skamania and Klickitat counties, resulting in numerous killed and top-killed ponderosa pines every year since 2010. CFI flights and distribution have been monitored using pheromone baited traps placed by Washington State University (WSU) Extension, the USFS and WDNR. In 2011 and 2012, high numbers of CFI were collected along the Columbia River from White Salmon west to Vancouver. Low numbers of CFI have been collected as far north as Ft. Lewis west of the Cascades and Trout Lake east of the Cascades. The new Washington distribution of CFI includes Klickitat, Skamania, Clark, Cowlitz, Lewis, Thurston, and Pierce Counties.

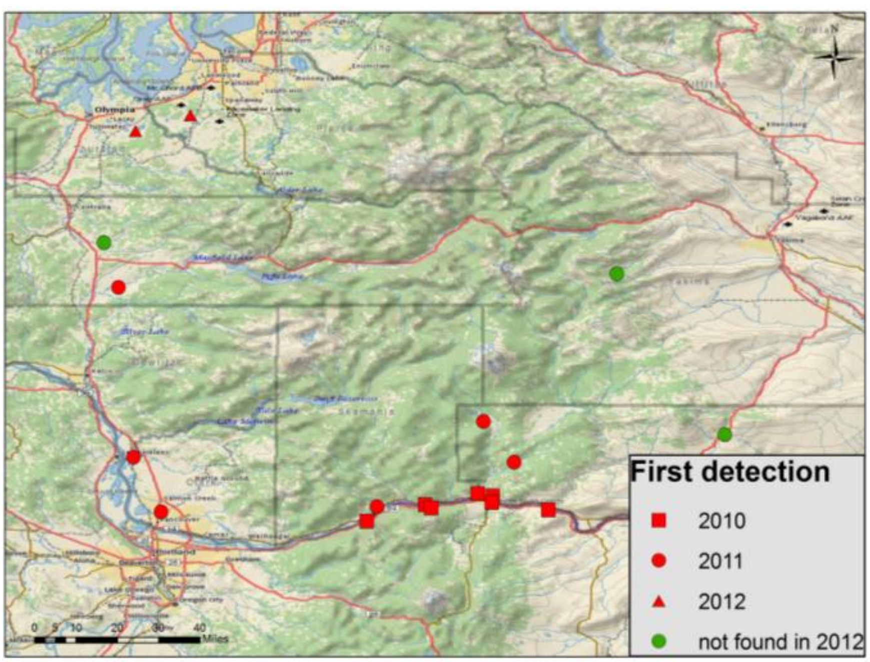


Figure 25. *California fivespined Ips monitoring trap locations in Oregon and Washington, 2010-2012. Map by: Aleksandar Dozic, Washington DNR.*

For more information on managing CFI, see the 2012 WSU Extension outreach publication: "Pest Watch: California Fivespined Ips - A Pine Engraver Beetle New to Washington State." http://cru.cahe.wsu.edu/CEPublications/FS085E/FS085E.pdf

Defoliators

Western Spruce Budworm (*Choristoneura occidentalis* Freeman)

The east slopes of the Washington Cascade Mountains and mountains of northeastern Washington continue to experience an outbreak of western spruce budworm (WSBW). Areas with WSBW defoliation recorded in the 2012 aerial survey have decreased slightly to 511,000 acres, down from 539,000 in 2012. The average area defoliated by WSBW in Washington over the past ten years is 388,000 acres. The area affected is expanding in northeastern Washington (Pend Oreille, Stevens, Ferry, and eastern Okanogan counties) and the south Cascades. The total area with defoliation has decreased by about 15% in the central and north Cascades.

In the central and north Cascades, Kittitas and Okanogan counties were the most heavily affected. Direct mortality from defoliation (especially in smaller trees), top-kill, and mortality from Douglas-fir beetle and fir engraver are becoming more common in these areas. Pheromone trap catches were generally lower in northeastern Washington and the central and north Cascades, indicating light to moderate defoliation in 2013 (Fig. 28). Small pockets of defoliation have expanded and new areas have been mapped in the northwest corner of the Yakama Indian Reservation and just south of Mt. Adams. Pheromone trap catches in these areas were lower in 2012, indicating patchy to light defoliation in 2013 (Fig. 28).

Glenn Kohler, Washington DNR

Figure 26. *Severe defoliation by western spruce budworm along Blewett Pass.*

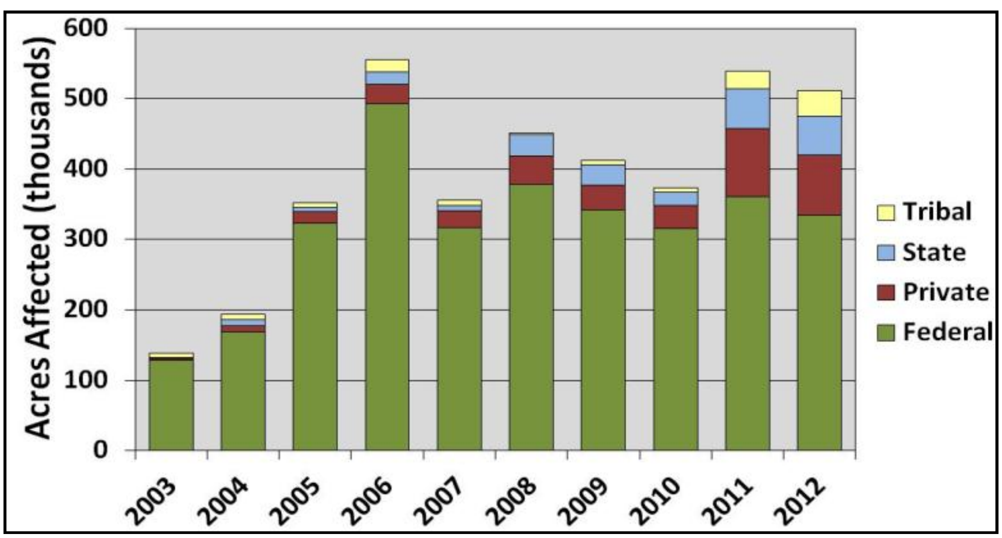


Figure 27. *Ten year trend for total acres affected by western spruce budworm in Washington.*

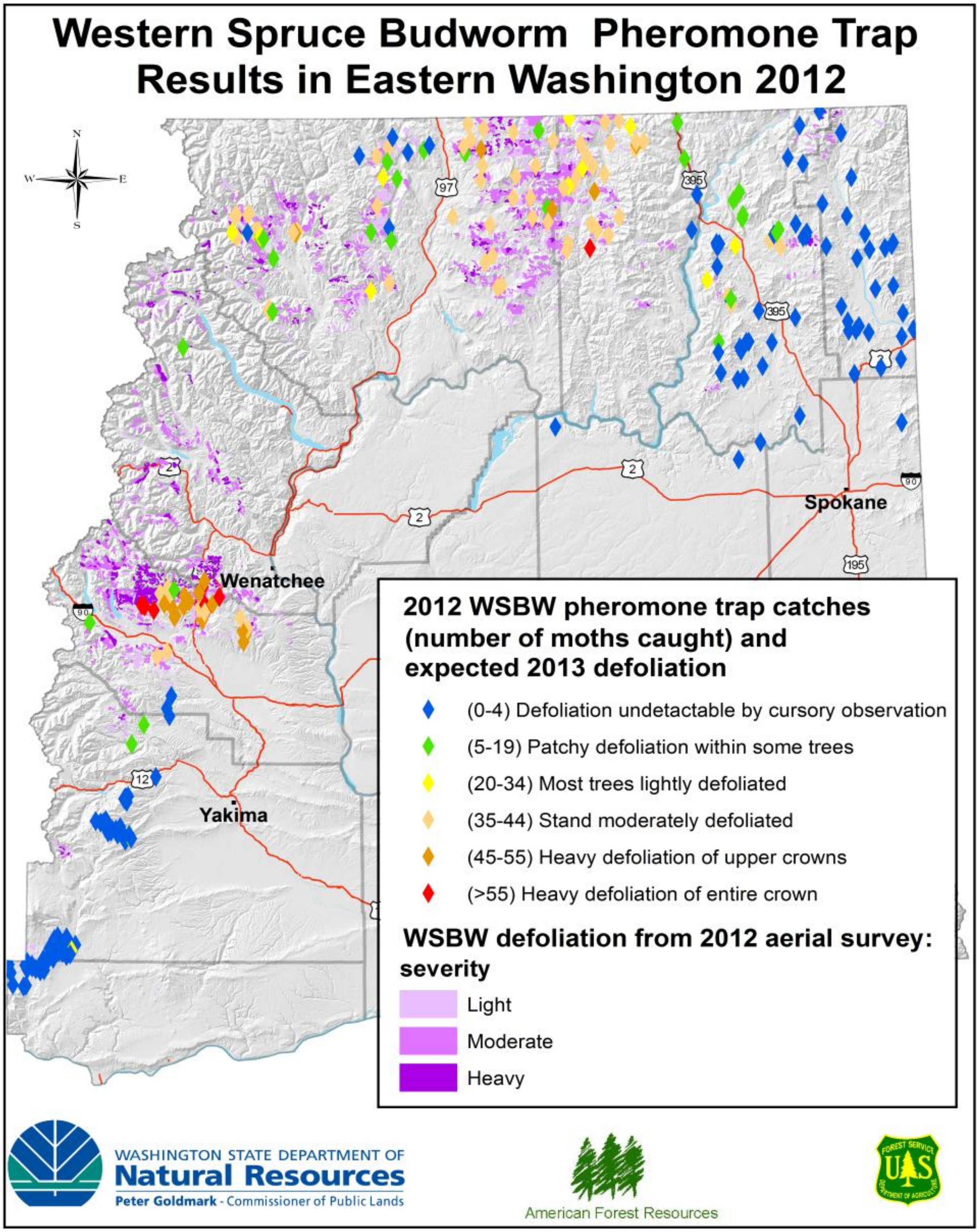


Figure 28. *Western spruce budworm pheromone trap catch results for 2012, expected 2013 defoliation and defoliation detected by the 2012 aerial survey.* *Map by: Aleksandar Dozic, Washington DNR*

Douglas-fir Tussock Moth (*Orgyia pseudotsugata* McDunnough)

Spokane County and north Idaho: The Spokane County vicinity Douglas-fir tussock moth (DFTM) outbreak has collapsed. 2012 aerial survey recorded 70 acres with DFTM defoliation in the Tekoa Mountain area, down from a high of 1,600 acres in and near Spokane County in 2011. This outbreak resulted in very little direct mortality to host trees in Washington. In north Idaho, damage was more severe, causing host mortality in some stands. However the majority of affected areas are recovering from defoliation. The Idaho State Department of Lands (IDL) aerial survey mapped approximately 26,000 acres with new DFTM defoliation in north Idaho in 2012, down from a peak of 68,000 acres in 2011.

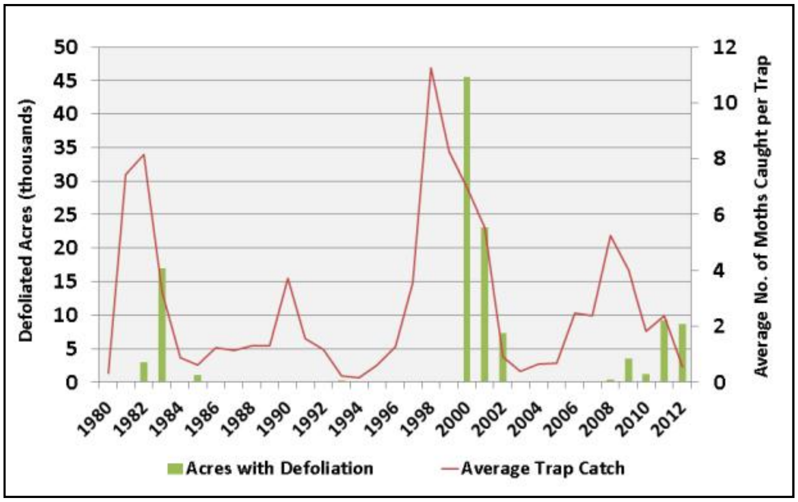


Figure 29. *Correlation of DFTM pheromone trap catches with observed defoliation.*

Blue Mountains: In 2012, approximately 8,600 acres with DFTM defoliation were recorded in the Umatilla National Forest in the Blue Mountains of Washington and approximately 1,800 acres in Oregon. The current affected area in Washington is generally north of the 7,800 acres defoliated in 2011 but still within the Umatilla NF. Defoliation primarily affected grand fir, subalpine fir and to a lesser extent Douglas-fir and spruce. Damage is still typically light, with the top third of the crown most heavily defoliated. Low numbers of new egg masses suggest the outbreak in the Blue Mountains is collapsing and there isn't likely to be much more defoliation in 2013.

Glenn Kohler, Washington DNR

Figure 30. *Douglas-fir defoliated by Douglas-fir tussock moth in the Blue Mountains, 2012.*

Hemlock Loopers (*Lambdina fiscellaria lugubrosa* (Hulst) and *Nepytia phantasmaria* (Strecker))

The 2012 aerial survey mapped approximately 1,400 acres with hemlock looper defoliation, up from 300 acres in 2011. The affected area is primarily around Baker Lake and Lake Shannon in Whatcom and Skagit counties. The heaviest defoliation has occurred in and around Horseshoe Cove Campground on the west shore of Baker Lake. There is whole tree mortality from looper defoliation in these stands, primarily in understory trees. The population of hemlock loopers in northwest Washington is likely to decline due to natural controls, resulting in less defoliation in 2013.

Glenn Kohler, Washington DNR

Figure 31. *Virus-killed hemlock looper caterpillar near Baker Lake in 2012.*

Larch Casebearer (*Coleophora laricella* Hübner) NON-NATIVE

2012 defoliation from larch casebearer (LC) totaled approximately 1,700 acres in Washington, primarily in Stevens, Pend Oreille, Spokane counties and the Blue Mountains. This is a sharp decrease from 16,000 acres with LC damage recorded in 2011. The last outbreak of widespread larch damage was in 2008 when 39,000 acres were defoliated by LC and 31,000 acres with larch needle cast disease damage were mapped. Because larch re-foliates annually, it takes several years of damage to cause serious injury to larch.

USDA Forest Service, R6 Archive

Figure 32. Larch casebearer larva with 'case' of old needles.

Gypsy Moth (*Lymantria dispar* Linnaeus) NON-NATIVE

In 2012, the Washington State Department of Agriculture (WSDA) placed 19,021 gypsy moth pheromone traps in Washington. 12,748 of these were for European gypsy moth (EGM) detection and delimiting and 6,273 were for Asian gypsy moth (AGM) detection. Twenty-seven (27) gypsy moths were collected from three (3) catch areas, all in western Washington. Twenty-five (25) of the 27 EGM catches were caught in the Tukwila area, where an eradication project is being proposed for 2013. Of the three catch areas, two (2) areas (Capitol Hill in Seattle and Lost Lake in Snohomish County) were new detections for gypsy moth in 2012. All 27 moths collected in 2012 were the North American variety of EGM from the established European population in the eastern United States. No AGM have been trapped in Washington since 1999. A total catch of 27 moths is not unusually high when more than 19,000 traps are used. In the past twelve years, the highest number of moths collected was 75 in 2006. WSDA will propose an eradication project for spring 2013 at the Tukwila site in King County where multiple egg masses and pupal cases were found. No gypsy moths were detected in summer 2012 at the Puyallup or Eatonville eradication sites.

Western Tent Caterpillar (*Malacosoma californicum* (Packard))

Scattered outbreaks of western tent caterpillar (WTC) developed throughout interior western Washington in 2012. Large aggregations of wandering caterpillars were reported by the public in summer 2012. Aerial survey observed WTC defoliation on 7,700 acres in western Washington, primarily in cottonwood, other poplars, and red alder. This is a big increase from the 181 acres defoliated in 2011. Most of the affected area was in Whatcom, Snohomish, King, Lewis, Cowlitz, and Skamania counties. 8,400 acres with WTC defoliation were recorded statewide. The severity of defoliation was light to moderate and many of the same stands were also affected by foliar diseases. WTC outbreaks are cyclical and rarely last more than a few years.

Glenn Kohler, Washington DNR

Figure 33. Red alder defoliated by western tent caterpillar near Chehalis, Washington.

Western Blackheaded Budworm (*Acleris gloverana* (Walsingham))

200 acres with western blackheaded budworm (WBB) defoliation were observed about four miles west of Baker Lake in Whatcom County. Both grand fir and western hemlock were lightly defoliated. Some WBB pupae collected were killed by parasitic ichneumonid wasps (*Phaeogenes* sp.). This is the first time WBB defoliation has been observed in aerial survey since 2003. In recent years, light WBB defoliation has been observed on Pacific silver fir from the ground in the Cedar River Watershed east of Seattle.

Glenn Kohler, Washington DNR

Figure 34. Western blackheaded budworm pupa on western hemlock.

Pine Needle Sheathminer (*Zelleria haimbachi* Busck)

Pine needle sheathminer caterpillars feed in the base of current year needles in ponderosa and lodgepole pines. Feeding does not cause tree mortality, but can reduce growth. A localized outbreak of pine needle sheathminer resulted in 320 acres with defoliation to both ponderosa and 'shore pine' lodgepole pine at several sites in Lewis County around Chehalis. Although damage to new foliage was severe, host trees are likely to recover.

Figure 35. Lodgepole pine shoots damaged by pine needle sheathminer feeding.

Glenn Kohler, Washington DNR

Branch and Terminal Insects

Balsam Woolly Adelgid (*Adelges piceae* Ratzeburg) NON-NATIVE

Balsam woolly adelgid (BWA) is a non-native sucking insect that has caused defoliation and mortality to subalpine fir, Pacific silver fir, and grand fir in Washington. Most current damage is recorded in subalpine fir in high elevation forests throughout Washington. Approximately 42,000 acres with defoliation and/or mortality from BWA were observed in 2012, an increase from 25,000 acres in 2011. This is below a recent peak of 60,000 acres in 2009 but over the 10-year average of 38,000 acres. BWA damage, primarily to subalpine fir and Pacific silver fir, was recorded at high elevations of the Blue Mountains, the Olympic Mountains, and on both the west and east slopes of the Cascade Mountains, and scattered areas of northeastern Washington. Haze from forest fires in Russia made it difficult for observers to see BWA signatures on flights over the Olympic Mountains. There were 9,500 acres with some host mortality attributed directly to BWA damage in 2012. Approximately 6,500 acres in these same high elevation areas were mapped with some western balsam bark beetle caused mortality in subalpine fir. BWA infestation can be a predisposing factor to western balsam bark beetle attack.


Glenn Kohler, Washington DNR

Figure 36. Balsam woolly adelgid 'wool' on bark of subalpine fir.

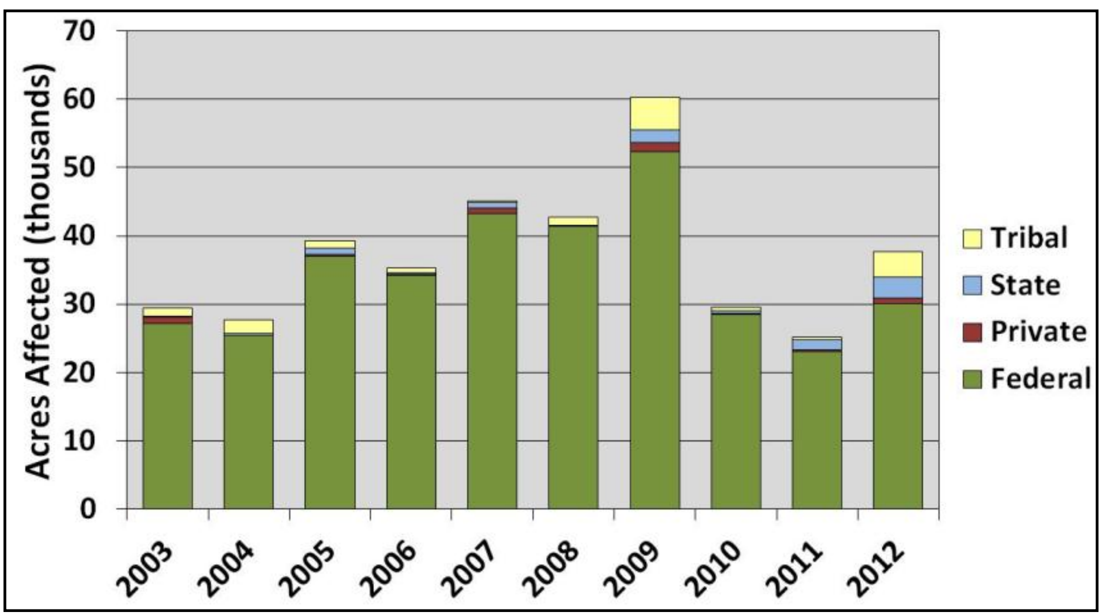


Figure 37. *Ten year trend for total acres affected by balsam woolly adelgid in Washington.*

Animals

Bear Damage / Root Disease

Aerial survey records scattered, pole sized, newly dead trees as 'bear damage.' Based on ground checking observations, bear girdling and root disease are the primary causes of this type of damage. Drought stress, porcupines, or mountain beavers may also play a role. Bears strip tree bark in spring and it takes more than one year for the tree to die and needles to become red (visible from the air). In years with wet and cool spring conditions, the berries that bears feed on mature later, so bears are more likely to feed on trees as an alternative. Also, above average spring precipitation may delay tree needles becoming red which may result in less observed damage that year. Other factors that may influence fluctuation in bear damage acreage are local bear populations and age of trees.

Approximately 200,000 acres with bear damage mortality were observed in 2012, which is slightly more than the 180,000 acres mapped in 2011. The ten year average of acres with bear damage in Washington is 250,000. The average number of trees per acre (TPA) killed was higher in 2012 (1.74 TPA) than 2011 (1.60 TPA). The estimated total number of trees killed was approximately 350,000, which was higher than the 290,000 trees killed in 2010.

In the Quinault Indian Reservation area, the bear damage situation continues to improve. Observers in 2012 mapped 21,281 acres with bear damage which is 7% less than the 22,892 acres mapped in 2011. Compared to previous years, it appears that bear damage is more common at higher elevations in the Quinault Indian Reservation area.

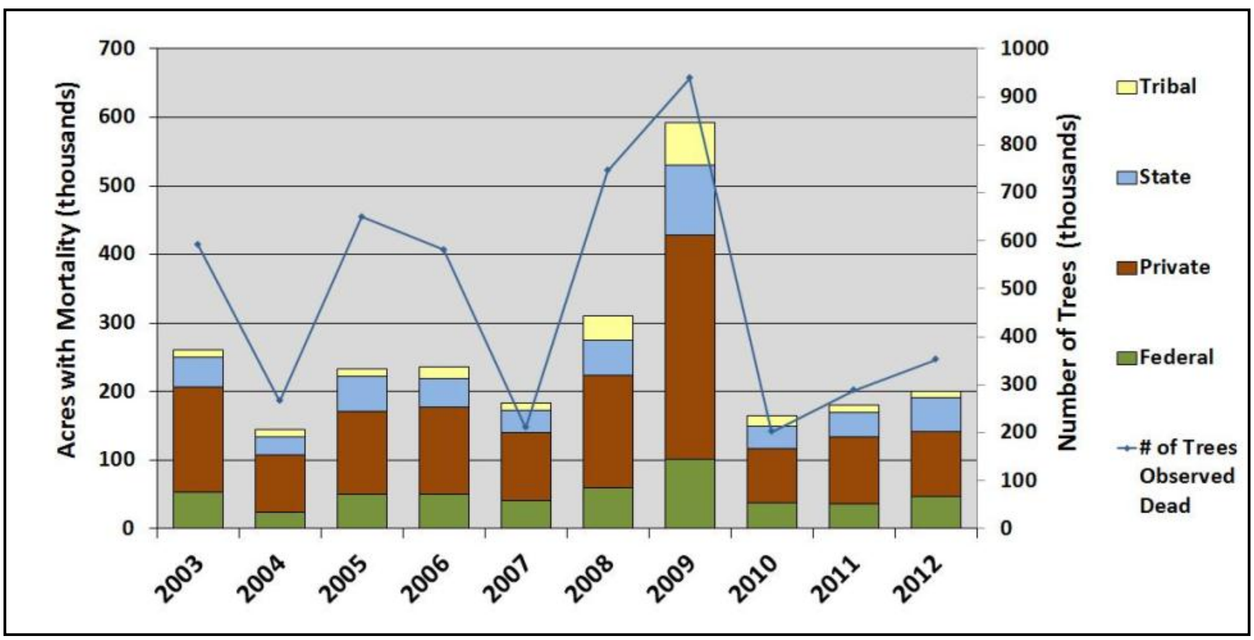


Figure 38. *Ten year trend for acres and number of trees affected by bear damage in Washington.*

Diseases

Cankers

White Pine Blister Rust (*Cronartium ribicola* Fisch.) NON-NATIVE

This exotic disease infects five needle pines such as western white pine and whitebark pine. The mortality of whitebark pine is of special concern because this species provides critical wildlife forage, is very slow growing, is crucial to healthy alpine ecosystems and is currently on a list of candidate species eligible for Endangered Species Act protection. In 2012, 4,050 acres of whitebark pine mortality were observed throughout the high elevation mountainous areas of the eastern Cascades, although much of this was attributed to mountain pine beetle. A light, broad scattering of western white pine mortality was observed in northeast and south-central Washington (1,050 acres). This was less whitebark and western white pine mortality than what was observed in 2011 (6,200 acres). The Washington aerial survey records very little area affected specifically by white pine blister rust (295 acres in 2011) because mortality signatures can be difficult to distinguish from mountain pine beetle from the air.

Amy Ramsey-Kroll, Washington DNR

Figure 39. *White pine blister rust infected white bark pine with dead top.*

A cooperative rust resistant western white pine field trial between WDNR and the Dorena Genetic Resource Center of the USFS continued this year. The six western Washington sites are now six years old. While the trees were not surveyed this year, an average of 12.3% of the trees had white pine blister rust stem symptoms across the sites in 2011. Of this 12.3%, there were an average of 1.7 white pine blister rust cankers per infected tree. Approximately 95% of the seedlings planted in 2006 are still alive and included in the study. Causes of mortality have included planting failure, root disease, mountain beaver damage, and white pine blister rust. Five year summary results were presented at the 2012 Society of American Foresters Convention in Spokane, WA.

Brian Luis, US Forest Service

Figure 40. *Rust resistant western white pine field trial site in southwest Washington.*

Amy Ramsey-Kroll, Washington DNR

Figure 41. *White pine blister rust infected western white pine.*

Foliar Diseases

Cottonwood Foliar Diseases (*Marssonina* spp. and *Melampsora* spp.)

Figure 42. *Hybrid poplar plantation infested with* Melampsora *foliar disease, Skagit County.*

Figure 43. *Black cottonwoods infested with foliar disease.*

7,160 acres of *Populus* spp. (black cottonwood, *Populus trichocarpa* Torr. & A. Gray, and hybrid poplars) with foliar disease were recorded in western Washington this year. *Marssonina* and *Melampsora* fungi were responsible for the foliar damage in cottonwood and hybrid poplar trees, which was primarily located in western Skagit and Snohomish counties. This is a significant increase from the 100 acres of foliar disease recorded in *Populus* spp. in 2011. The damage in 2011 was caused by two different foliar fungi, *Septoria* spp. and *Venturia* spp. and primarily affected black cottonwood along Interstate 90 and in Wahkiakum county. Foliar diseases are likely to be an issue when there are cool, wet spring weather patterns.

Figure 44. Marssonina *foliar disease.*

Figure 45. Melampsora *foliar disease.*

Larch Needle Cast (*Meria laricis* Vuill.)

Defoliation from larch needle cast disease (LNC) was recorded on 38,800 acres in eastern Washington in 2012, primarily in Ferry, Kittitas, Pend Oreille, Spokane, Stevens and Yakima counties. This is a significant increase of LNC from 2011, when only 4,000 acres were mapped. *Meria laricis* is a fungus that benfits from frequent rain, especially in the spring and summer, so the increased incidence of LNC is likely associated with the unusually wet spring in 2012.

Glenn Kohler, Washington DNR

Figures 46 and 47. *Larch needle cast.*

Pine Needle Casts (*Dothistroma* spp., *Elytroderma* spp., *Lophodermella* spp.)

Needle cast diseases increased significantly in lodgepole pine (*Pinus contorta* Douglas ex Loudon var. *latifolia* Engelm. Ex S. Watson) and ponderosa pine (*Pinus ponderosa* Lawson & C. Lawson) in 2012, likely due to above normal spring rainfall. Lodgepole pine needle cast increased from 450 acres in 2011 to 10,500 in 2012. Ponderosa pine needle cast increased from 2 acres in 2011 to 7,200 acres in 2012. The pine needle casts were only mapped aerially, so the specific causal foliar pathogens are not known. However, the most common foliar pathogens of lodgepole and ponderosa pine are *Dothistroma* spp., *Elytroderma* spp., and *Lophodermella* spp..

Jane Taylor, US Forest Service

Figure 48. *Lodgepole pine infected with Elytroderma foliar disease.*

Robert James, US Forest Service

Figure 49. *Dothistroma foliar disease.*

Sue Hagle, US Forest Service

Figure 50. *Lodgepole pine infected with Lophodermella foliar disease.*

Swiss Needle Cast (Phaeocryptopus gaeumannii (Rohde) Petrak)

The fungus that causes Swiss needle cast (SNC) is found throughout the range of its host, Douglas-fir (Shaw et al. 2011). The disease is most damaging near the coast due to the fungi-favorable climatic and topographic conditions. Swiss needle cast causes premature needle loss and can reduce growth of host trees, as well as alter wood properties and affect stand structure and development (Kanaskie and McWilliams 2011).

Daniel Omdal,, Washington DNR

Figure 51. *Swiss needle cast symptomatic Douglas-fir trees. Notice the chlorotic foliage and low needle retention.*

In 2012, a SNC aerial survey in Washington was coordinated with a ground survey. The 2012 Washington SNC survey was flown in mid-May and covered approximately 2.7 million acres of forest (Fig. 52.) Seventy five ground sites were included in the SNC ground survey. Fourteen sites were associated with "severe" SNC aerial survey polygons, 26 with "moderate" polygons and 35 were not associated with any aerial survey polygons (referred to as, "other" in the results). Site and individual tree characteristics were recorded at each site. Foliar samples were collected at each site and assessed for *P. gaeumannii* density.

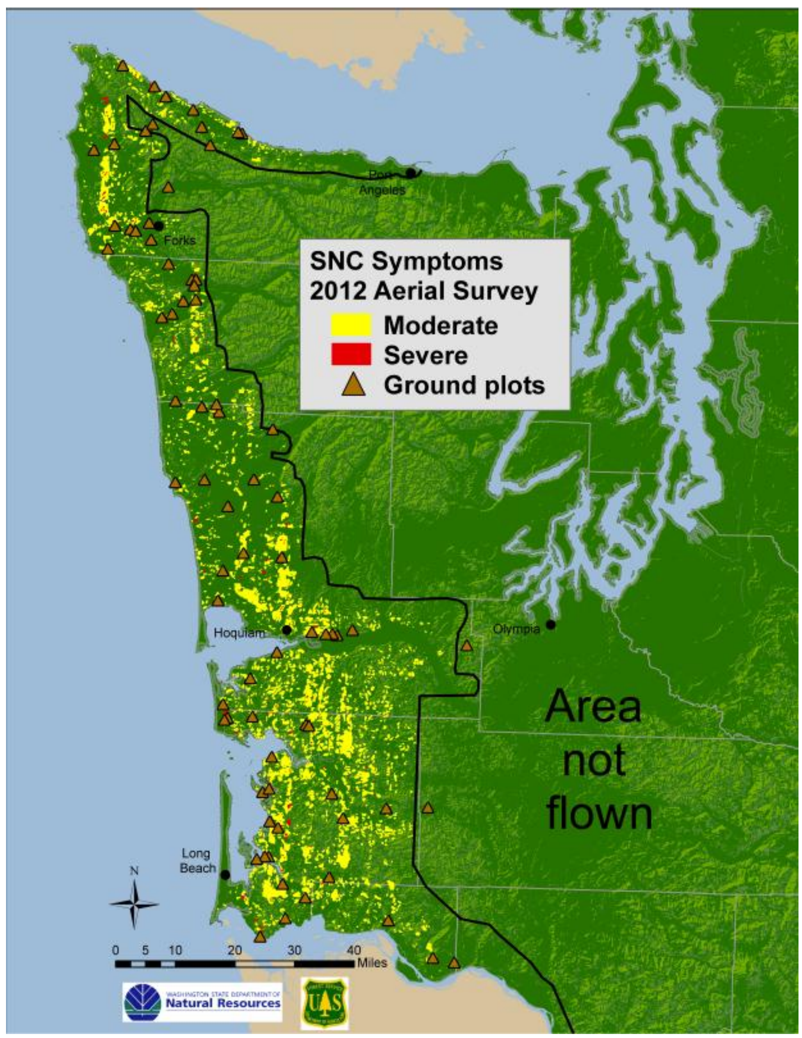


Figure 52. *Washington Swiss needle cast aerial survey map.*
Map by: Amy Ramsey-Kroll, Washington DNR.

The aerial survey mapped 228,500 acres of Douglas-fir with obvious symptoms of SNC (yellow to yellow-brown foliage). Approximately 8.5% of the total acres surveyed in 2012 were symptomatic.

Daniel Omdal, Washington DNR

Figure 53. *Douglas-fir trees displaying a Swiss needle cast symptom of chlorosis, or yellowing.*

Daniel Omdal, Washington DNR

Figure 54. *Douglas-fir trees displaying Swiss needle cast symptoms of chlorosis, or yellowing, and low needle retention.*

Crown color is the characteristic used to aerially map SNC symptoms, so our finding of significantly more yellowing foliage in the ground survey "severe" sites was expected. Also, the average needle retention, in years, was significantly less in the "severe" and "moderate" sites, which was another expected result. However, other results from the ground survey did not correspond well with the aerial survey. The percentage of Douglas-fir in the stands was significantly lowest in the "severe" sites and the "other" sites, not the expected "severe" sites, had the highest *P. gauemannii* incidence.

The SNC aerial survey can be used to coarsely document trends in damage over time. The ground data show that SNC is present in areas that were not mapped during the aerial survey. While the aerial survey can be used as a guide for identifying areas impacted by SNC, on the ground surveys should be conducted in stands of interest, if resources permit, before SNC mitigating management decisions are made.

References:

Kanaskie, A. and M. McWilliams. 2011. 2011 Swiss Needle Cast Aerial Survey. Oregon Dept. of Forestry, Office report, Salem, OR. Aerial survey data available online at www.oregon.gov/ODF/privateforests/fhMaps.shtml; last accessed Sept 20, 2011.

Shaw, D.C., G.M. Filip, A. Kanaskie, D.A. Maguire, and W.A. Littke. 2011. Managing an epidemic of Swiss needle cast in the Douglas-fir region of Oregon; the role of the Swiss Needle Cast Cooperative. J. of For. 109(2): 109-119.

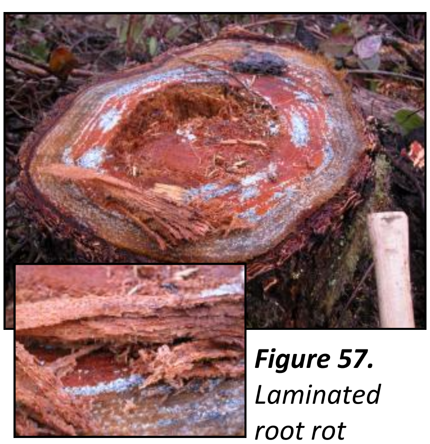
Root Diseases

Glenn Kohler, Washington DNR

Figure 55. *Annosus root disease stump decay and fruiting structure (in hand, white).*

Daniel Omdal, Washington DNR

Figure 56. *Armillaria mushrooms and mycelial fan underneath bark of tree.*



Amy Ramsey-Kroll, Washington DNR

Figure 57. *Laminated root rot decay in stump and close up of wood decay.*

Root diseases have a significant role in forest change in Washington. The most important root diseases in Washington are Annosus root disease (*Heterobasidion* spp.), Armillaria root disease (*Armillaria* spp.) and laminated root rot (*Phellinus sulphurascens* Pilát and *Phellinus weirii* (Murrill) Gilb.). They can affect many different species of trees, cause tree mortality and growth loss, promote diverse stand structure and habitat conditions, and decrease human safety as a result of hazard trees. Root diseases are underestimated using aerial survey methods because root disease caused mortality aerial signatures are difficult to distinguish from bark beetle mortality and bear damage. Approximately 200 acres were recorded as affected by root disease only in 2012 and 200,000 acres were recorded as bear damage/root disease (see page 23 for more information). Ground based survey methods provide a more comprehensive and accurate record of root disease affected acreage in Washington, but these surveys can be resource intensive, limiting the data available.

However, this year a new publication summarized over 30 years of research in south-central Washington, near Glenwood and the Mount Adams area, concerning root and stump removal to control Armillaria root disease in ponderosa pine. Results suggested that such treatment is not economically viable. The publication can be found here: http://www.fs.fed.us/pnw/pubs/journals/pnw_2012_shaw001.pdf

In 2009, WDNR installed conifer susceptibility trial plots near Glenwood, WA. Douglas-fir, ponderosa pine, western larch and western white pine were planted in Armillaria and Annosum root disease patches and around the bases infected trees, in efforts to determine species susceptibility to the root diseases. We continue to monitor seedling health on these plots, and plan to use the data to inform land managers in the area about management options for replanting harvested or thinned root disease infested stands.

Other Diseases

Sudden Oak Death (*Phytophthora ramorum* Werres & de Cock) NON-NATIVE

This exotic disease, caused by *Phytophthora ramorum*, has caused tree mortality in California and southwestern Oregon. Western Washington is at risk for *P. ramorum* caused plant infections due to the presence of known *P. ramorum* hosts in the natural environment, suitable climatic conditions (extended periods of moist weather and mild temperatures) and the presence of nurseries receiving *P. ramorum* infected host stock. While our only native oak species, Oregon white oak, is not susceptible to *P. ramorum*, the host list includes local species such as: grand fir, rhododendron, big leaf maple, Douglas-fir, evergreen huckleberry, Pacific madrone and salal, among others. In Washington, *P. ramorum* caused mortality or damage is unlikely to be recorded using aerial survey methods because *P. ramorum* symptoms are too subtle. Therefore, on the ground monitoring and survey projects are conducted to detect and track the disease.

Aquatic monitoring and forest and nursery perimeter surveys have been conducted in Washington since 2003, with efforts since 2006 focusing on aquatic areas near nurseries with previously reported positive *P. ramorum* plant stock. In 2012, 12 *P. ramorum* stream baiting traps were placed in 11 western Washington waterways. Positive samples were found in four waterways. Three of those were associated with the Sammamish River in King County, a river where positives samples have been detected since 2007. The other positive waterway was a creek located in forested area in Lewis county, one that was also positive in 2011. The source of the *P. ramorum* inoculum remains uncertain, but in the waterways associated with the Sammamish River, genetic evidence is pointing toward previously positive nurseries.

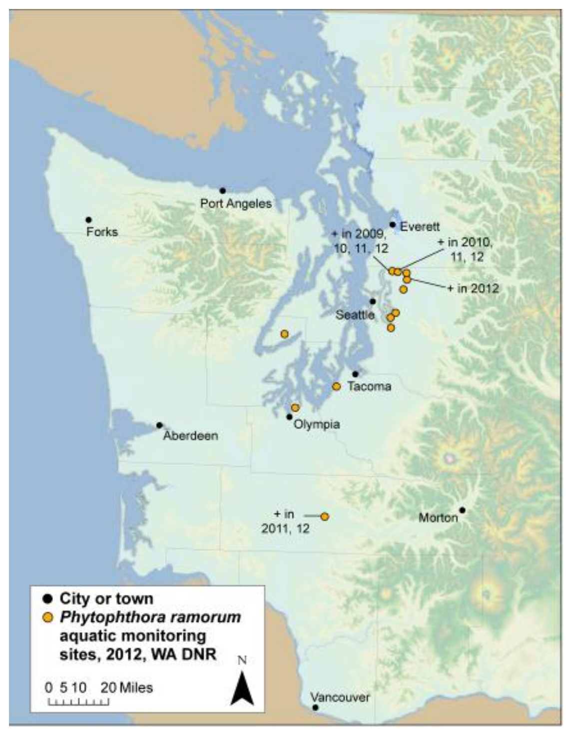


Figure 58. *WDNR stream baiting locations for* Phytophthora ramorum*. Map by: Amy Ramsey-Kroll, Washington DNR*

Since aquatic sampling began in 2006, *Phytophthora ramorum* has been detected in water samples from five waterways in western Washington: two in King County, one in Pierce County, one in Lewis County and one in Clark County. Diseased plants have only been found associated with one of the waterways (Pierce County) and were destroyed.

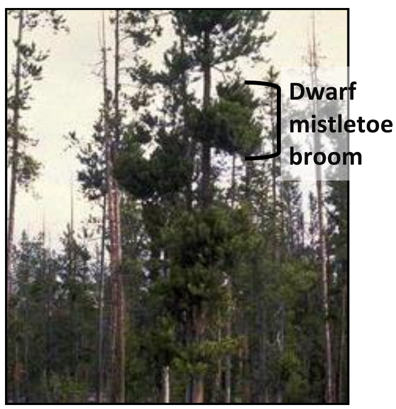
Dwarf Mistletoes

Dwarf Mistletoe (*Arceuthobium* spp.)

Dwarf mistletoes are parasitic, flowering plants that can grow on native conifers in Washington. True firs (grand, noble, subalpine, noble and Pacific silver), Douglas-fir, lodgepole pine, hemlock (western and mountain), ponderosa pine, and larch are all susceptible. In most cases, there is a specific *Arceuthobium* spp. for each host species (Figs. 59-63). Dwarf mistletoe infections can sometimes cause the formation of abnormal branch growths, called brooms (Fig. 60). Impacts of dwarf mistletoe can be both positive and negative. The positive impacts of dwarf mistletoe infections include the creation of wildlife habitat, specifically nesting platforms in Douglas-fir for the northern spotted owl and in western hemlock for the marbled murrelet. Negative impacts of dwarf mistletoe infections include reduced forest productivity from tree growth loss and mortality.

Daniel Omdal, Washington DNR

Figure 59. *Dwarf mistletoe (*Arceuthobium laricis*) infected western larch.*



Bill Jacobi, Colorado State University

Figure 60. *Dwarf mistletoe (*Arceuthobium americanum*) infected lodgepole pine.*

Glenn Kohler, Washington DNR

Figure 61. *Dwarf mistletoe (*Arceuthobium douglasii*) infected Douglas-fir.*

Amy Ramsey-Kroll, Washington DNR

Figure 62. *Ponderosa pine dwarf mistletoe plant (*Arceuthobium campylopodum*).*

Amy Ramsey-Kroll, Washington DNR

Figure 63. *Western hemlock dwarf mistletoe plant (*Arceuthobium tsugense subsp. tsugense*).*

Data and Services

Every year, all forested acres in Washington are surveyed from the air to record recent tree damage. This aerial survey is made possible by the cooperation of the WDNR and the USFS. It is very cost effective for the amount of data collected. These maps are great tools for a quick look at what forest disturbance events have occurred in your neck of the woods. They produce excellent trend information and historical data.

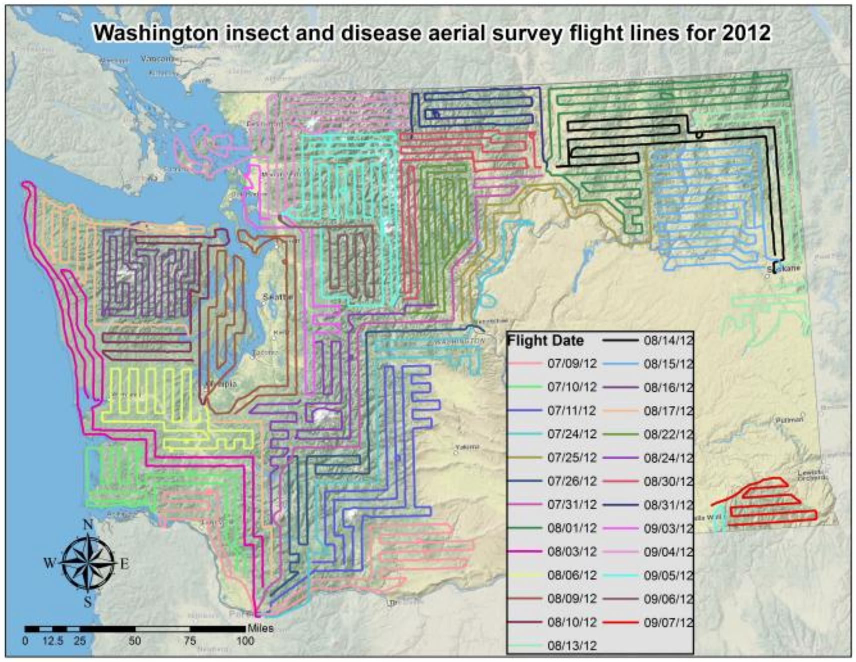


Figure 64. *Washington insect and disease aerial survey flight lines for 2012. Map by: Aleksandar Dozic, Washington DNR*

Electronic PDF Maps Available for Download

Traditional insect and disease survey quadrangle maps from 2003 to 2012 are available for download as PDF files at: www.fs.usda.gov/goto/r6/fhp/ads/maps

Click on the year of interest from the list of available years. Simply click the map you want from the interactive map of Oregon and Washington and it will download the PDF.

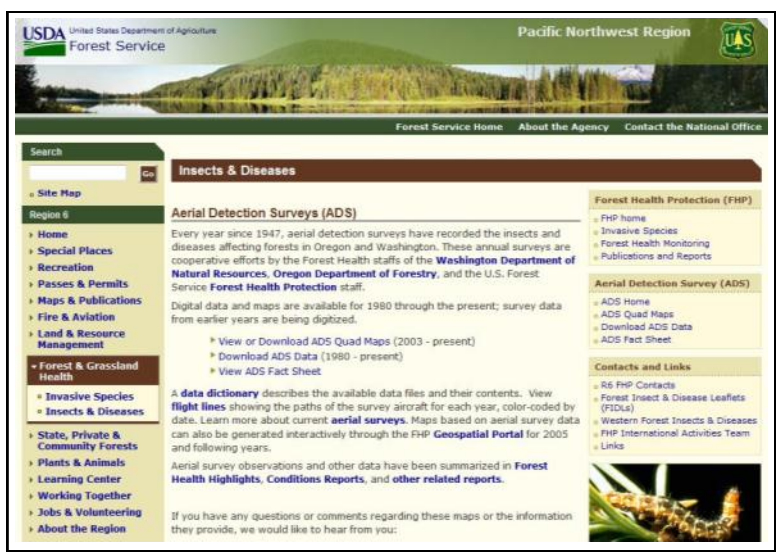


Figure 65. *Downloadable aerial survey maps and data on USFS Region 6 Forest Health Protection website.*

GIS Data Available for Download

Washington DNR also maintains downloadable GIS datasets, including aerial survey data for Washington State from 1980 to 2012, known as "Bugs n Crud" at:
http://www.dnr.wa.gov/BusinessPermits/Topics/Data/Pages/gis_data_center.aspx
Click on "Available GIS Data," then scroll down to "Forest Disturbance."

Forest Health Websites

Washington Forest Health Highlights reports are published annually and include the latest information on exotic pest problems, insect and disease outbreaks and recent forest damage trends for Washington. Recent annual reports, WDNR research and other forest health information are available at:
http://www.dnr.wa.gov/ResearchScience/Topics/ForestHealthEcology/Pages/rp_foresthealth.aspx

Historic annual highlights reports for Oregon and Washington are available at:
www.fs.usda.gov/goto/r6/fhp/highlights

Major insect and disease identification and management information, illustrations and graphical trend analysis of Pacific Northwest forest health issues are available at:
www.fs.usda.gov/goto/r6/fhp

Field Guides

The "Field Guide to Diseases and Insect Pests of Oregon and Washington Conifers," produced by the USDA Forest Service Pacific Northwest Region, is a great reference for anyone wanting to learn more about forest pests in the Pacific Northwest.

"Common Tree Diseases of British Columbia" is a field guide that includes many forest diseases found in the Pacific Northwest. It is available free of charge through Natural Resources Canada, Canadian Forest Service. Call (250) 363-0600 or go to:
http://cfs.nrcan.gc.ca/publications?id=4633

Contacts and Additional Information

If you have questions about forest insect and disease activity in Washington, please contact one of these regional or field offices:

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