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Pacific Northwest Region
Forest Health Protection

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

Forest Health Highlights in Washington—2013

Washington State Department of Natural Resources
Forest Health Program
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Front cover: *Aerial observers Ben Smith (USDA Forest Service) and Aleksandar Dozic (Washington Department of Natural Resources). Photo: Mary Verry, USDA Forest Service.*

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Summary

Washington has 22.4 million acres of forestland. In 2013 approximately 593,000 acres of this land contained some level of tree mortality, tree defoliation, or foliar diseases. This is only about 55% of the 1.08 million acres reported in 2012. Acres with mortality from bark beetles decreased for most hosts in 2013. Mortality due to mountain pine beetle, Douglas-fir beetle, and fir engraver were at the lowest levels in the last ten years. The area with conifer defoliation decreased to approximately one third of the 2012 area, primarily due to the western spruce budworm defoliated area dropping to a ten-year low. New outbreaks of western blackheaded budworm defoliation have expanded to over 14,000 acres in western Washington. Previous statewide annual totals were:

2011: 950,000 acres **2010:** 937,000 acres **2009**: 1.73 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. Pacific Northwest weather was influenced by the La Nada (neutral) effect in 2013, resulting in a moderately wet spring and above average temperatures June through September.

Approximately 1.9 million trees were recorded as recently killed.

Pine bark beetle activity recorded by aerial survey in Washington decreased in 2013 to approximately 107,000 acres compared to the 156,000 acres in 2012. **Mountain pine beetle** (MPB) damage decreased to the lowest level in the last ten years; declines were seen for all pine hosts. The most concentrated areas of MPB-caused mortality occurred in Chelan County, western Okanogan County, northern Ferry County, and near the border between Yakima and Klickitat counties.

Approximately 11,000 acres with **Douglas-fir beetle** (DFB) caused mortality were observed statewide in 2013, down from 26,000 acres in 2012. This is the lowest level recorded in the last ten years. Concentrated areas with DFB-caused mortality were detected in western Okanogan County, likely associated with long-term defoliation by western spruce budworm.

An outbreak of **western spruce budworm** continues to damage host trees in areas of eastern Washington; however, the area affected decreased significantly in 2013 to 178,000 acres, approximately one third of the 511,000 acres reported in 2012. A similar decline has also been reported in adjacent western states and British Columbia. Mid-elevation forested areas of Kittitas, Okanogan, and Ferry counties were most heavily affected.

Approximately 14,000 acres with **western blackheaded budworm** defoliation were observed in western Washington, primarily on the east side of the Olympic Peninsula and west of Mt. Rainier in Lewis County. Both western hemlock and Pacific silver fir were moderately defoliated.

An outbreak of **Douglas-fir tussock moth** in the Blue Mountains from 2011 to 2012 has collapsed due to natural controls. A 2011 to 2012 outbreak of **hemlock loopers** in the vicinity of Baker Lake in Whatcom and Skagit counties has also collapsed due to natural controls.

Needlecast diseases in eastern Washington affecting larch and pine decreased significantly in 2013. Approximately 11,000 acres of needlecast symptoms were observed in western larch, 4,500 acres in lodgepole pine, and 200 acres in ponderosa pine.

Bear (animal damage) activity recorded by aerial survey dropped slightly in 2013 to approximately 183,000 acres, down from 200,000 recorded in 2012.

Weather and Forest Health

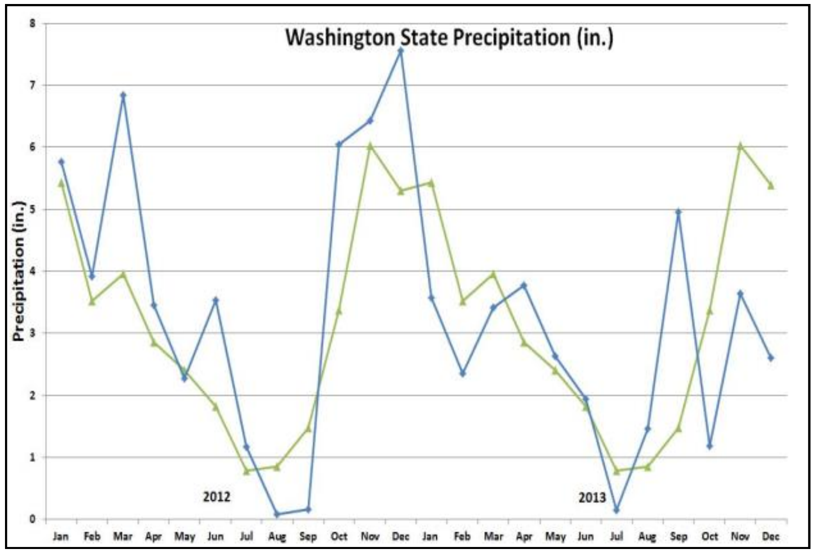


Figure 1. *Average monthly precipitation and 30-year average (green line) for Washington. Source: National Climatic Data Center (http://www.ncdc.noaa.gov/cag/).*

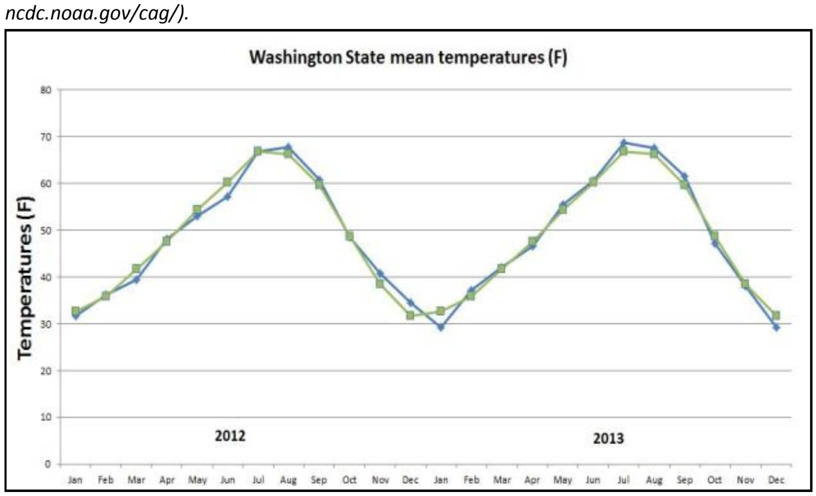


Figure 2. *Monthly mean temperature and 30-year average (green line) for Washington. Source: National Climatic Data Center (http://www.ncdc.noaa.gov/cag/).*

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 break-age from cold, snow or ice), heat stress, flooding, land-slides 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 when summer precipitation was at or below average, the number of bark beetle-killed trees may increase the following year. Typically, conifer trees killed by bark beetles do not appear red until the year after they died. Increases in mortality from bark beetles related to events such as drought or storms may not appear in aerial survey data until two years following the event. An increase in bear damaged trees may occur the year after an unusually wet and cool spring due to delayed availability of berries, drawing bears to trees as an alternate food source.

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.

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.

Drought

2013 spring precipitation for much of Washington was slightly above average but was followed by record low rainfall for the month of July. Fortunately, precipitation was well above normal in August and September, reducing potential summer drought stress on trees. The Blue Mountains area experienced four months of moderate drought conditions from June through September. Southern Klickitat County experienced abnormally dry conditions from June through August. Chelan County and surrounding areas also experienced abnormally dry conditions from mid-July through mid-August. Average 2013 summer temperatures were slightly above normal across the state. Much of Washington was abnormally dry from mid-October through the end of December 2013 (Figure 3). By mid-December, much of the state was below 50% of normal fall precipitation and the Cascade Mountains were below 70% of normal precipitation. Trees experiencing drought stress can become more susceptible to insect and disease attacks and are less likely to recover from damage. Two summer months with no rain in 2012 contributed to increased mortality of young trees in western Washington apparent in 2013 (for more detail, see section on drought damage below). In eastern Washington, trees growing in dense or overstocked stands have a higher likelihood of experiencing drought stress.

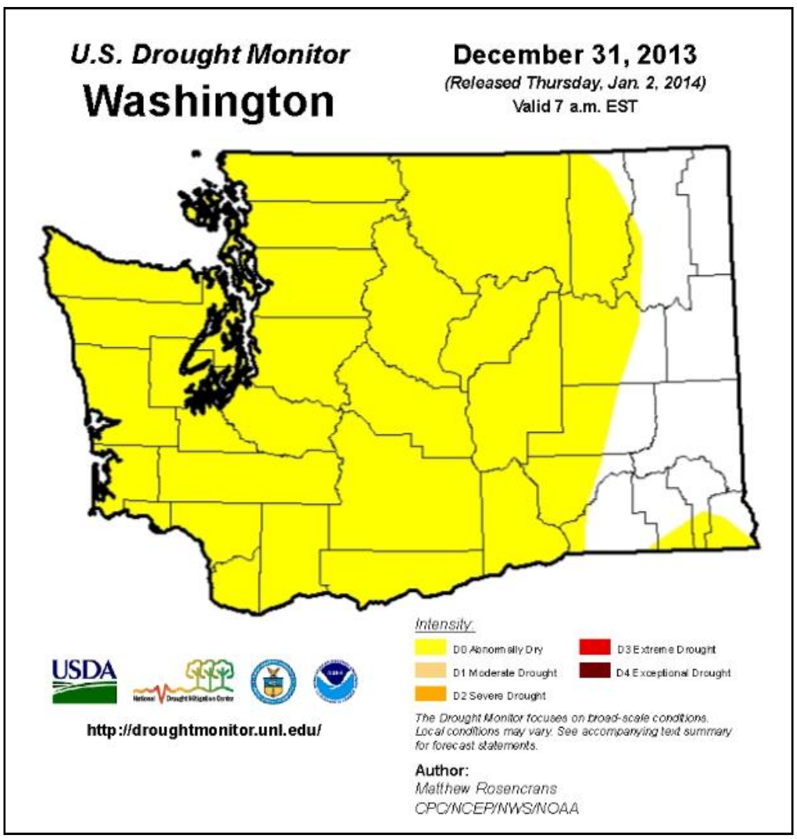


Figure 3. *Abnormally dry condition for most of Washington as of December 31, 2013. Source: US Drought Monitor (http://droughtmonitor.unl.edu).*

Drought Damage

In spring 2013, an unusual number of conifer trees in western Washington exhibited top-kill, dead branches and whole tree mortality. The majority of trees examined showed no indication of being killed by pathogens, insects, or other animals. The damage was primarily the result of an extended period with little to no rain during August and September 2012 and a drier than normal spring in 2013. Douglas-fir trees 5-15 years old appeared to be the most commonly affected, but some larger trees also showed symptoms. Some conifer plantations lost as much as 10% of young trees. Damage was most severe in areas with rocky soils, such as in glacial outwash around the Puget Sound. Areas affected were from the south Puget Sound region to Vancouver and along the Columbia River Gorge. Secondary bark beetles, such as **Douglas-fir pole beetle** (*Pseudohylesinus nebulosus* (LeConte)) and **Douglas-fir engraver** (*Scolytus unispinosus* LeConte) were found in some trees, but were not the primary cause of mortality. This pattern of mortality in young trees was likely recorded in aerial survey data as 'bear damage'.

Glenn Kohler, Washington DNR

Figure 4. *Drought-killed Douglas-fir trees.*

Fire

The 2013 wildfire season began unusually early for western Washington due to abnormally hot, dry, and windy conditions in early May. Two small wildfires, the C Line Fire in Capital State Forest and the Dog Mountain Fire near Riffe Lake in Lewis County, each burned approximately 100 acres. Wildfire season typically begins the last week of June, but in eastern Washington was delayed in 2013 due to wetting rains in late June. Wildfire conditions worsened across Washington in July and August with warm and dry weather. The number of lightning strikes in 2013 was above normal, but 68% of the 750 Washington Department of Natural Resources (WDNR) jurisdiction fires were human caused. Approximately 126,000 acres burned in WDNR protection areas, well above the 10-year average of 29,000 acres burned. Major fires included Colockum Tarps Fire near Wenatchee, Eagle Fire near Leavenworth, Manastash Ridge Fire near Cle Elum, and Mile Marker 28 Fire near Goldendale. Aerial survey was postponed for several days due to smoke conditions across Eastern Washington.

Jennifer Croft, USDA Forest Service

Figure 5. *Colockum Tarps fire.*

Aerial Detection Survey

The annual insect and disease aerial detection survey (ADS) in Washington was conducted by the USDA Forest Service (USFS) in cooperation with WDNR. The survey is flown at 90-150 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 the estimates that were made 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 ten times.

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.

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 after 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, when direct effects of the burn have mostly subsided, pests can be credited with the newest tree damage, and that damage is counted in the aerial survey totals.

Mary Verry, USDA Forest Service

Figure 6. *Aerocommander used for 2013 aerial survey in Washington.*

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.

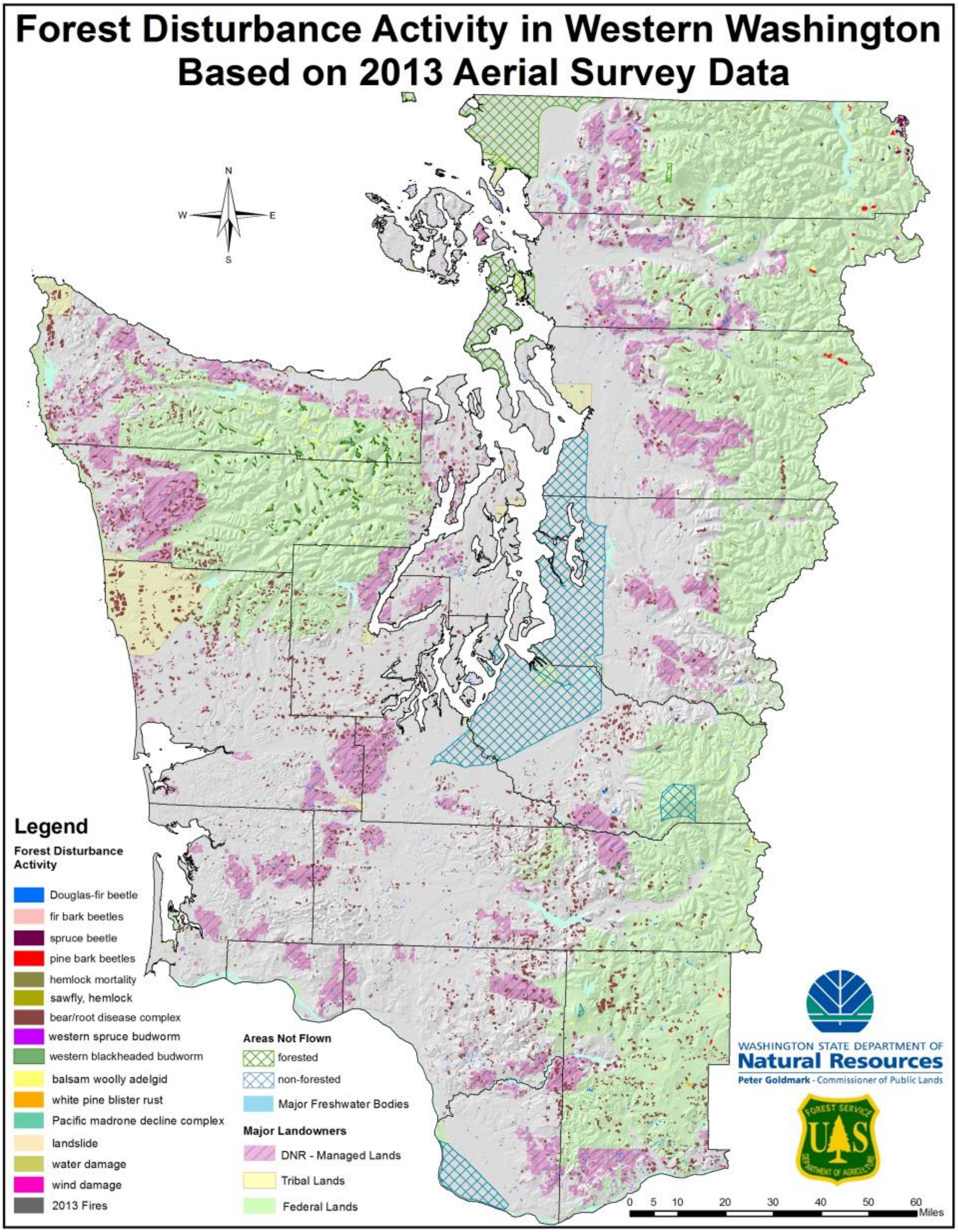


Figure 7. *Forest disturbance map of Western Washington composed from 2013 aerial survey data.*
Map by: Aleksandar Dozic, Washington DNR

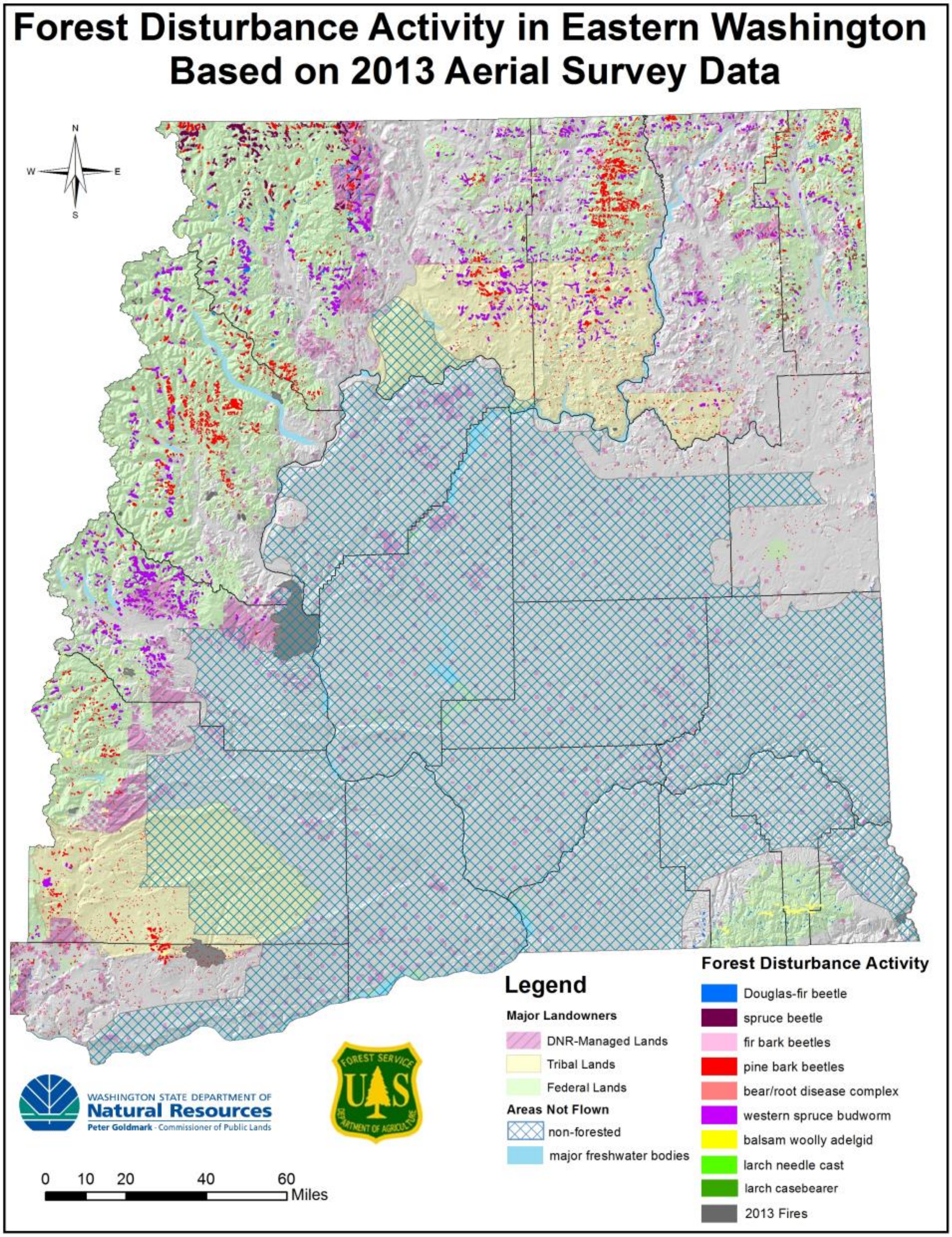


Figure 8. *Forest disturbance map of Eastern Washington composed from 2013 aerial survey data.*
Map by: Aleksandar Dozic, Washington DNR

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. Under the law, the Commissioner of Public Lands is responsible for serving as the state's lead on all forest health issues.

Figure 9. *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, changed forest conditions 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. The Forest Health Hazard Warning areas encompass approximately 1.8 million acres of forestland in Okanogan and Ferry counties and 260,000 acres of forestland in Klickitat and Yakima counties.

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

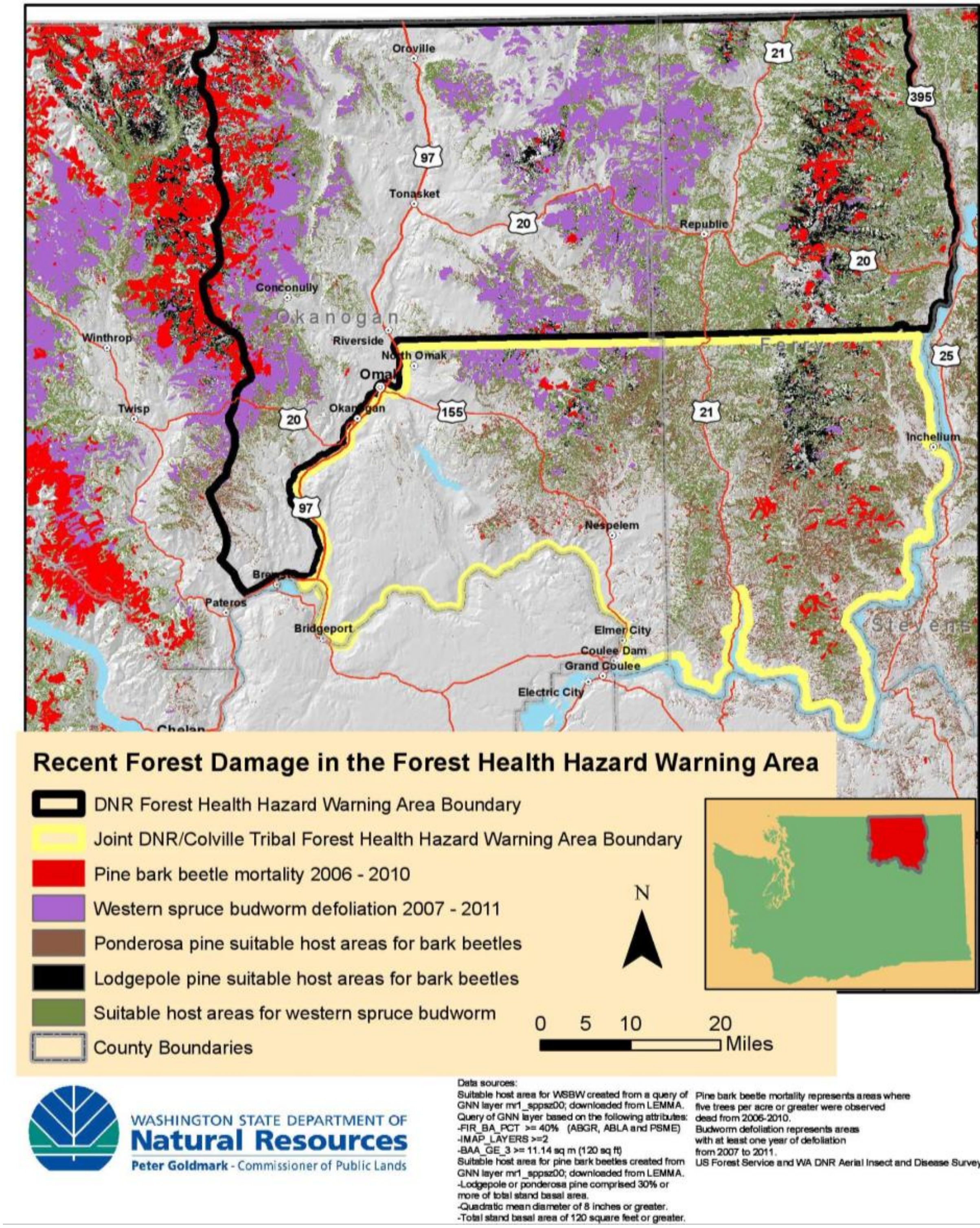


Figure 10. *Recent forest insect damage in the Okanogan and Ferry Counties Forest Health Hazard Warning Area.* *Map by: Chuck Hersey, Washington DNR*

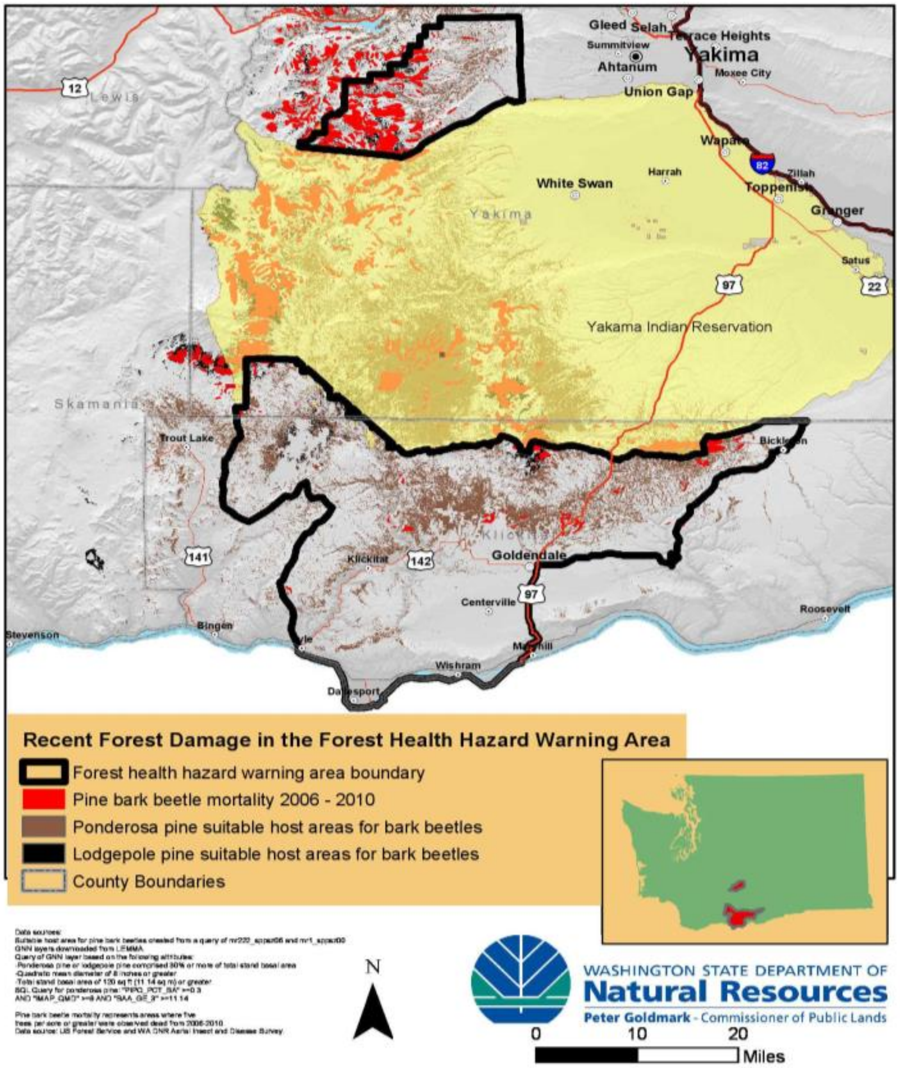


Figure 11. *Recent forest insect damage in the Klickitat and Yakima Counties Forest Health Hazard Warning Area.*
Map by: Chuck Hersey, Washington DNR

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. Historically there were about 820,000 acres of large diameter, low density mixed conifer and ponderosa pine forests in the Forest Health Hazard Warning areas. Today only about 170,000 acres of this forest structure exists in the Warning Areas. Douglas-fir and grand fir are also much more abundant now than they were historically due to fire suppression. **The primary forest management action** the technical advisory committee recommends **to improve the resiliency of dry mixed conifer and ponderosa pine forests is to thin forests, reduce the number of trees to the level the site can support and change the species composition to favor more ponderosa pine and western larch**. Ponderosa pine and western larch are much better adapted to the frequent fire regime that historically occurred in these forest types.

2012 and 2013 Forest Health Warning Outreach Efforts

Following the issuance of the Forest Health Hazard Warnings, WDNR initiated a public outreach campaign to notify landowners in the Warning Areas about forest health concerns in their area and resources available to address the concerns. In August 2012, 10,517 notices were mailed to landowners with parcels one acre or greater and containing at least 0.5 acres of conifer forest in the Warning Areas. The notices described what a Forest Health Hazard Warning meant, tools to help landowners assess if their forest was at risk and recommendations on how to reduce risk. WDNR also set up a toll free number landowners could call to request assistance. **To request assistance, please call: 1-855-338-8200.** A website was created to help landowners learn more about western spruce budworm and pine bark beetles, recommended actions to reduce risk and an online landowner assistance request form that directed landowner requests directly to WDNR foresters in their region. Numerous press releases and stories about the Forest Health Hazard Warnings ran in local newspapers.

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 in 2012 and 2013 to educate landowners about forest health in the region, what they can do to improve the resiliency of their forests and professional forestry assistance available. Eleven informational workshops and five all day intensive hands-on field workshops were held in Goldendale, Tonasket, Republic, Glenwood, Chesaw, Wauconda, Curlew, Leavenworth, Everett and Vancouver. A total of 416 landowners participated in the workshops.

WDNR foresters provided technical assistance to over 500 landowners that manage over 97,000 acres as a direct result of the Forest Health Hazard Warning outreach efforts.

Mike Johnson, Washington DNR

Figure 12. Landowners receive hands-on training in stand density measurement techniques.

Chuck Hersey, Washington DNR

Figure 13. Landowner hands-on forest health workshop in Glenwood, WA (May 2013).

This number includes landowners that received a Forest Health Hazard Warning notice and called the toll free number, filled out an online assistance request form or attended one of the workshops. Technical assistance consisted of landowner site visits, referrals to consulting foresters, cost-share program sign-ups, phone consultations, parcel map preparation and factsheet dissemination. In response to increased forest landowner assistance requests in the Forest Health Hazard Warning areas, WDNR hired four natural resource specialists in those regions. The goal is to provide landowners with the professional assistance they need to determine if there are actions (i.e. thinning their forest) that can reduce the risk of damage from forest insects.

Using federal grant funds, WDNR partnered with WSU Extension to create radio and television advertisements targeting forest landowners in Okanogan and Ferry counties. The advertisements helped raised awareness of forest health and wildfire risks in the region and directed landowners to WDNR for further assistance. These advertisements ran on local radio stations and a Spokane area television station in the fall 2013.

In 2014, WDNR will continue to focus on forest health concerns in the Forest Health Hazard Warning areas. Collaborative forest health improvement projects will be pursued on federal, state and private lands. These collaborative projects will center around thinning forest stands to reduce tree density and decrease the amount of Douglas-fir and grand fir.

Chuck Hersey, Washington DNR

Chuck Hersey, Washington DNR

Figure 14. *Unhealthy, dense forest before thinning (above and below).*

Figure 15. *Healthy, resilient forest after thinning (above and below).*

Chuck Hersey, Washington DNR

Chuck Hersey, Washington DNR

Insects

Bark Beetles

Fir Engraver (*Scolytus ventralis* LeConte)

Fir engraver can attack all species of true fir (*Abies*) in Washington, but the primary hosts in Washington are grand fir and noble fir. Mortality due to fir engraver declined in 2013 to 9,200 acres, the lowest level in the past decade, continuing a downward trend in the total area affected over that period. The area with mortality from fir engraver has steadily fallen from a recent high of 236,000 acres in 2007. The 10,000 trees observed dead in 2013 was also a ten-year low. The average intensity was just over one tree killed per acre. Scattered, endemic levels occurred in most areas of the state, with more concentrated tree mortality in Ferry, Stevens, Pend Oreille and Spokane counties.

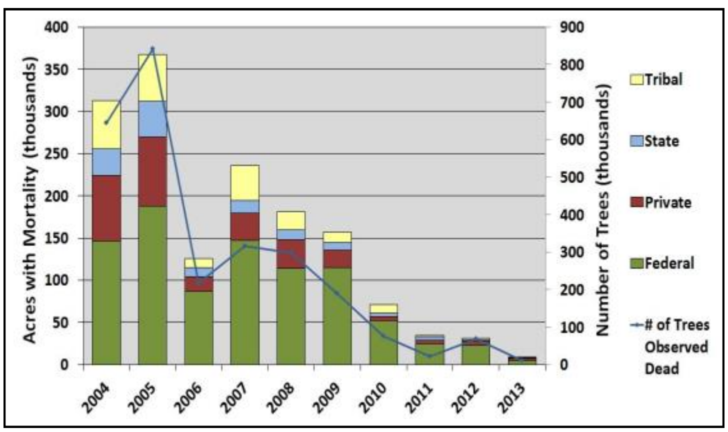


Figure 16. *Ten year trend for total acres and number of trees affected by fir engraver in Washington.*

Donald Owen, California Department of Forestry and Fire Protection, Bugwood.org

Figure 17. *Fir engraver adult.*

USDA Forest Service—Ogden Archive, Bugwood.org

Figure 18. *Horizontal fir engraver egg galleries.*

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 high elevation forests of Washington. The 3,200 acres with WBBB caused mortality in 2013 was the lowest amount seen in a decade and half of what it was in 2012. 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:

2012: 6,500 2011: 8,100 2010: 16,000 2009: 16,000 2008: 32,000

Douglas-fir Beetle (*Dendroctonus pseudotsugae* Hopkins)

Daniel Miller, USDA Forest Service, Bugwood.org

Figure 19. *Characteristic pattern of Douglas-fir killed in groups by Douglas-fir beetle.*

Approximately 11,000 acres with Douglas-fir beetle (DFB) caused mortality were observed statewide in 2013, down from 26,000 acres in 2012. This is the lowest level observed in the last ten years. Concentrated areas of mortality were detected in western Okanogan County in the Okanogan-Wenatchee National Forest and the Loomis State Forest. This was likely associated with long-term defoliation by western spruce budworm in those areas. Trees stressed by defoliation are more likely to be attacked by bark beetles. There was a notable increase in the amount of scattered mortality in southern Ferry, Stevens, and Pend Oreille counties. Factors leading to this increase are unknown, but may be related to western spruce budworm defoliation in this area in recent years.

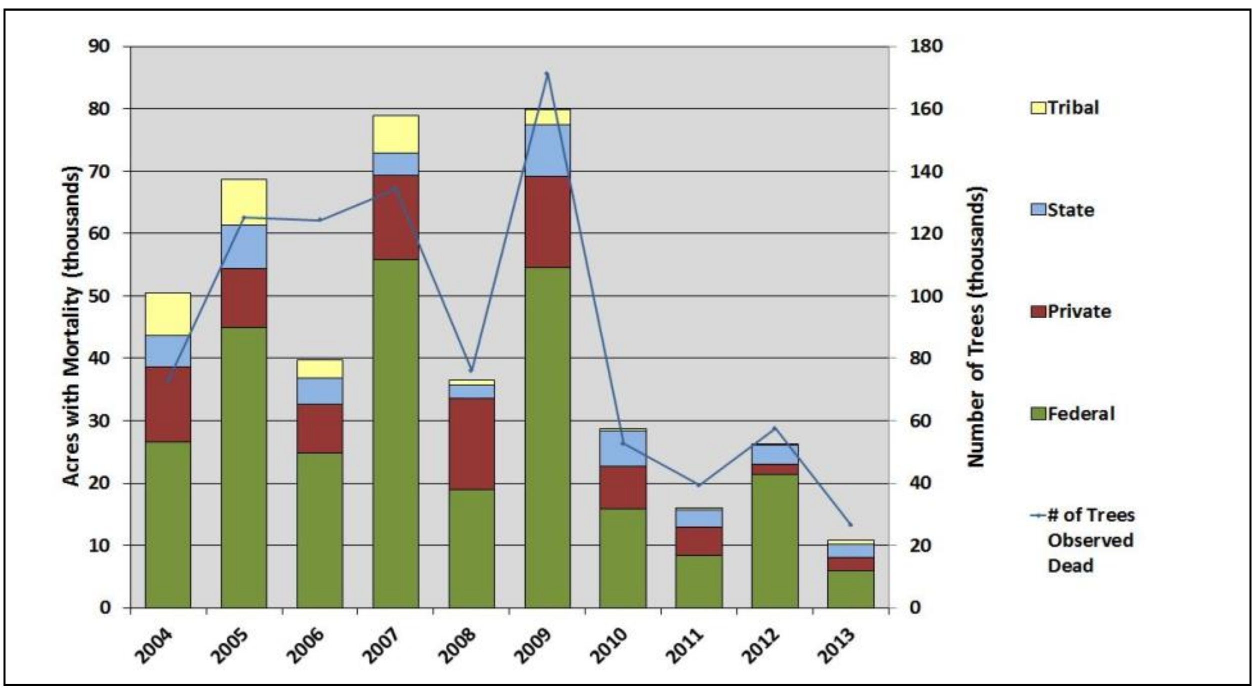


Figure 20. *Ten year trend for total acres and number of trees affected by Douglas-fir beetle in Washington.*

Spruce Beetle (*Dendroctonus rufipennis* Kirby)

The 33,000 acres affected by spruce beetle in 2013 was equal to the ten-year average and approximately half the area mapped in 2012. The majority of the mortality occurred in the vicinity of the Pasayten Wilderness within the Okanogan-Wenatchee National Forest 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.

Edward H. Holsten, USDA Forest Service

Figure 21. *Adult female and eggs of spruce beetle.*

Connie Mehmel, USDA Forest Service

Figure 22. *Engelmann spruce mortality from spruce beetle in Okanogan County.*

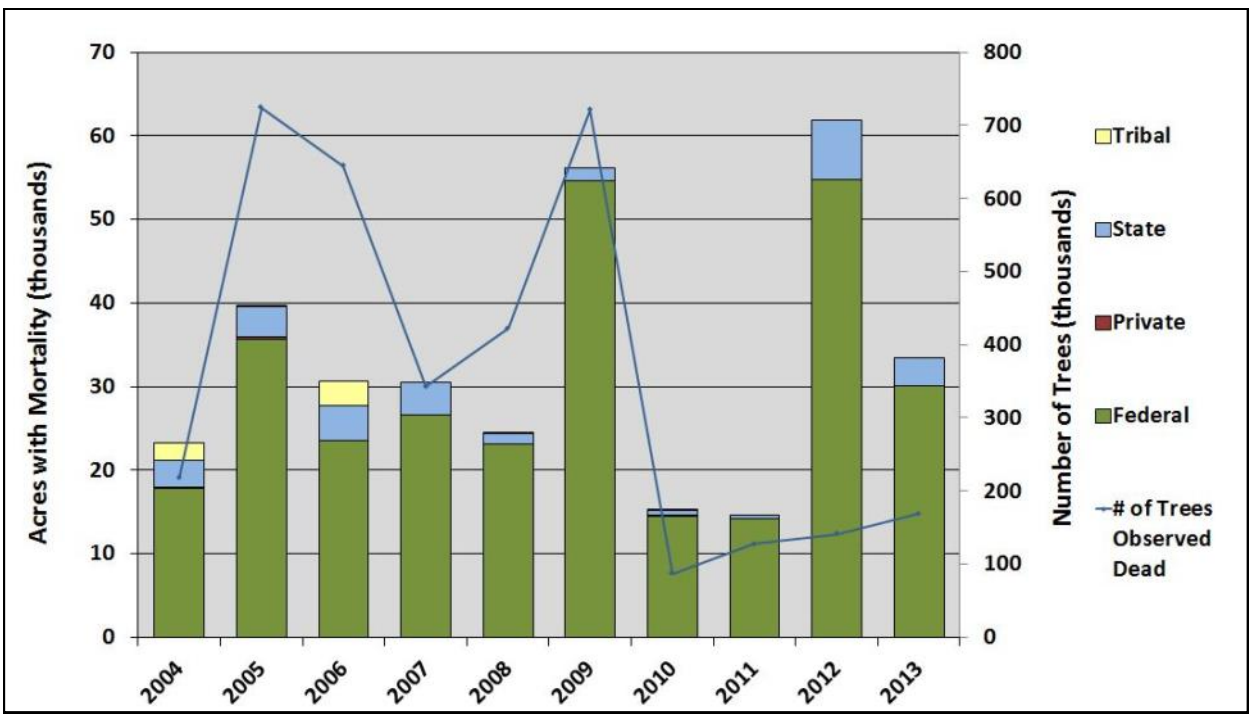


Figure 23. *Ten year trend for total acres and number of trees affected by spruce beetle in Washington.*

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

The number of acres with pine trees killed by bark beetles decreased in 2013 to approximately 107,000 acres, down from 156,000 acres in 2012. Mountain pine beetle (MPB) and *Ips* pine engraver damage decreased in all pine hosts. However, western pine beetle-caused mortality in ponderosa pine increased (Table 1). Mortality from MPB was at a ten-year low in 2013, but localized outbreaks continue. The most concentrated areas of mortality of lodgepole, ponderosa, and whitebark pines occurred in Chelan and western Okanogan Counties near Lake Chelan and within the Okanogan-Wenatchee National Forest. Increased mortality of lodgepole and ponderosa pines also occurred in the Colville National Forest in northern Ferry County and in the Simcoe Mountains near the southern border of the Yakama Indian Reservation. Scattered mortality of ponderosa pines, due to both mountain and western pine beetle, was widely dispersed across central and northeastern Washington including Yakima, Klickitat, Ferry, Stevens, Pend Oreille and Spokane counties.


Glenn Kohler, Washington DNR

Figure 24. *Stand of lodgepole pine with heavy mountain pine beetle caused mortality.*

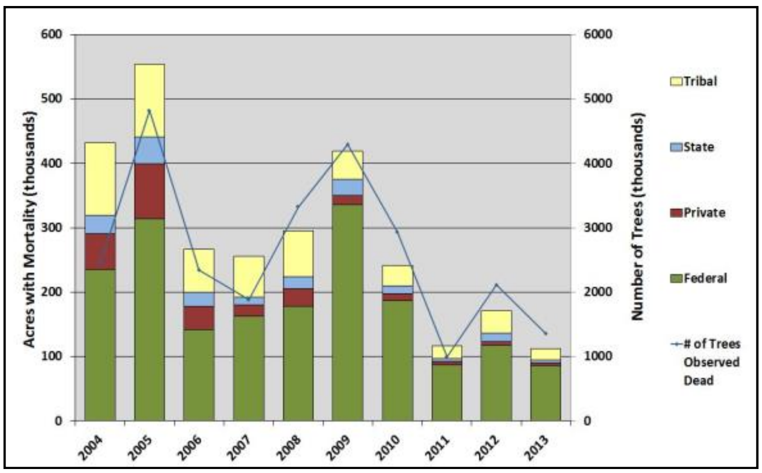


Figure 25. *Ten year trend for total acres and number of trees affected by pine bark beetles in Washington.*

Table 1. 2013 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	95,000	1,317,000
mountain pine beetle	ponderosa pine	12,000	34,000
mountain pine beetle	whitebark pine	1,200	910
mountain pine beetle	western white pine	430	510
western pine beetle	ponderosa pine	3,100	3,500
pine engravers (*Ips* species)	all pines	260	700

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

California Fivespined Ips (*Ips paraconfusus* Lanier)

Glenn Kohler, Washington DNR

Figure 26. *Ponderosa pine mortality caused by California fivespined Ips in Klickitat County.*

Mortality attributed to *Ips* pine engravers declined statewide in 2013; however, localized outbreaks of California fivespined Ips (CFI) continued to cause unusually high levels of ponderosa pine mortality in areas along the Columbia River Gorge in Klickitat and Skamania counties. CFI is a pine engraver beetle native to California and Oregon that was recorded for the first time in Washington State in 2010. 2013 was the fourth year of CFI outbreaks in the eastern Columbia River Gorge, resulting in numerous killed and top-killed ponderosa pines every year since 2010. Attacks by western pine beetle (*Dendroctonus brevicomis* LeConte) and red turpentine beetle (*Dendroctonus valens* LeConte) may also contribute to mortality of some larger ponderosa pines. CFI has been a serious pest of young ponderosa pine plantations in the Willamette Valley in Oregon. CFI flights and distribution have been monitored annually using pheromone baited traps placed by Washington State University (WSU) Extension, USFS, and WDNR. In 2013, traps were placed in eight counties not previously monitored. Collections are still being analyzed. To date, 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, Lewis, Thurston, and Pierce Counties (Fig. 27). For more information, see the 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

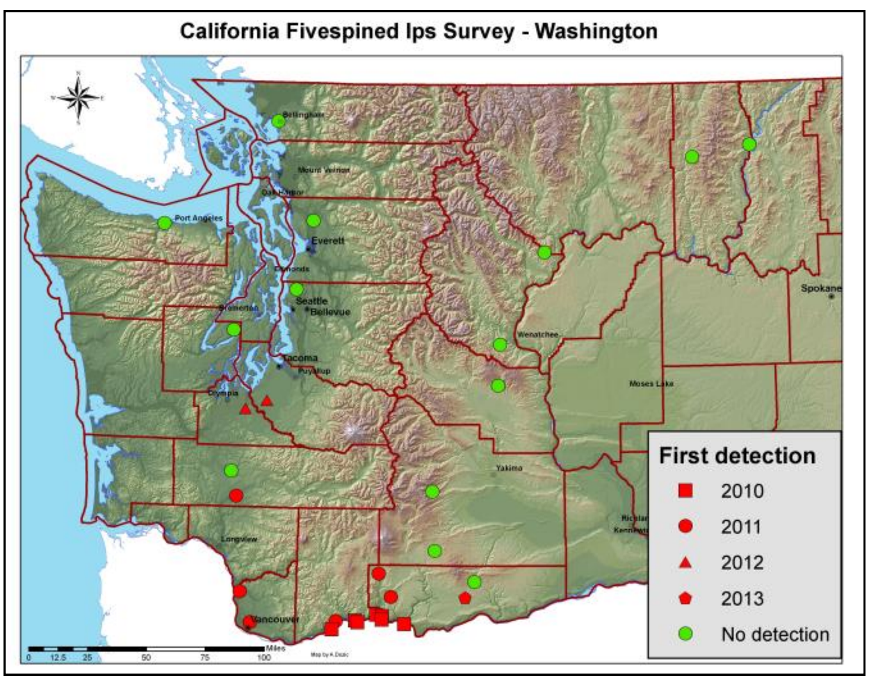


Figure 27. *California fivespined Ips monitoring trap locations in Washington, 2010-2013. Map by: Aleksandar Dozic, Washington DNR.*

Defoliators

Western Spruce Budworm (*Choristoneura freemani* Razowski) - previously *C. occidentalis* Freeman

Areas with western spruce budworm (WSBW) defoliation recorded in the 2013 aerial survey decreased to approximately 178,000 acres. This is 65% below the 511,000 acres recorded in 2012 and the lowest total since 2003. The average WSBW defoliation in Washington over the past ten years is 392,000 acres. A similar decline has also been reported in adjacent western states and British Columbia. In some areas of the Cascade Mountains, the signature used to detect defoliation was obscured due to a late flush of growth after WSBW larvae had finished feeding. Despite the decreased area, outbreaks continue to result in heavy defoliation of host trees in Kittitas, Okanogan, and Ferry Counties. The extent of affected areas in Stevens and Pend Oreille counties increased significantly in 2013.

William M. Ciesla, Forest Health Management International, Bugwood.org

Figure 28. *Western spruce budworm larva.*

After several consecutive years of defoliation in the central and north Cascades (Fig. 30), direct mortality from defoliation, top-kill, and mortality from Douglas-fir beetle and fir engraver are becoming more common. Pheromone trap catches in Kittitas, Okanogan, and Ferry counties indicate continued moderate to heavy defoliation in 2014 (Fig. 31). New areas of defoliation have been mapped in Stevens, Pend Oreille, and Yakima counties. Pheromone trap catches in those areas indicate defoliation in 2014 is likely to be patchy (Fig. 31).

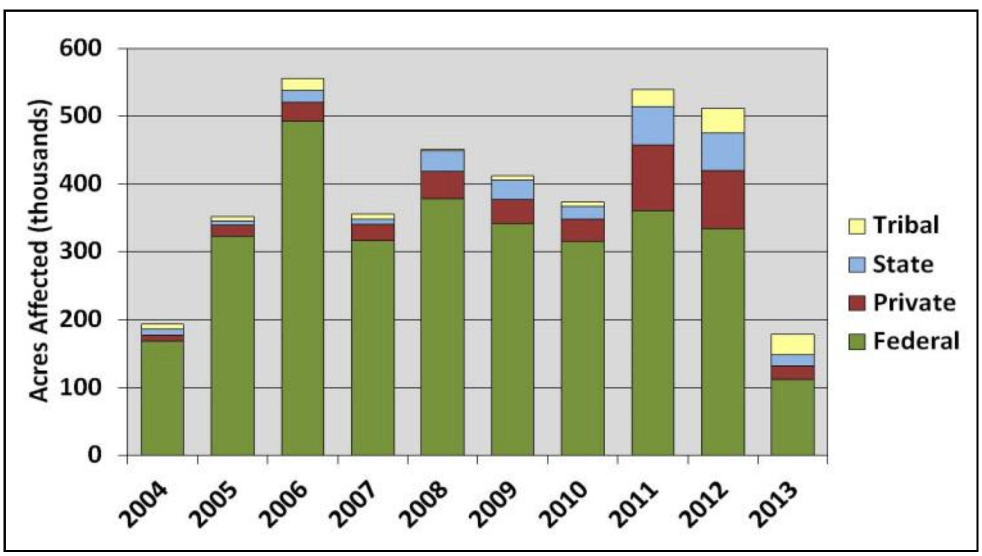


Figure 29. *Ten year trend for total acres affected by western spruce budworm in Washington.*

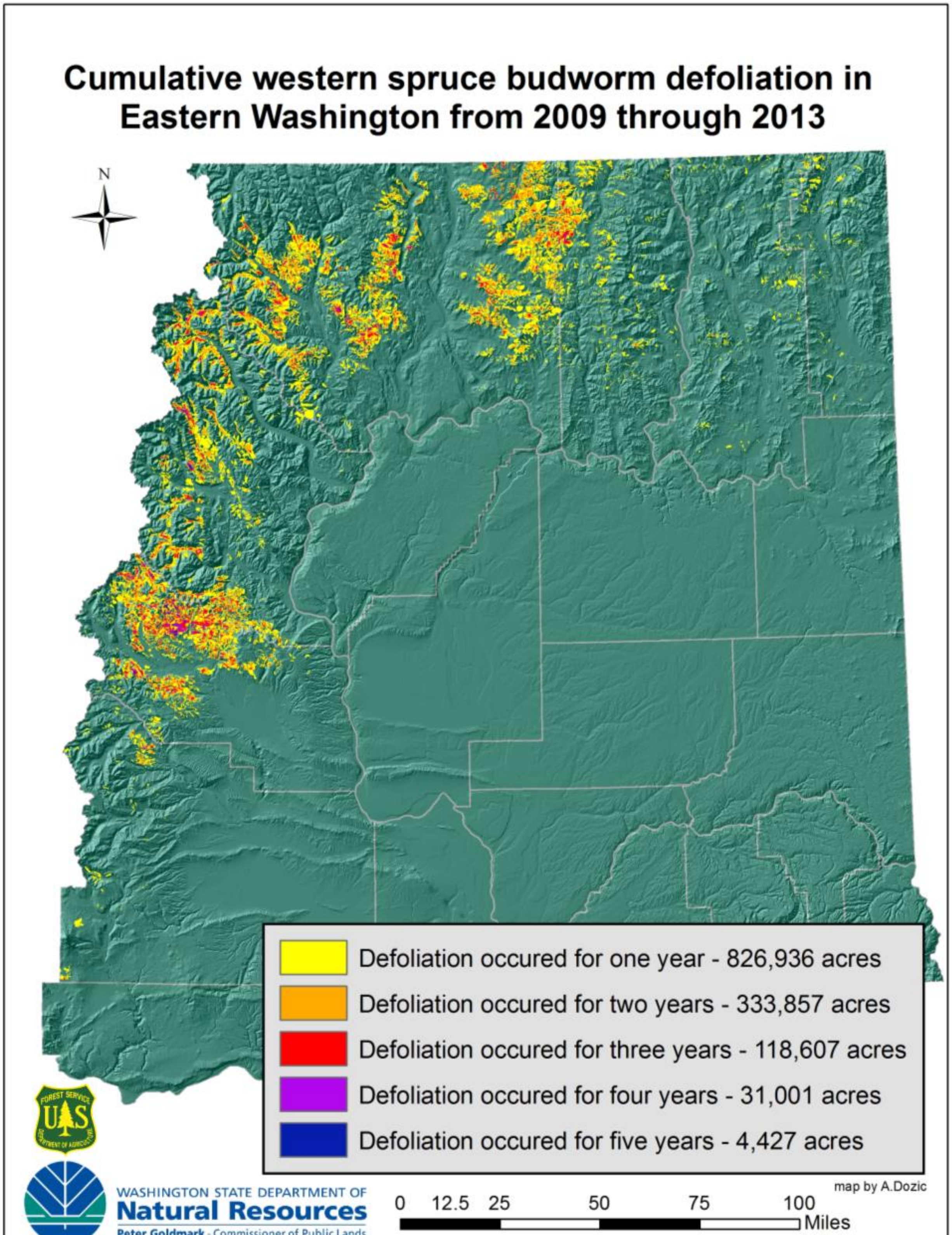


Figure 30. *Cumulative western spruce budworm defoliation from 2009 through 2013. Map by: Aleksandar Dozic, Washington DNR*

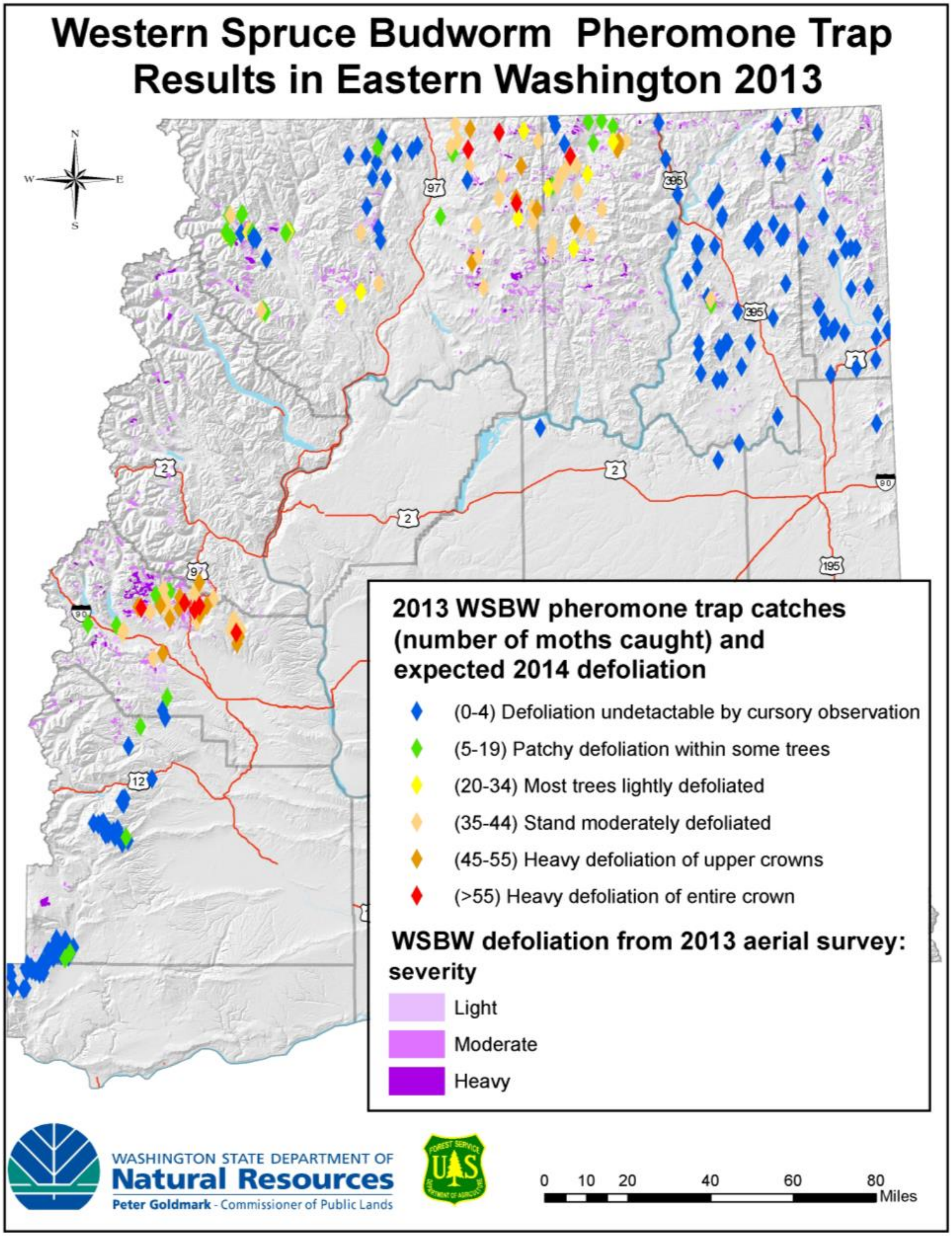


Figure 31. *Western spruce budworm pheromone trap catch results for 2013, expected 2014 defoliation and defoliation detected by the 2013 aerial survey.* *Map by: Aleksandar Dozic, Washington DNR*

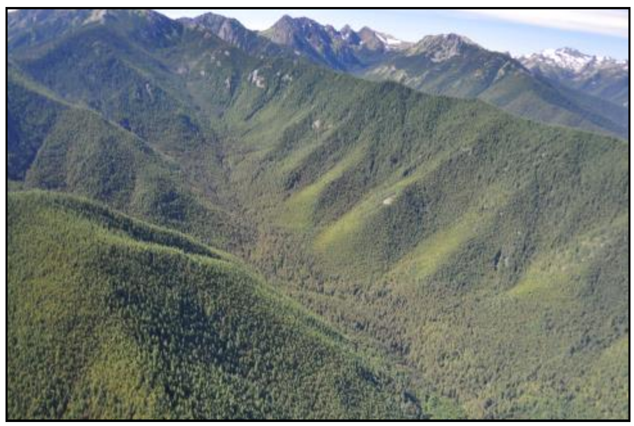
Douglas-fir Tussock Moth (*Orgyia pseudotsugata* McDunnough)

2013 was the first year since 2007 that almost no defoliation by Douglas-fir tussock moth (DFTM) was recorded in Washington. Three recent DFTM outbreaks that affected Okanogan County, the Spokane County area, and the Umatilla National Forest in the Blue Mountains have collapsed. In 2013, one 30-acre polygon of light DFTM defoliation was mapped in an area of Spokane County that was previously heavily defoliated. A statewide network of "Early Warning System" pheromone traps are monitored annually for evidence of rising DFTM populations ahead of the next outbreak. 2013 pheromone trap catches indicate a DFTM outbreak is not likely in 2014.

Previous annual total acres with defoliation from Douglas-fir tussock moth:
2012: 8,700 2011: 9,400 2010: 1,200 2009: 3,600 2008: 318

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

Approximately 14,000 acres with western blackheaded budworm (WBB) defoliation were observed in western Washington, primarily on the east side of the Olympic Peninsula and west of Mt. Rainier in Lewis County. This was a significant increase from the 200 acres of damage near Baker Lake in 2012 and in different areas. Both western hemlock and Pacific silver fir were moderately defoliated. At least one third of WBB pupae collected were killed by parasitic ichneumonid wasps (*Phaeogenes* species). The last WBB outbreak in Washington occurred from 2002 to 2003 in the central Cascades near Snoqualmie and Stevens Passes. The largest outbreak recorded in Washington affected over 450,000 acres from 1970 to 1973.



Ben Smith, USDA Forest Service

Figure 32. *Western blackheaded budworm defoliation on the eastern Olympic Peninsula.*

Glenn Kohler, Washington DNR

Figure 33. *Western blackheaded budworm larvae.*

Glenn Kohler, Washington DNR

Figure 34. *Western blackheaded budworm defoliated western hemlock.*

Oregon white oak defoliation

Western oak looper (*Lambdina fiscellaria somniaria* (Hulst)) defoliated oaks were reported in residential areas on the north side of Joint Base Lewis McChord (JBLM) in Pierce County. Despite being heavy, the JBLM damage was not recorded in aerial survey because it is in restricted airspace. Lighter oak looper damage was also reported from the ground near Vader in Lewis County. These outbreaks are likely to expand in 2014.

Glenn Kohler, Washington DNR

Figure 35. *Western oak looper adult.*

Pacific tent caterpillar (*Malacosoma constrictum* (H. Edwards)) is closely related to the western tent caterpillar, but prefers to feed on oak foliage and is only found in Pacific Coast states. Defoliation by Pacific tent caterpillar in Oregon white oak stands was reported at several sites in Klickitat County but was not recorded in aerial survey because damage was light.

Oak pit scales (*Asterodiaspis* species) are sucking insects that cause branch tip dieback, delayed leaf expansion in spring, and clumping of foliage in oaks. In recent years, oak pit scale (OPS) damage has contributed to scattered oak mortality in Klickitat County and Wasco County in Oregon. In 2013, WDNR conducted a statewide survey of OPS populations and damage. Over 1,100 branches were collected at 37 plots from the San Juan Islands to Klickitat County and examined for OPS populations; their presence was confirmed in 92% of the plots (Fig. 38). The **golden oak scale**, *Asterodiaspis variolosa* (Ratzeburg), is the only species of OPS identified from the Washington collections to date. OPS crown symptoms were more common and OPS populations tended to be higher at sites east of the Cascade Mountains.

Glenn Kohler, Washington DNR

Figure 36. *Pacific tent caterpillar larva on Oregon white oak.*

Glenn Kohler, Washington DNR

Figure 37. *Oak pit scales on an Oregon white oak sapling.*

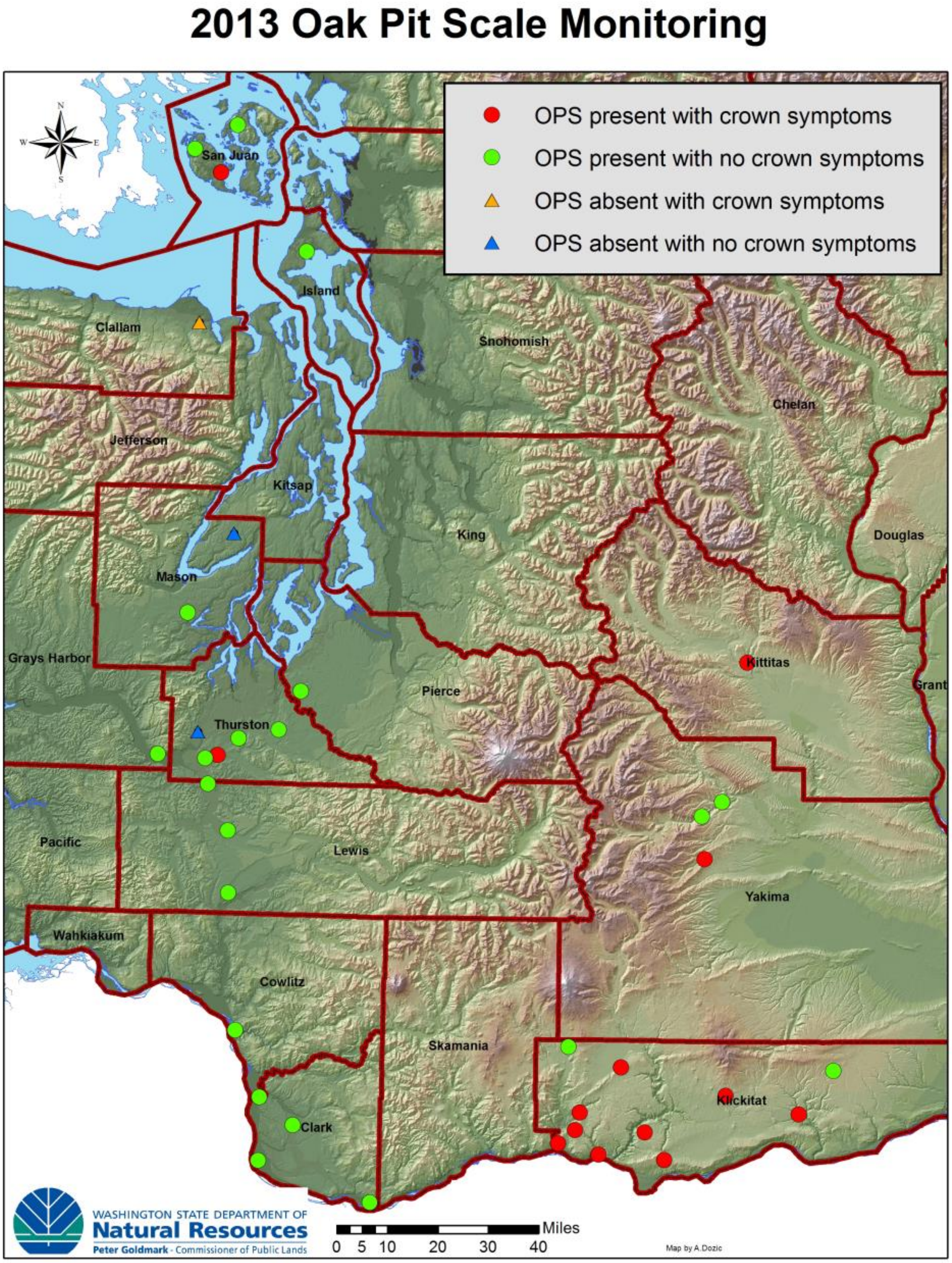


Figure 38. *2013 oak pit scale (OPS) monitoring sites showing distribution of OPS and crown symptoms. Map by: Aleksandar Dozic, Washington DNR*

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

No hemlock looper defoliation was mapped in 2013. Approximately 1,400 acres were defoliated in 2012 and 300 acres in 2011. This two-year outbreak that occurred in the vicinity of Baker Lake in Whatcom and Skagit counties appears to have collapsed due to natural controls. Outbreaks are often sporadic and short lived. The previous 2001-2003 outbreak in western Washington peaked at 35,000 acres.

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


Glenn Kohler, Washington DNR

Figure 39. *Western larch defoliated by larch casebearer.*

Larch casebearer is an exotic insect that feeds on the foliage of western larch. 2013 defoliation from larch casebearer (LC) totaled approximately 730 acres in Washington, primarily in Stevens, Pend Oreille, and Spokane counties. This is the second year of decline in LC damage. The last outbreak affected 39,000 acres in 2008. Because larch re-foliates annually, it takes several years of damage to cause serious injury to larch.

Previous annual total acres with defoliation from larch casebearer:

- 2012: 1,700
- 2011: 16,000
- 2010: 0
- 2009: 216
- 2008: 39,000

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

Scattered outbreaks of western tent caterpillar (WTC) continued throughout western Washington in 2013. Aerial survey observed WTC defoliation on 6,100 acres in 2013, down from 8,400 acres in 2012. Most of the affected area was around the Puget Sound, northeast Olympic Peninsula, San Juan Islands, Lewis County, and Cowlitz County. Defoliation was observed primarily in cottonwood, other poplars, and red alder. WTC outbreaks are cyclical and rarely last more than a few years


Elliott Menashe, www.greenbeltconsulting.com

Figure 40. *Western tent caterpillar larvae.*

Leaf beetles (Chrysomelidae)

In 2013, outbreaks of leaf beetles caused very noticeable damage to red alders and willows primarily in western Washington. As many as 5,000 acres may have been affected, with the highest concentrations of damage on the Kitsap Peninsula, around the south end of Puget Sound, and in areas of northeast Washington. Feeding leaf beetle larvae skeletonize leaves causing a reddish-bronze color and loss of foliage. The most abundant species causing this defoliation was the **alder flea beetle** (*Altica ambiens* (LeConte)). Adult alder flea beetles were reported swarming in great numbers in the fall at some locations. Several other leaf beetle species may feed on alder and willow in Washington, such as **Pacific willow leaf beetle** (*Pyrrhalta decora carbo*) and several ***Chrysomela* species**.

Karen Ripley, Washington DNR

Figure 41. *Alder flea beetle larvae and damage to red alder leaves.*

Aleksandar Dozic, Washington DNR

Figure 42. *Leaf beetle-caused defoliation of red alder.*

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

In 2013, the Washington State Department of Agriculture (WSDA) placed 18,622 gypsy moth pheromone traps in Washington. 11,576 of these were for European gypsy moth (EGM) detection and delimiting and 7,046 were for Asian gypsy moth (AGM) detection. One (1) gypsy moth was collected from one (1) catch area in the Capitol Hill area of Seattle. The moth collected in 2013 was 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. In the past twelve years, the highest number of moths collected was 75 in 2006. An eradication project site near Tukwila was treated four times with Btk (Foray XG) using ground equipment on 10.5 acres in the spring of 2013. In addition, 181 acres of the surrounding area were aerially treated with disparlure (Disrupt II) once during summer 2013 for the purpose of mating disruption. This was the first use of mating disruption technology for a gypsy moth eradication project in Washington. No gypsy moths were trapped near the Tukwila site during summer 2013. No eradication projects have been proposed for 2014.

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 21,000 acres with defoliation and/or mortality from BWA were observed in 2013, down from 38,000 acres in 2012. This is well below a recent peak of 60,000 acres in 2009 and the 10-year average of 36,000 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. There were 3,600 acres with some host mortality attributed directly to BWA damage in 2013. Approximately 3,200 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 43. *Crown symptoms of balsam woolly adelgid infestation on subalpine fir in the Blue Mountains.*

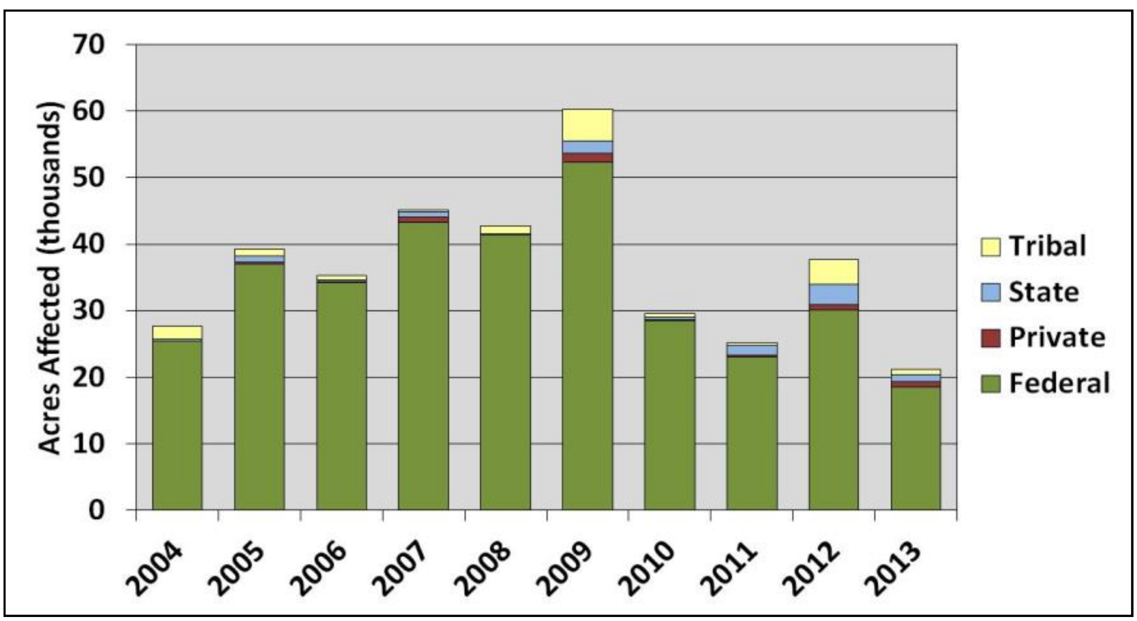


Figure 44. *Ten year trend for total acres affected by balsam woolly adelgid in Washington.*

Animals

Bear Damage / Root Disease

Figure 45. *Douglas-fir mortality from bear damage as seen from the air.*

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 183,000 acres with bear damage mortality were observed in 2013, which is slightly less than the 200,000 acres mapped in 2012. The ten year average of acres with bear damage in Washington is 242,000. The average number of trees per acre (TPA) killed was smaller in 2013 (1.65 TPA) than 2012 (1.74 TPA). The estimated total number of trees killed was approximately 300,000, which was less than the 350,000 trees killed in 2012.

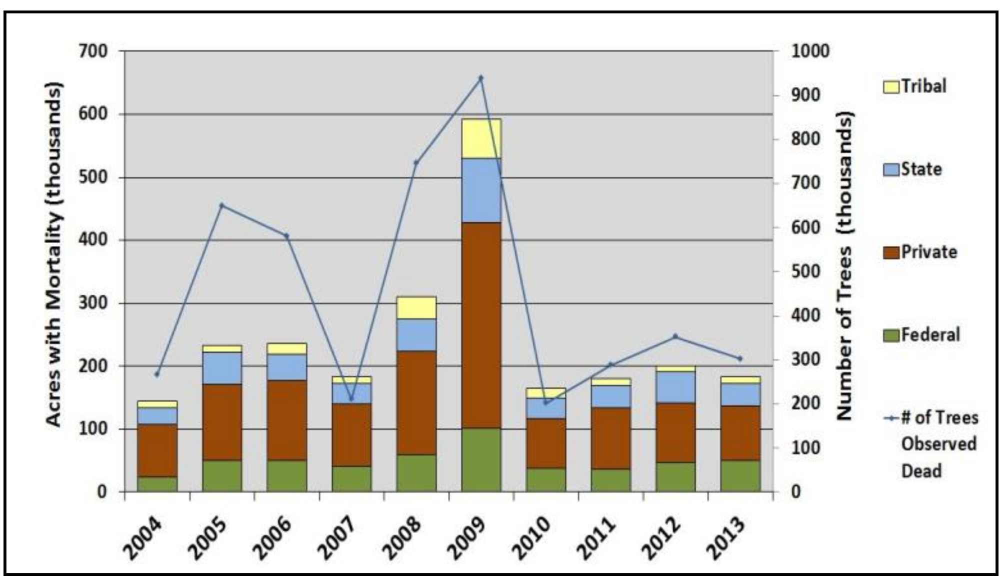


Figure 46. *Ten year trend for acres and number of trees affected by bear damage in Washington.*

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. In 2013, mortality was detected on 1,200 acres of whitebark pine and 400 acres of western white pine 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. This was less mortality than what was observed in 2012 (5,100 acres). The aerial survey records very little area affected specifically by white pine blister rust (180 acres in 2013) because signatures can be difficult to distinguish from mountain pine beetle from the air.

2013 was the eighth of a cooperative rust resistant western white pine field trial between WDNR and the Dorena Genetic Resource Center of the USFS. 8,000 trees were surveyed, recording tree height, mortality, and damage and white pine blister rust (WPBR) infection incidence and severity. To date, there is still little mortality from WPBR-caused infections, but there are a significant number of trees infected with the pathogen (Fig. 47). It is unknown at this time how many WPBR-infected trees will die from bole cankers.

Six new rust resistant western white pine field trials will be established in eastern Washington in 2014 and 2015.

Figure 48. *Map of western white pine field trial sites in western Washington.*
Map by Amy Ramsey-Kroll, Washington DNR

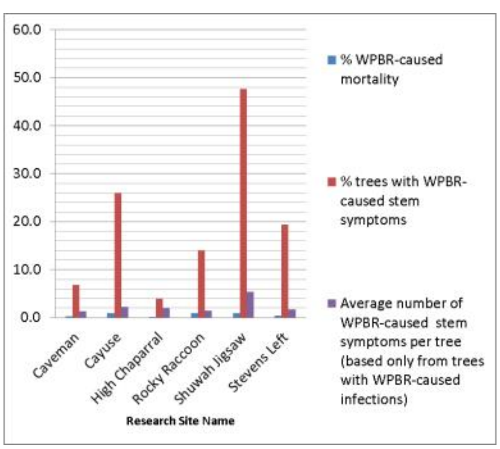


Figure 47. *White pine blister rust infected western white pine.*

Foliar Diseases

Conifer Needle Casts

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

Larch Needle Cast (*Meria laricis* Vuill.)

Swiss Needle Cast on Douglas-fir (*Phaeocryptopus gaeumannii* (Rohde) Petrak)

Mike Johnson, Washington DNR

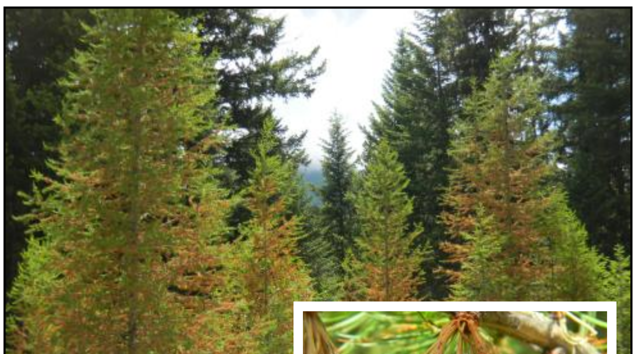


Figure 49. *Larch needle cast.*

Phil Hess, Consulting Forester

Figure 50. *Ponderosa pine needle cast.*

Conifer defoliation from needle casts, caused by multiple genera and species of fungi (at least 13 in Washington state), were recorded on 19,000 acres in 2013. This is about one-third of the acreage mapped with needle cast diseases in 2012 (56,000 acres). The decline in observed needle casts is likely attributed to weather conditions, specifically a drier spring and summer than what occurred in 2012. Needle cast fungi rely on warm, wet conditions to colonize and infect conifer needle tissue and without those conditions, new infections are unable to occur.

In 2013, through a cooperative effort between the WDNR and the Oregon State University College of Forestry Swiss Needle Cast Cooperative (SNC Co-op) (http://sncc.forestry.oregonstate.edu/), eight new Swiss needle cast monitoring plots were established in southwest Washington. The plots will be used to assess the growth impacts of the disease, to monitor any changes in the behavior of the disease, to research epidemiology and management strategies, to investigate the links to climate with greater precision, and to improve current Swiss needle cast disease models. The plots are located in Pacific, Wahkiakum, and western Lewis counties on WDNR state lands and will be in place for at least ten years. The SNC Co-op also installed 33 additional plots in western Oregon.

Hardwood Foliar Diseases, Dieback, and Declines

Multiple fungal genera and species cause foliar diseases, branch dieback and overall tree health declines in hardwood species in Washington. The most common host species mapped during the aerial survey include bigleaf maple (*Acer macrophyllum* Pursh), Pacific madrone (*Arbutus menziesii* Pursh), and poplars (*Populus* spp.). During the 2013 aerial survey, 1,700 acres of hardwood damage was mapped. This is about one-fifth of the acreage mapped in 2012 (9,300 acres) and only about 0.1% of the total acreage of tree damage mapped for the state this year. The decline in observed hardwood damage is likely attributed to drier spring and summer weather conditions, compared to the wetter than usual spring and summer in 2012.

Amy Ramsey-Kroll, Washington DNR

Figure 51(left). *Bigleaf maple dieback and damage observed from the ground.*

Marianne Elliott, Washington State University

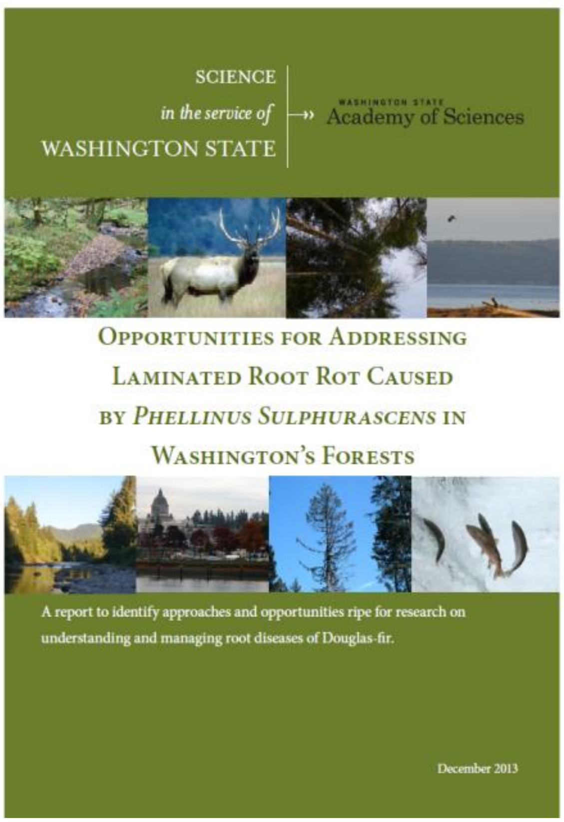
Figure 52 (right). *Pacific madrone dieback and damage observed from the ground.*

Figure 53 (right). Melampsora *foliar disease on hybrid poplar.*

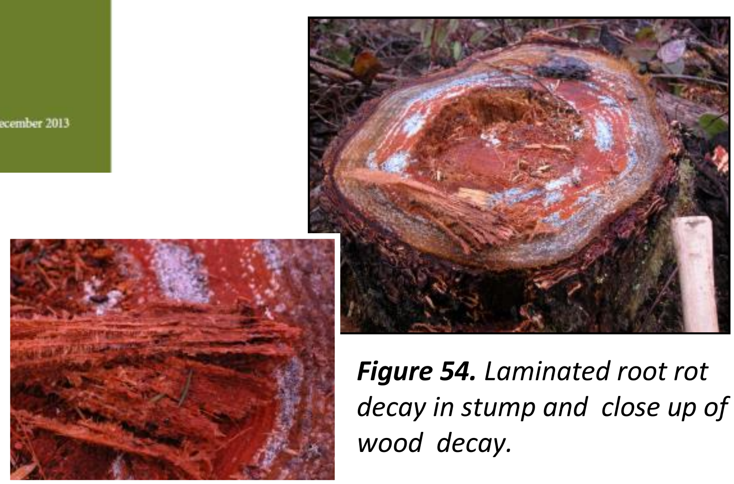
Glenn Kohler, Washington DNR

Root Diseases

Root diseases play 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 signatures can be difficult to distinguish from bark beetle mortality and bear damage. 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.



In December, a new report was published by the Washington State Academy of Sciences entitled, "Opportunities for addressing laminated root rot caused by *Phellinus sulphurascens* in Washington's forests." The report examines and summarizes the current state of knowledge regarding laminated root rot, recommends several on-the-ground management strategies for the disease, and stresses the need for molecular biology research in order to better understand the host-pathogen life cycle and interactions of *P. sulphurascens*. A copy of the report can be found here: http://www.washacad.org/initiatives/files/WSAS_Laminated_Root_Rot_%202013.pdf.



Amy Ramsey-Kroll, Washington DNR

Figure 54. *Laminated root rot decay in stump and close up of wood decay.*

In 2009, WDNR installed root disease conifer susceptibility trial plots in Klickitat County, near the town of Glenwood. Western larch, western white pine, ponderosa pine, and Douglas-fir seedlings were planted in Armillaria and Annosus root disease patches (North Glenwood site, 3 plots) (Fig. 55) and around the bases of infected trees and stumps (Bullchute site, 30 plots), in efforts to determine species susceptibility and tolerance to the root diseases.

Amy Ramsey-Kroll, Washington DNR

Figure 55. *Western larch, western white pine, ponderosa pine and Douglas-fir seedlings planted around a root disease infected tree. This is one plot examining the susceptibility and tolerance to Armillaria root disease.*

In 2013, we surveyed the 5 year old seedlings and recorded any damage or mortality associated with each tree (Figs. 56 and 57). There has been a lot more mortality than expected and very few trees have been killed by Armillaria or Annosus root diseases. The greatest levels of seedling mortality have been in our North Glenwood plots, which are located on a very exposed, dry and harsh site. The Bullchute plots are not as exposed, are still dry, but had some overstory canopy cover while the seedlings were establishing, which may contribute to the higher seedling survival levels. Regarding overall survival and mortality levels, Douglas-fir has performed the poorest across all plots and ponderosa pine is currently performing the best. All species have had some trees die due to root diseases, primarily Armillaria root disease. The plots will continue to be monitored over time.

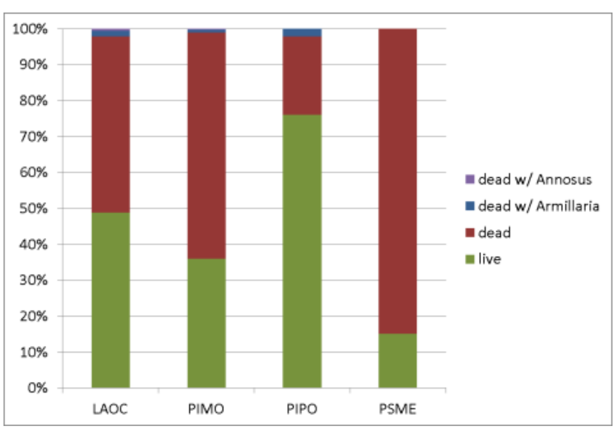


Figure 56. *Average percentage of living, dead and root-disease caused dead trees in North Glenwood root disease trial plots. LAOC = western larch, PIMO = western white pine, PIPO = ponderosa pine, PSME = Douglas=fir*

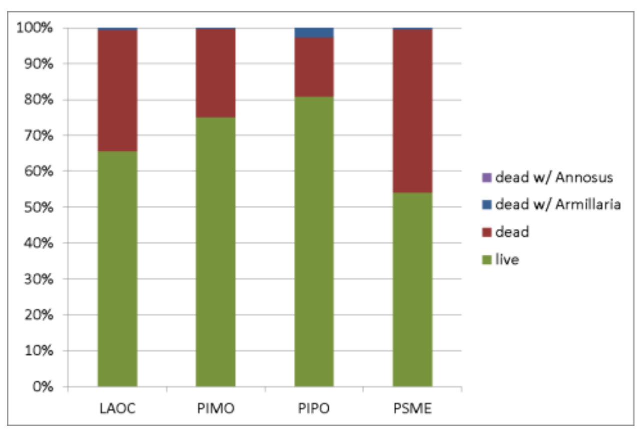


Figure 57. *Average percentage of living, dead and root-disease caused dead trees in Bullchute root disease trial plots. LAOC = western larch, PIMO = western white pine, PIPO = ponderosa pine, PSME = Douglas=fir*

Other Diseases

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

Glenn Kohler, Washington DNR

Figure 58. *Washington's native Oregon white oak (*Quercus garryana *Dougl. Ex Hook.) is not susceptible to* Phytophthora ramorum*, the causal agent of Sudden Oak Death.*

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, bigleaf 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 2013, eleven *P. ramorum* stream baiting sites were established in western Washington waterways. Positive samples were found in two waterways, one in Clallam County and one in Thurston County. Eleven additional sites were repeatedly sampled in Clallam County to try and determine the origin of the detected *P. ramorum* inoculum. Results from those sites are currently negative or inconclusive.

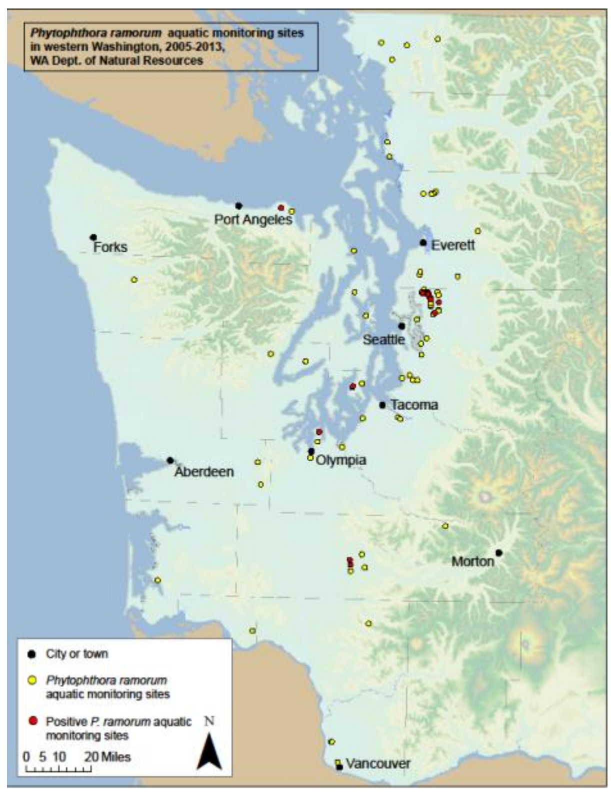


Figure 59. *WDNR stream baiting locations for* Phytophthora ramorum*.*

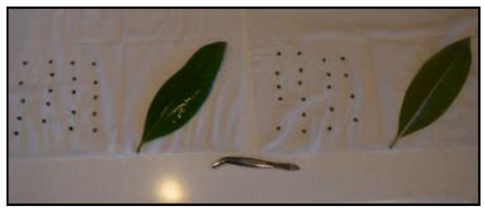
Map by: Amy Ramsey-Kroll, Washington DNR

In 2013, we changed our aquatic monitoring sampling methodology to increase efficiency. Stream baiting was the primary method used to detect *P. ramorum* since aquatic monitoring began in Washington. This method involved placing several rhododendron leaves into a mesh envelope, then floating the leaf filled envelope in the target waterway for one to two weeks (Figure 60). This method required at least two visits to the target waterway/site for one set of samples.

Amy Ramsey-Kroll, Washington DNR

Figure 60. *Traditional stream baiting methods for detecting Phytophthora using mesh bags with rhododendron leaves (above).*

Our new, Bottle-of Bait method, requires only one visit to each waterway/site for each set of samples. Multiple individual water samples are collected at each site and combined together in a large bottle, then taken back to the lab. Freshly collected, wild, rhododendron leaves are then placed directly into the bottles of water or are hole-punched into tiny pieces and those small pieces are placed into the bottles of water (Figure 61). The leaves and the water incubate for 72 hours. The entire leaves and leaf pieces are then removed from the water and submitted to a lab for cultural and/or molecular detection of *P. ramorum*.



Daniel Omdal, Washington DNR

Figure 61. *Bottle-of-Bait method for detecting Phytophthora using water samples and entire leaves or leaf pieces.*

Daniel Omdal, Washington DNR

	Phytophthora ramorum Monitoring Year								
Sample Name/#	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
BC24							+		
CLC39								+	
DR41									+
LBC12							+		
MC31							+	+	
Rosedale		+		+					
SAM07			+	+	+	+		+	
SAM12					+	+			
SAM13						+	+		
SAM14					+	+			
SAM15					+				
SAM18						+			
SAM20					+	+			
SAM21					+				
SAM25					+				
SAM27					+				
SAM28					+				
Woodin Creek 21						+	+	+	
Woodard Creek47									+
Total positive Waterways	0	1	1	2	9	8	5	4	2
Number Waterways Sampled	10	10	10	12	51	21	17	11	11
Total waterways sampled/year with positive *P. ramorum* detections (%)	0%	10%	10%	17%	18%	38%	29%	36%	18%

Since aquatic sampling began in 2005, *P. ramorum* has been detected in water samples from seven waterways in western Washington: two in King County and one in Clallam, Clark, Lewis, Pierce, and Thurston counties. Diseased plants have only been found associated with one of the waterways (Pierce County) and were destroyed.

Table 2. Phytophthora ramorum *aquatic baiting results. Grey cells indicate sites not sampled, "+" indicates positive for* P. ramorum, *blank cells indicate sampled, but not positive. Only the positive sites since 2005 are displayed in the table.*

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.

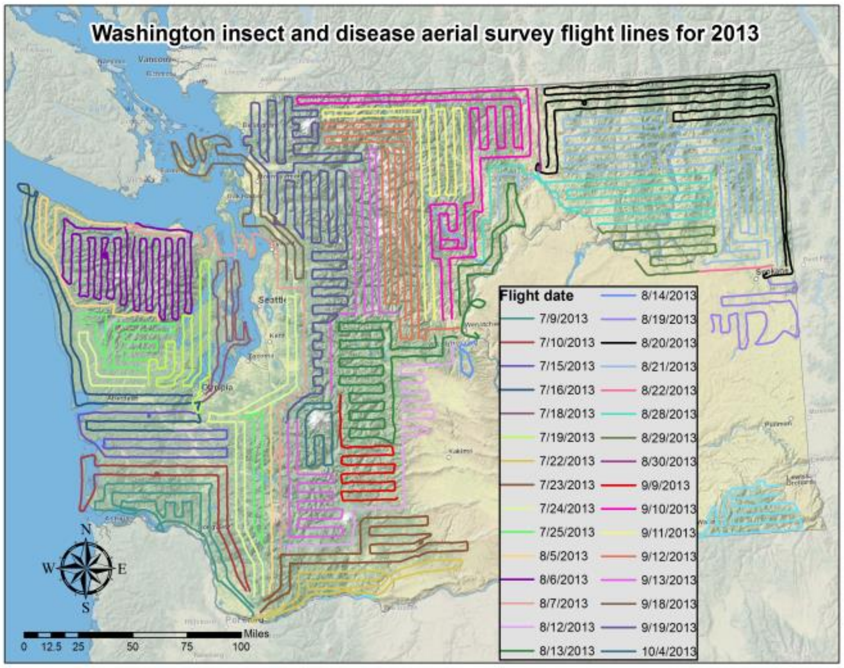


Figure 62. *Washington insect and disease aerial survey flight lines for 2013. Map by: Aleksandar Dozic, Washington DNR*

Electronic PDF Maps Available for Download

Traditional insect and disease survey quadrangle maps from 2003 to 2013 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 list of available years. Simply click the map you want from the interactive map of Oregon and Washington and it will download the PDF.

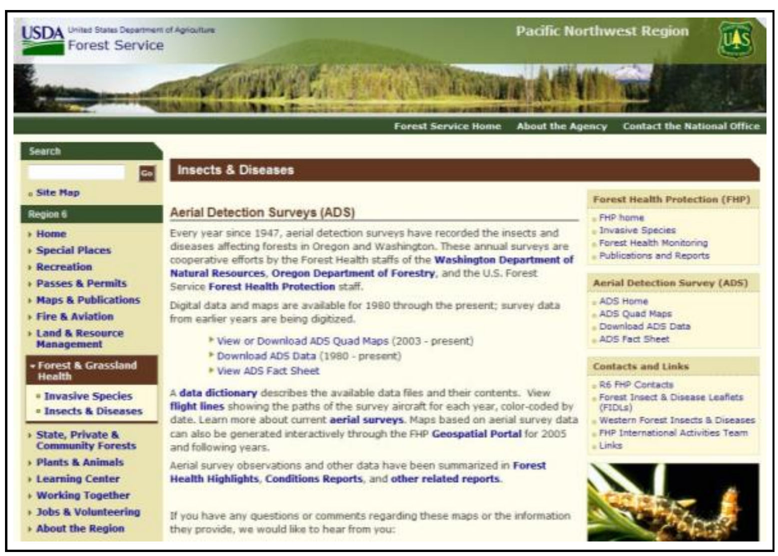


Figure 63. *Downloadable aerial survey maps and data on USFS Region 6 Forest Health Protection website.*

GIS Data Available for Download

Washington DNR also maintains downloadable GIS datasets, including aerial survey data for Washington State from 1980 to 2013, 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:

Washington Department of Natural Resources — Forest Health Program
1111 Washington St SE
PO Box 47037
Olympia, WA 98504-7037

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Amy Ramsey-Kroll	Forest Pathologist	(360) 902-1309	amy.kroll@dnr.wa.gov
Karen Ripley	Forest Health Program Manager	(360) 902-1691	karen.ripley@dnr.wa.gov

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USDA Forest Service — Wenatchee Service Center
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USDA Forest Service — Westside Service Center
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