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Forest Health Protection

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

Forest Health Highlights in Washington—2011

Washington State Department of Natural Resources
Forest Health Program
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Front cover: *Douglas-fir tussock moth larva on grand fir, Spokane County 2011. Photo: Glenn Kohler, Washington Department of Natural Resources (WDNR).*

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Summary

Washington has 22.4 million acres of forestland. In 2011 approximately 950,000 acres of this land contained some level of tree mortality, tree defoliation or foliar diseases. This is very similar to the 937,000 acres reported in 2010. Acres with mortality from bark beetles decreased for all hosts in 2011 and in many hosts to half the level recorded in 2010. Mild weather conditions and ample soil moisture in 2010 likely resulted in fewer bark beetle attacks. Damage by major defoliating insects, such as western spruce budworm, larch casebearer and Douglas-fir tussock moth increased in 2011. Previous annual total statewide acres with damage were:

2009: 1.73 million acres **2008**: 1.36 million acres **2007**: 1.4 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. 2011 spring precipitation was above average for all forested regions of Washington. No drought conditions existed for forested areas of Washington State in 2011. Areas with major wildfires are not surveyed for two years following the event, tending to temporarily decrease acres of damage.

Approximately 1.5 million trees were recorded as recently killed.

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 is expanding in northeastern Washington and severity of defoliation is increasing in parts of the Cascades. Areas with WSBW defoliation recorded in the 2011 aerial survey have increased to 539,000 acres, the highest amount since 2006.

Defoliation by the **Douglas-fir tussock moth** (DFTM) increased to 9,200 acres, up from more than 1,200 acres in 2010 and 3,500 acres in 2009. In 2011 the area of DFTM defoliation in Spokane County increased to 1,425 acres. Ground surveys indicate this outbreak is collapsing in Spokane County. 2011 was the first year with widespread DFTM defoliation in the Blue Mountains of Washington, totaling 7,800 acres.

A recent outbreak of **Douglas-fir beetle** (DFB) in western Washington has come to an end. Approximately 16,000 acres with DFB-caused mortality were observed statewide in 2011, down from 28,500 acres in 2010. In 2011, the area with **fir engraver** and **western balsam bark beetle** activity decreased to half what it was in 2010.

Pine bark beetle activity recorded by aerial survey in Washington decreased in 2011 to almost 111,000 acres, a decrease by at least half the 242,000 acres in 2010. Also, the area affected by pine bark beetles in Ferry, Stevens and Pend Oreille counties decreased to 20,000 acres in 2011, less than one third the 66,500 acres mapped in those counties in 2010. Observers mapped much smaller pockets in this area compared to the previous year and it appeared these small pockets were surrounded with old mortality.

2011 defoliation from **larch casebearer** (LC) totaled approximately 16,000 acres in Washington, primarily in Ferry, Stevens and Pend Oreille counties. This is a sharp increase from no LC damage recorded in 2010. Widespread defoliation by larch needle cast disease in the same area in 2010 may have obscured signature of an irrupting LC population.

A new outbreak of **hemlock loopers** is developing around Baker Lake and Darrington in the North Cascades. Approximately 300 acres of defoliation in old growth hemlock forests near Baker Lake were recorded in the 2011 aerial survey.

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 2011, 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 will not be apparent until the 2013 aerial survey.

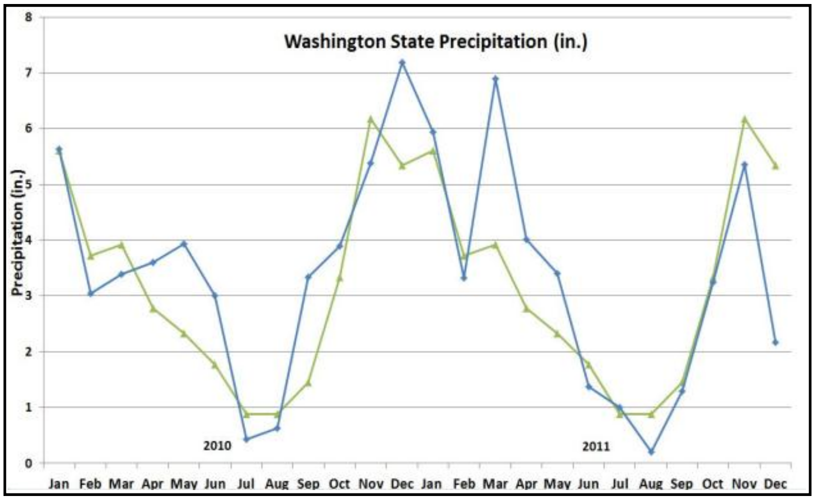


Figure 1. Average monthly precipitation and 30-year average (green line) for Washington. Source: National Climatic Data Center (http://www.ncdc.noaa.gov/oa/climate/research/cag3/cag3.html).

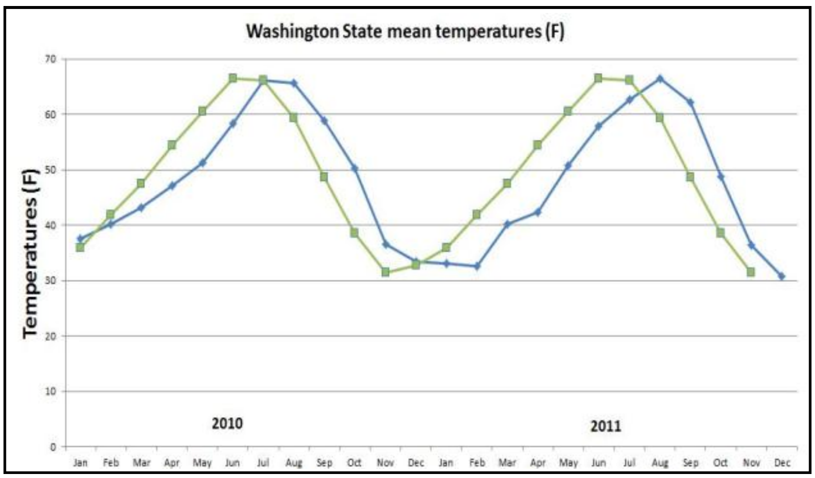


Figure 2. Monthly mean temperature and 30-year average (green line) for Washington. Source: National Climatic Data Center (http://www.ncdc.noaa.gov/oa/climate/research/cag3/cag3.html).

Aerial surveys also aim to record the location and severity of certain weather related events, 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.

Drought

2011 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 and bear damage in 2011. Average maximum spring and summer temperatures were below normal across Washington in 2011. Maximum temperatures in Washington historically occur during July and stay at an elevated level for an entire month. In 2011 the maximum temperature was measured in the beginning of August and lasted for only a few days. Drought conditions did not occur anywhere in the state in 2011, which is unusual for the normally hot, dry months of July through October. 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 2011 fire season was delayed several weeks because of wet and cold spring weather caused by El Niño. Elevated levels of snowpack were recorded through late spring. Only 7,604 acres were burned which is 65% below average for the past ten years. Most of the fires were less than 10 acres in size (97%), and the total number of 549 fires was 39% below average for the past ten years.

In 2011, WDNR managed Type 2 or Type 3 fire suppression teams on nine large fires in Washington, totaling just over 5,500 acres. In general, Type 2 fires are more complex, larger, and require more resources than Type 3 fires. At 3,626 acres, the Monastery Fire northeast of Goldendale was the largest (Fig. 3). It began when sparks emitted from a vehicle ignited multiple fires along Highway 97. The fire grew rapidly due to dry fuel conditions and low relative humidity. The fire destroyed 29 homes and 79 outbuildings as it burned through mixed conifers, grass and brush. Second in size, the Salmon Fire west of Omak began when sparks from grinding equipment ignited dry brush and burned 1,910 acres of grass, brush and timber. At 537 acres, the largest Type 3 fire was the Barber Mountain Fire near Nighthawk in Okanogan County. In summary, of the nine largest fires in 2011, eight were started by vehicles, equipment or human activities, including one arson. The cause of one fire was undetermined.

Dean Thornberry, Washington Incident Management Team 3

Figure 3. *Monastery Fire near Goldendale, 2011.*

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.

On the other hand, we have been obtaining increasingly helpful background imagery for our sketchmapper system. 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.


Glenn Kohler, Washington DNR

Figure 4. *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.

Areas burned by wildfire are not mapped until the second year following the fire. From the air it can be difficult to distinguish mortality caused by the fire from mortality caused by insects or disease. After a year has passed, the direct effects of the fire have mostly subsided and pests are credited with the newest tree damage.

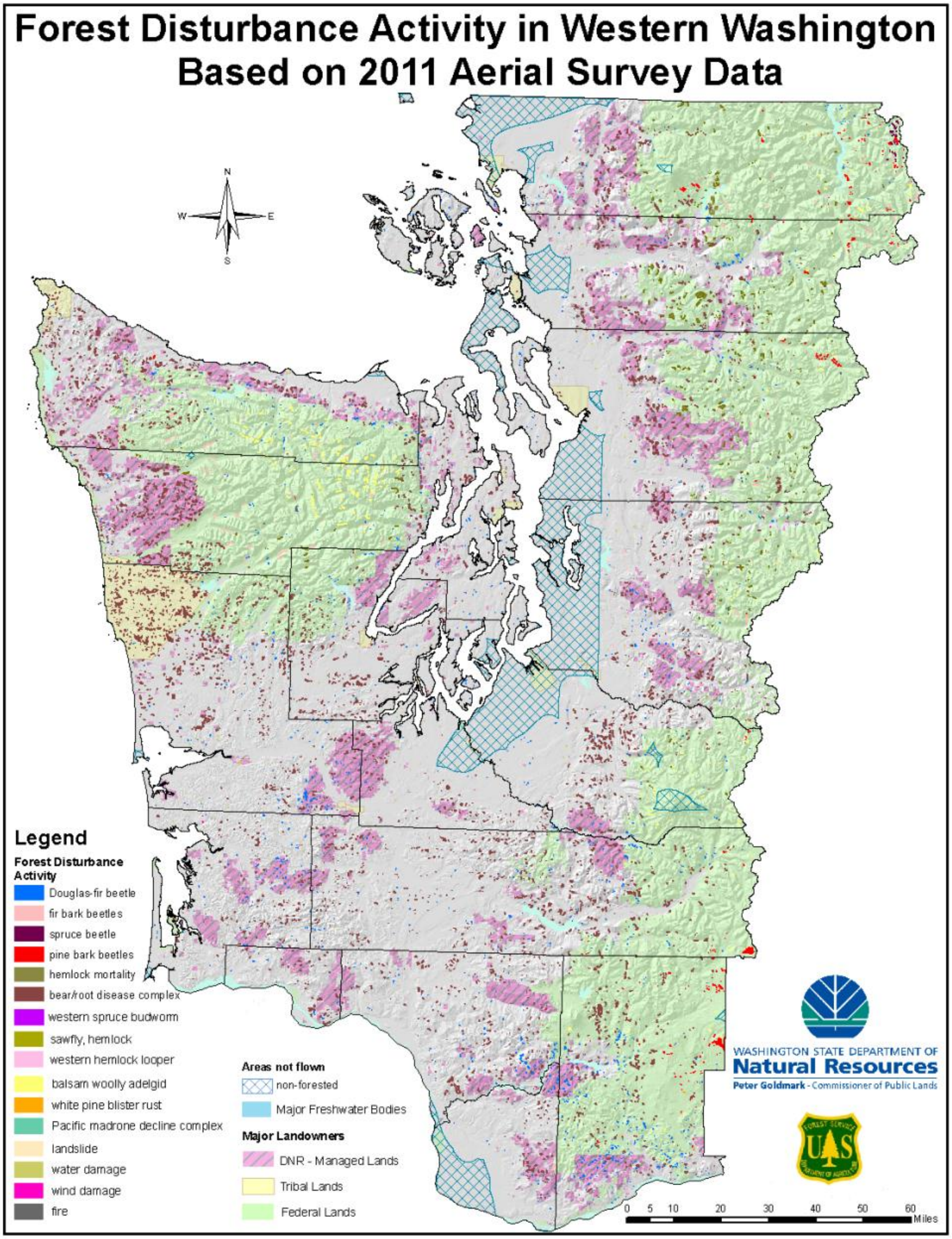


Figure 5. *Forest disturbance map of Western Washington composed from 2011 aerial survey data.*
Map by: Aleksandar Dozic, Washington DNR

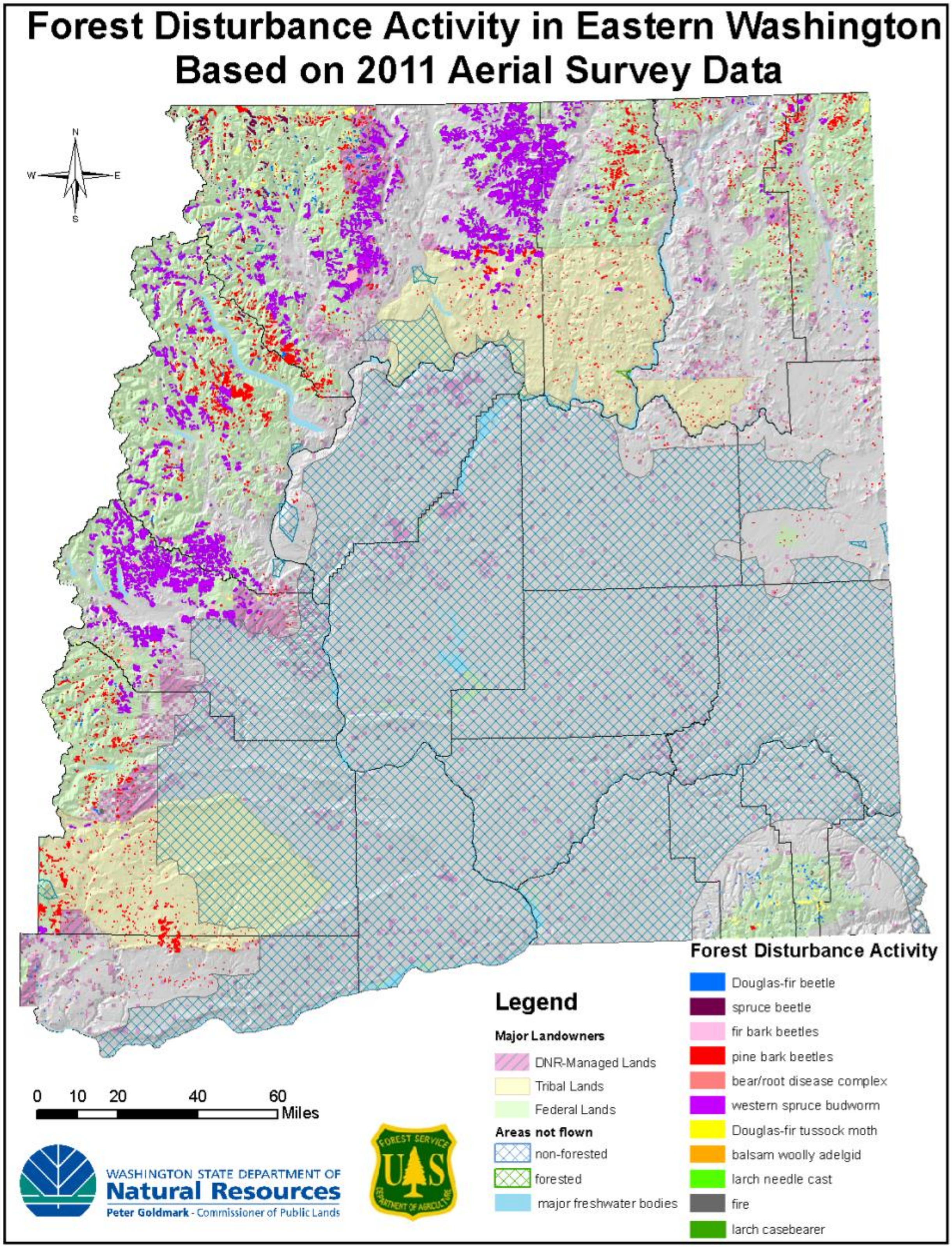


Figure 6. *Forest disturbance map of Eastern Washington composed from 2011 aerial survey data.*
Map by: Aleksandar Dozic, Washington DNR

Insects

Bark Beetles

Fir Engraver (*Scolytus ventralis* LeConte)

Figure 7. *Horizontal egg galleries of fir engraver in grand fir, northeastern Washington.*

The 35,000 acres with fir engraver caused mortality recorded in 2011 were the lowest level in the past decade. Areas with scattered individual fir engraver-killed trees were common in forested areas throughout the state. The average intensity was under one tree killed per acre. Having only 35,000 acres mapped evenly across the state could be the result of the unusually wet 2010 season. Scattered low level mortality is typical during non-outbreak years. Above normal rainfall amounts during the spring months of 2011 may contribute to another below average year of fir engraver caused mortality mapped in 2012.

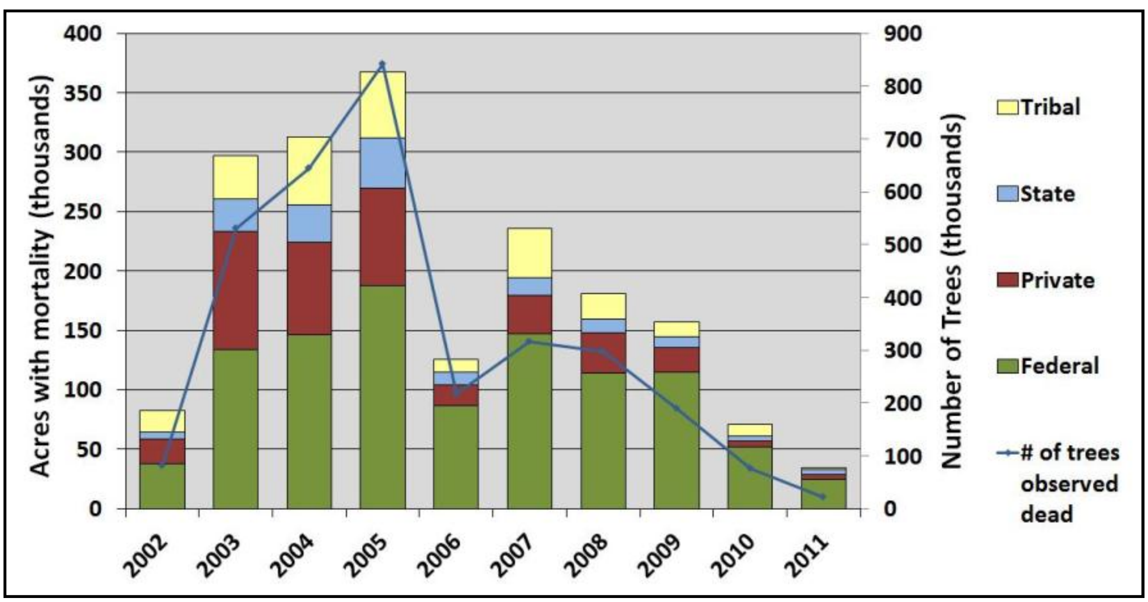


Figure 8. *Ten year trend for total acres and number of trees affected by fir engraver in Washington.*

Douglas-fir Beetle (*Dendroctonus pseudotsugae* Hopkins)

Approximately 16,000 acres with Douglas-fir beetle (DFB) caused mortality were observed statewide in 2011, down from 28,500 acres in 2010. This is the fewest number of acres with DFB-killed trees since 1998. A recent outbreak triggered by wind damage in western Washington has come to an end. Acres with DFB-killed trees mapped in western Washington have declined to 10,000 acres in 2011 from a record 33,000 acres in 2009 and 18,500 acres in 2010. The decrease is likely due to DFB being killed as they entered healthy trees and other natural controls.

Rob Hoff, Washington DNR

Figure 9. *Group of Douglas-fir beetle-killed trees in Capitol State Forest.*

Compared to 2010, DFB activity has decreased in most of western Washington with the exception of Whatcom, Skagit and San Juan Counties which had slight increases. DFB activity in the Blue Mountains continues a downward trend from a peak of 20,000 acres with mortality in 2008. The area with DFB-caused mortality has increased in western Okanogan County.

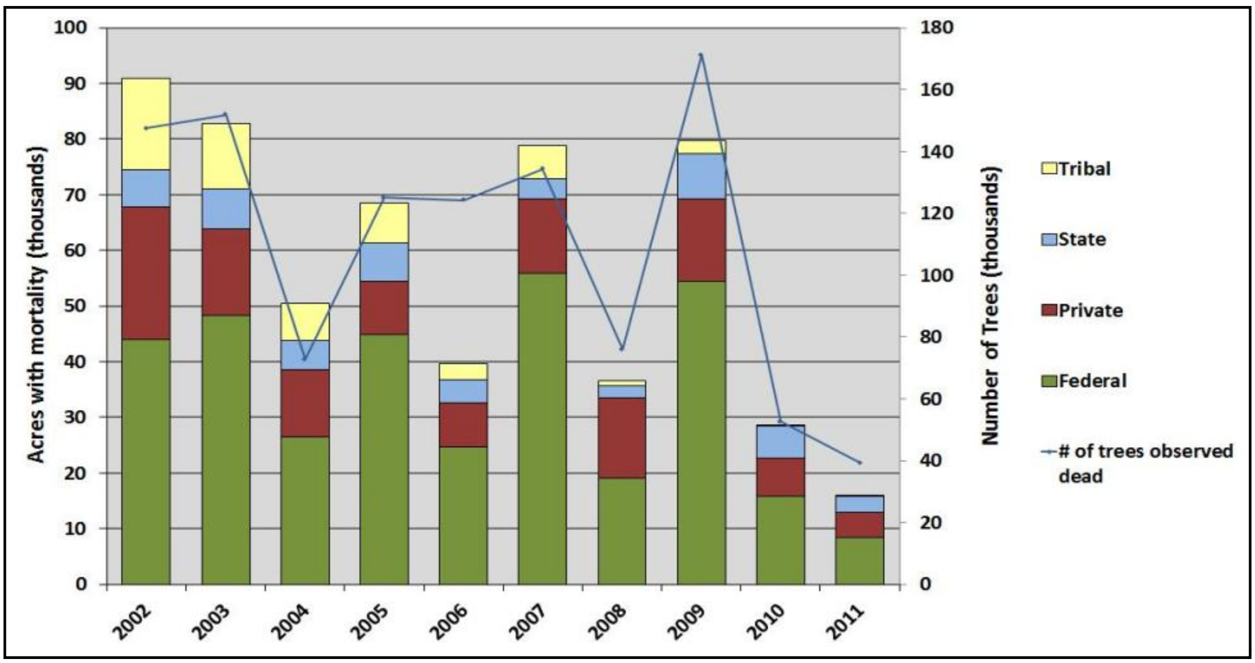


Figure 10. *Ten year trend for total acres and number of trees affected by Douglas-fir beetle in Washington.*

Spruce Beetle (*Dendroctonus rufipennis* Kirby)

14,700 acres with some spruce beetle-kill were observed in 2011 near the Cascade crest in western Okanagan 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. 2011 marks the fewest annual acres recorded in this outbreak since 2000, a significant decrease from the record high of 56,000 acres in 2009. The reduction in damaged acres may be caused by delayed onset of red crowns due to an unusually cool and wet spring in 2011.

Denis Du Bois, http://smallforestowner.blogspot.com/

Figure 11. *Spruce beetle caused mortality of Engelmann spruce near Tonasket.*

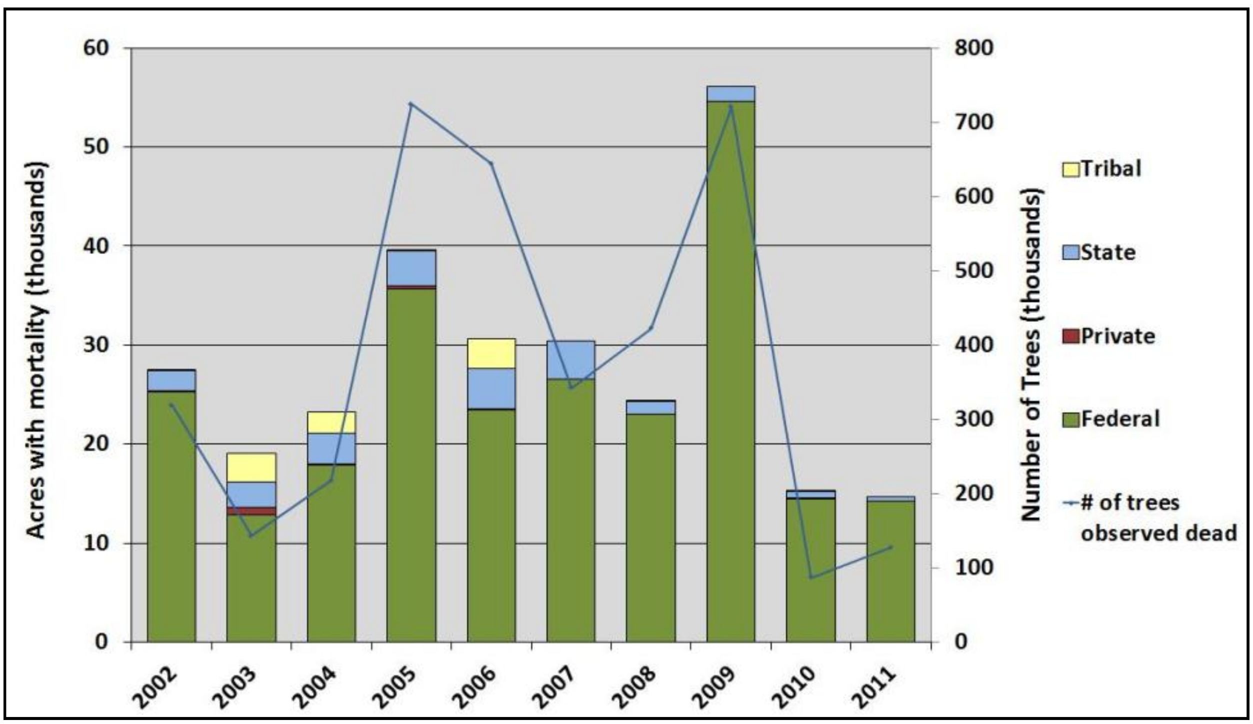


Figure 12. *Ten year trend for total acres and number of trees affected by spruce beetle in Washington.*

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

The number of acres with pine trees killed by bark beetles decreased in 2011 to almost 111,000 acres, down from 242,000 acres in 2010. The area affected by pine bark beetles in Ferry, Stevens and Pend Oreille counties also decreased to 20,000 acres in 2011, less than one third the 66,500 acres mapped in those counties in 2010. Observers mapped much smaller pockets in this area compared to the previous year and it appeared that these small pockets were surrounded by old mortality. Other areas that have experienced high mortality from pine bark beetles in recent years had significantly less beetle-kill in 2011.

Darci Carlson, US Forest Service

Figure 13. *Mountain pine beetle-killed lodgepole pine at Shady Pass.*

Areas with reduced pine bark beetle activity include the North Cascades Mountains of Chelan and Okanogan Counties (56,000 acres in 2011 and 107,000 acres in 2010) and the Cascade Mountains in Klickitat and Yakima Counties (25,000 acres in 2011 and 52,000 acres in 2010).

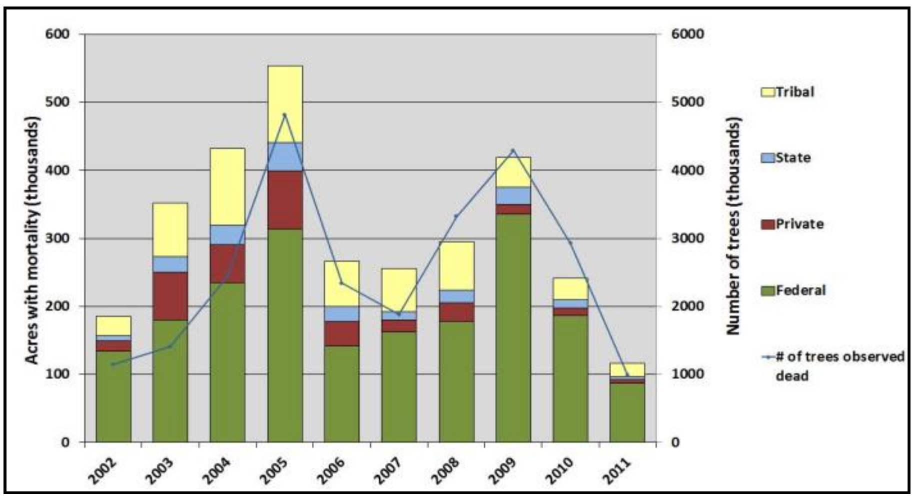


Figure 14. *Ten year trend for total acres and number of trees affected by pine bark beetles in Washington.*

Table 1. 2011 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	93,000	883,000
mountain pine beetle	ponderosa pine	14,000	87,000
mountain pine beetle	whitebark pine	5,500	16,000
mountain pine beetle	western white pine	515	1,400
western pine beetle	ponderosa pine	2,500	2,500
pine engravers (*Ips* species)	all pines	120	600

California Fivespined Ips (*Ips paraconfusus* Lanier)

The California fivespined Ips (CFI), *Ips paraconfusus*, a pine engraver beetle native to California and Oregon, was recorded for the first time in Washington State in 2010. A CFI outbreak near the town of White Salmon in Skamania and Klickitat Counties resulted in numerous killed and top-killed ponderosa pines in 2010 and 2011. CFI has been a serious pest of young ponderosa pine plantations in the Willamette Valley in Oregon. Monitoring for CFI using pheromone baited traps placed by Washington State University (WSU) Extension, USFS and WDNR have collected CFI in Trout Lake, Husum, several sites along the Columbia River from Lyle west to Vancouver, Ridgefield and Toledo. The farthest north monitoring site at Ft. Lewis did not collect any CFI in 2011. CFI numbers were highest in the White Salmon area, Lyle, Vancouver and Ridgefield. CFI numbers were lower at the more northern sites of Trout Lake, Husum and Toledo.

Todd Murray, Washington State University

Figure 15. *Ponderosa pine top-killed by California fivespined Ips near White Salmon, Washington.*

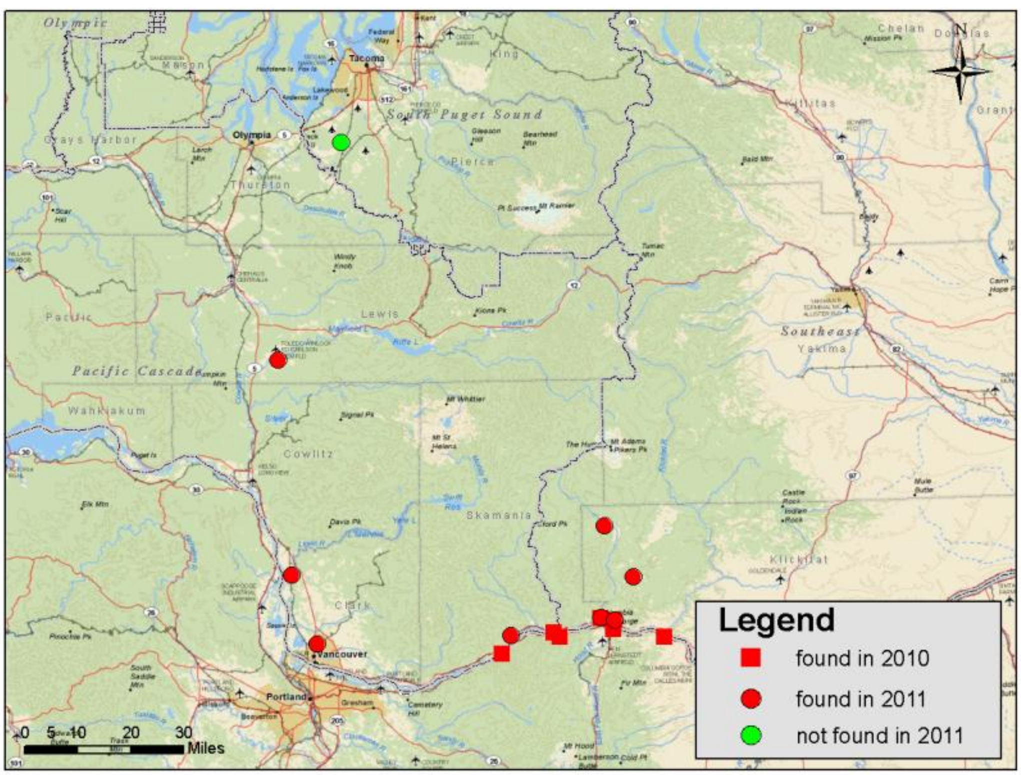


Figure 16. *California fivespined Ips monitoring trap locations in Oregon and Washington, 2010-2011. Map by: Aleksandar Dozic, Washington DNR.*

Defoliators

Western Spruce Budworm (*Choristoneura occidentalis* Freeman)

The east slopes of the Washington Cascade Mountains and mountains of northeastern Washington (eastern Okanogan and Ferry Counties) continue to experience an outbreak of western spruce budworm (WSBW). The area affected is expanding in northeastern Washington and severity of defoliation is increasing in parts of the Cascades. Areas with WSBW defoliation recorded in the 2011 aerial survey have increased to 539,000 acres, up from 373,500 acres in 2010 and 412,000 acres in 2009. This year's defoliated area is larger than in any year since the 556,000 acres in 2006. The average WSBW defoliation in Washington over the past ten years is 343,000 acres.

WSBW defoliated areas in northeastern Washington (Pend Oreille, Stevens, Ferry and eastern Okanogan counties) expanded significantly to approximately 193,000 acres in 2011 from 38,000 acres in 2010. Once again, Kittitas County had especially heavy defoliation. The 'scorched' crown signature and defoliation damage were much more intense in 2011. WSBW pheromone trap catches in the central and north Cascades, eastern Okanogan County and Ferry County predict heavy defoliation in 2012 (Fig. 19).

Figure 17. *Western spruce budworm caterpillar.*

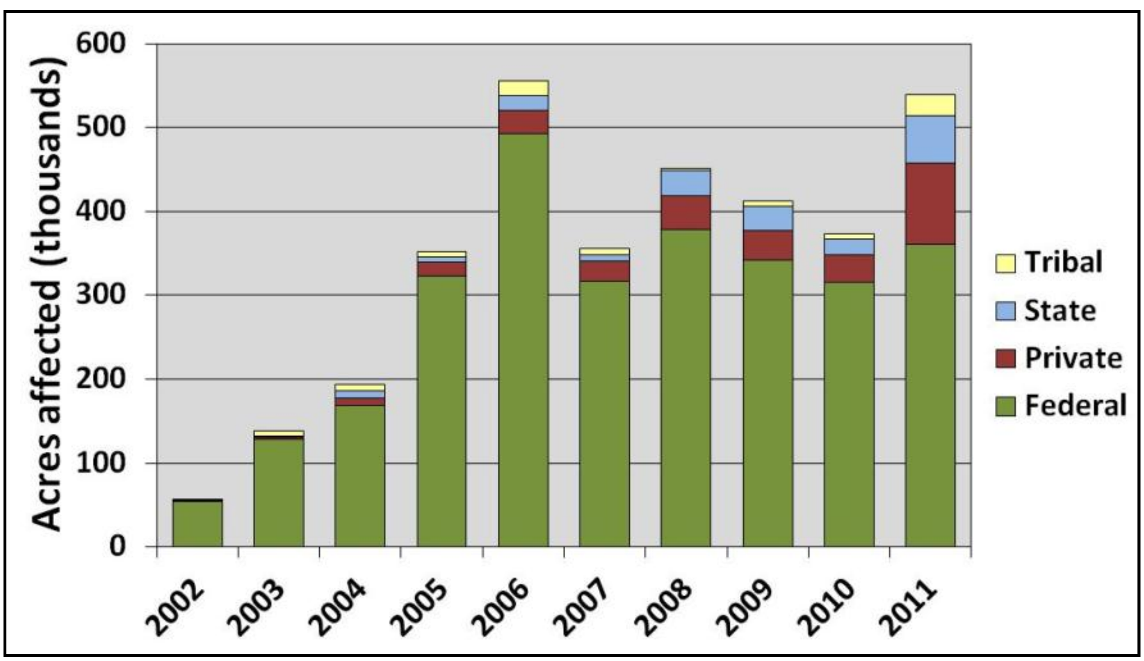


Figure 18. *Ten year trend for total acres affected by western spruce budworm in Washington.*

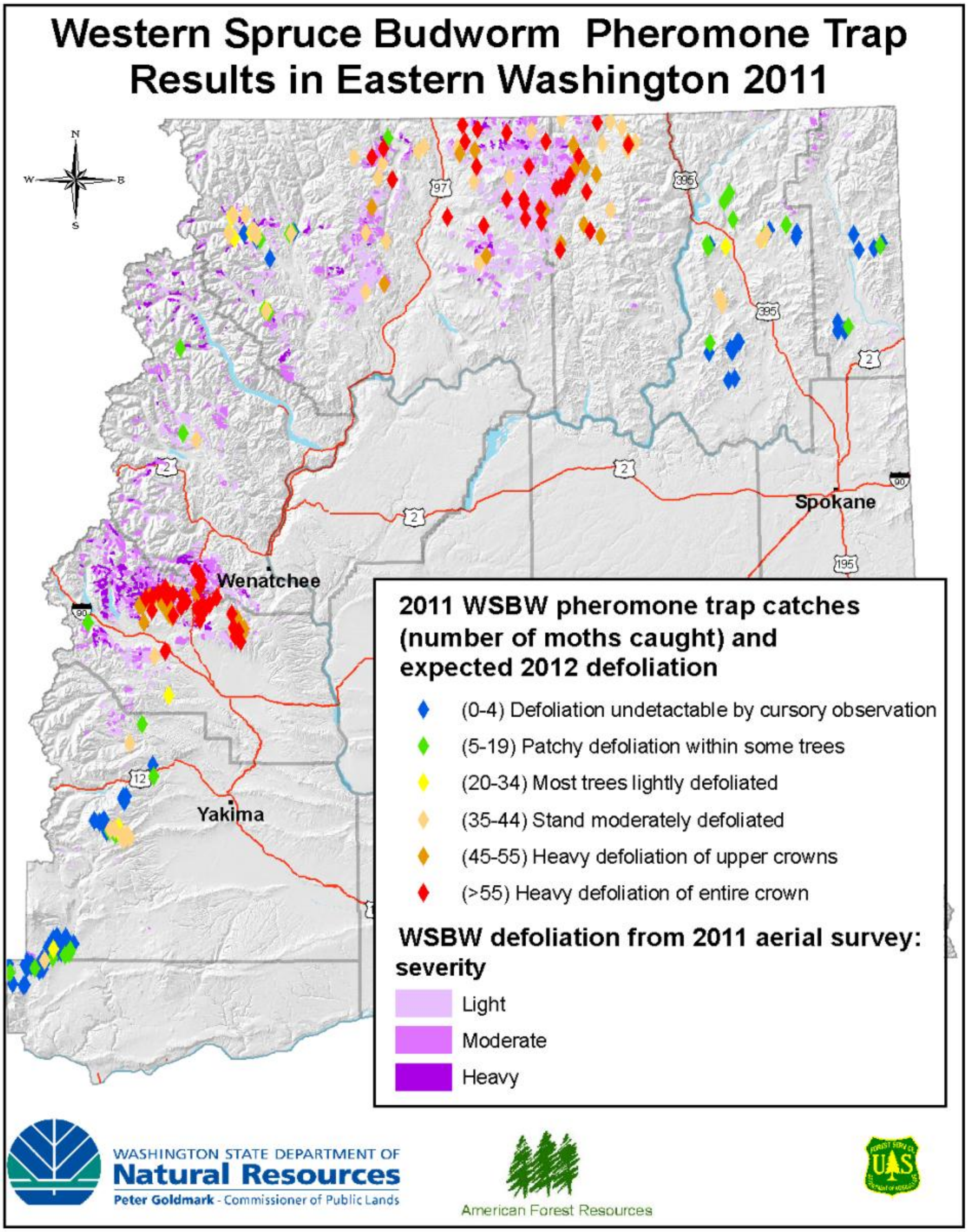


Figure 19. *Western spruce budworm pheromone trap catch results for 2011, expected 2012 defoliation and defoliation detected by the 2011 aerial survey. Map by: Aleksandar Dozic, Washington DNR*

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

Spokane County and north Idaho: Pheromone monitoring traps in eastern Spokane County indicated increasing Douglas-fir tussock moth (DFTM) populations in 2008 which have remained high through 2011. The USFS and WDNR cooperative aerial survey recorded just over 1,600 acres with defoliation in eastern Spokane County; an increase from 570 acres in 2010. The Idaho State Department of Lands (IDL) aerial survey mapped approximately 68,000 acres with defoliation in Kootenai, Benewah and Latah Counties in Idaho; a significant increase from the 8,500 acres mapped in 2010. In Washington, damage has primarily affected grand fir and Douglas-fir on Mica Peak, Tekoa Mountain and Gelbert Mountain. Defoliation has been moderate, with more heavy defoliation in the upper third of tree crowns. Low numbers of new egg masses and evidence of virus-killed caterpillars suggest the outbreak in Spokane County is collapsing and there is not likely to be much more defoliation in 2012.

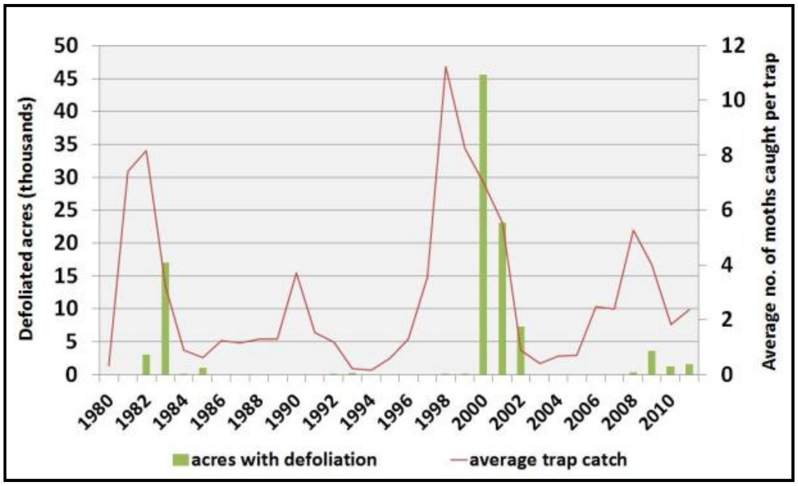


Figure 20. *Correlation of DFTM pheromone trap catches with observed defoliation.*

Blue Mountains: In 2011, approximately 7,800 acres of new DFTM defoliation were recorded in the Umatilla National Forest in the Blue Mountains of Washington and an additional 1,200 acres in northeast Oregon. USFS entomologists noted smaller areas of defoliation in 2010 that were too light to be recorded in aerial survey. Defoliation primarily affected grand fir, subalpine fir and to a lesser extent Douglas-fir and spruce in the wilderness area in Columbia and Garfield Counties. Damage is typically light, with the top third of the crown most heavily defoliated. Defoliation may expand in area and intensity in 2012.

Glenn Kohler, Washington DNR

Figure 21. *Light Douglas-fir tussock moth defoliation in Spokane County, 2011.*

Vicki Simmons, private landowner

Figure 22. *Newly hatched Douglas-fir tussock moth larvae on egg mass.*

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

In late summer 2011, WDNR and USFS received reports from people observing high numbers of inch-worm type caterpillars, droppings and defoliation damage in the vicinities of Baker Lake (Whatcom County) and Darrington (Snohomish County). USFS entomologists confirmed presence of both "western hemlock looper" *Lambdina fiscellaria lugubrosa* and "phantom hemlock looper" *Nepytia phantasmaria*, but the population is primarily western hemlock looper. With this information, aerial survey was able to accurately map approximately 300 acres with hemlock looper defoliation.

Darci Carlson, US Forest Service

Figure 23. *Hemlock looper defoliation at Baker Lake, 2011.*

The heaviest defoliation has occurred in and around Horseshoe Cove Campground on the west shore of Baker Lake. Areas along the Mountain Loop Highway about four miles south of Darrington are also affected. Defoliation was patchy and appeared more severe in understory trees.

Darci Carlson, US Forest Service

Figure 24. *Hemlock looper adults.*

The Mt. Baker area has been the site of past outbreaks of hemlock looper. Outbreaks are sporadic and Washington has not had one for several years. The last outbreak in western Washington was from 2001-2003. Areas affected were hemlock forests near Baker Lake, the City of Everett Watershed surrounding Lake Chaplain and near Arlington. A very large hemlock looper outbreak affected Pacific County in the 1960s.

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

Red alder defoliated by western tent caterpillar (WTC) was recorded on 181 acres in the northern area of the Mount Saint Helens National Volcanic Monument. The severity of defoliation was moderate. WTC caterpillar damage was also reported in hardwoods on San Juan Island and in aspen in northern Ferry County. It is likely WTC populations are increasing to outbreak levels in some areas of the state. As a result, damage may increase in 2012. WTC caterpillar outbreaks are cyclical and rarely last more than a few years.

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

Figure 25. *Larch casebearer infested stands in northeast Washington in 2011.*

Larch casebearer is an exotic insect that feeds on the foliage of western larch. In 2011, primarily light to moderate defoliation from larch casebearer totaled 16,268 acres in Washington, primarily in Ferry, Stevens and Pend Oreille counties. This is a sharp increase from no larch casebearer damage recorded in 2010. Widespread defoliation by larch needle cast disease in the same area in 2010 may have obscured the signature of an irrupting larch casebearer population. The last outbreak of widespread larch damage was in 2008 when 39,000 acres were defoliated by larch casebearer and 31,000 acres with larch needle cast damage were mapped. Because larch re-foliates annually, it takes several years of damage to cause serious injury to larch. Researchers at Oregon State University are currently evaluating persistence of parasitic wasps that were released in Oregon and Washington for biological control of larch casebearer in the 1970s.

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

In 2011, the Washington State Department of Agriculture (WSDA) placed 17,198 gypsy moth pheromone traps in Washington. 13,619 of these were for European gypsy moth (EGM) detection and delimiting and 3,579 were for Asian gypsy moth (AGM) detection. Sixteen (16) gypsy moths were collected from six (6) catch areas, all in western Washington. Ten (10) of the 16 EGM catches were near the Puyallup eradication project site, where twenty-nine (29) acres were ground sprayed in 2011 using the bacterial insecticide, *Bacillus thuringiensis* var. *kurstaki* (Btk). Of the six catch areas, three (3) areas were new detections for gypsy moth in 2011. All 16 moths collected 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 16 moths is not unusually high when more than 17,000 traps are used. In the past twelve years, the highest number of moths collected was 92 in 2000. WSDA proposed two eradication projects for spring 2012 in Pierce County. One will be near Eatonville where multiple egg masses and pupal cases were found. The other project is a follow-up to the 2011 treatment in Puyallup.

Figure 26. *Gypsy moth trap.*

Green Alder Sawfly (*Monsoma pulveratum* Retzius) NON-NATIVE

2011 was the second year of monitoring for the non-native green alder sawfly (GAS) in Washington using yellow sticky traps. GAS was first detected in Vancouver, Washington in 2010, however museum specimens date its introduction to at least 1995. In 2010 and 2011 monitoring for GAS was conducted by WSDA, USFS, WSU and WDNR. Over two years GAS was detected in 18 Washington counties including Kittitas, Ferry and Stevens in eastern Washington. GAS has also been recorded in Alaska, British Columbia, Idaho and Oregon. GAS defoliation of alder appears as numerous round 'shotholes' through the leaf, leaving most of the leaf intact. At monitoring sites where GAS larvae have been collected, defoliation damage has been moderate. Damage to red alder (*Alnus rubra* Bong.) in Washington has been nothing like the heavy damage to thin-leaf alder (*Alnus tenuifolia* Nutt.) in Alaska. In fact, two years of aerial survey using GAS positive sites as a 'heads-up' have not resulted in any alder defoliation being mapped from the air.

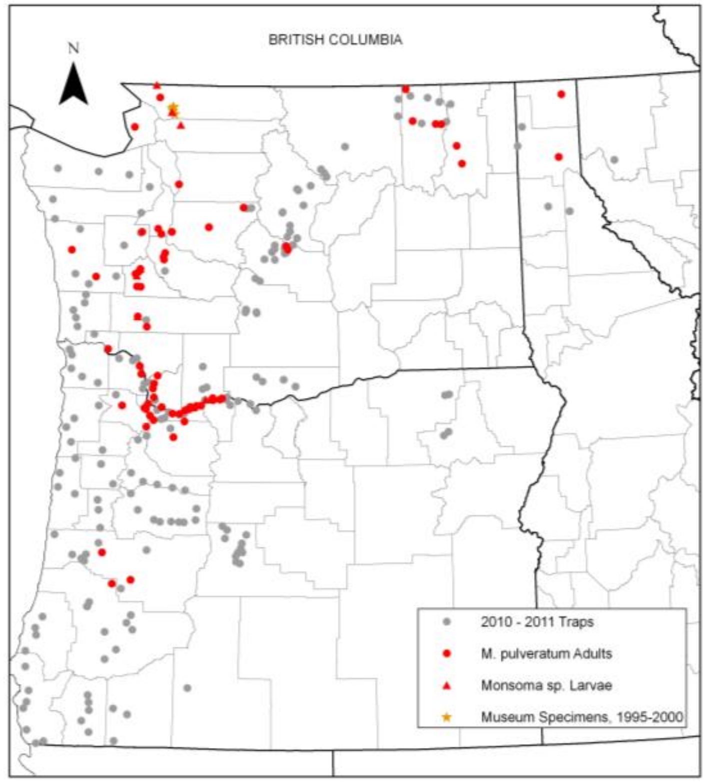


Figure 27. *Locations of GAS collections (red) and traps (grey) in the Pacific Northwest.* Map by: Chris Looney, WSDA

Conifer Defoliating Sawflies (Family Diprionidae)

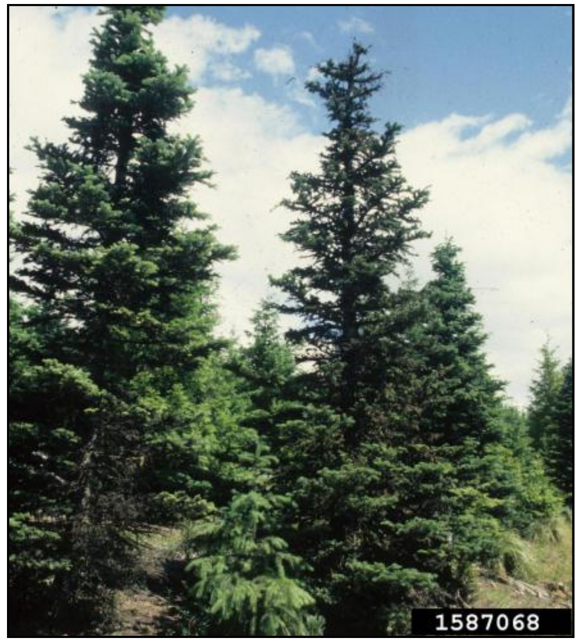
Conifer sawfly defoliated western hemlocks and Pacific silver firs were reported near Baker Lake by a USFS entomologist. While on a special flight to map hemlock looper damage, aerial surveyors recorded 1,027 acres of sawfly defoliated hemlock on forested slopes east of Baker Lake. Ground reports of conifer sawfly populations and minor defoliation include Pacific silver firs at Stampede Pass (near Snoqualmie Pass), ponderosa pines in south Spokane County and western larch in south Pend Oreille County. Light defoliation of ponderosa pine caused by both diprionid sawflies and pine butterfly was recorded on 60 acres about 15 miles northwest of Wenatchee.

Mike Johnson, Washington DNR

Figure 28. *Sawfly larvae feeding on ponderosa pine.*

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

Although it continues to be widespread in high elevation forests throughout Washington, damage from balsam woolly adelgid (BWA) totaled 25,239 acres in 2011, similar to the 30,000 acres affected in 2010. This is still well below a recent peak of 60,000 acres in 2009 and 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, on both the west and east slopes of the Cascade Mountains and scattered areas of northeastern Washington. There were 3,800 acres with some host mortality attributed directly to BWA damage. Approximately 8,000 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.



Elizabeth Willhite, US Forest Service

Figure 29. *Symptoms of BWA feeding in Pacific silver fir.*

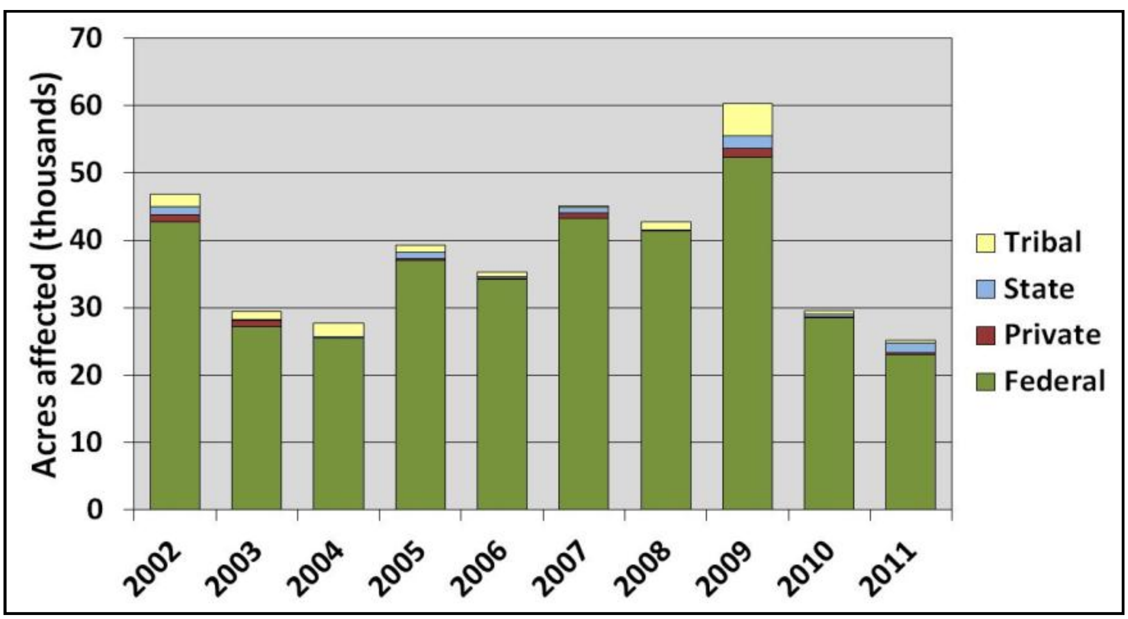


Figure 30. *Ten year trend for total acres affected by balsam woolly adelgid in Washington.*

Oak pit scales (*Asterolecanium* spp.)

Oak pit scales (OPS) are sucking insects that cause branch tip dieback, delayed leaf expansion in spring and clumping of foliage in oaks. In spring 2011, landowners spanning the Columbia River Gorge, from Lyle to Washougal reported damage and some mortality in Oregon white oaks. WDNR and WSU entomologists found OPS to be the primary cause of oak damage. Damage has now been recorded as far north as Tenino and Roy in the South Puget Sound area. Using ground data as a 'heads up,' aerial survey crews mapped approximately 240 acres of OPS damage and some mortality, coded as hardwood decline in oak (HDO), primarily in Klickitat County.

David Simon, private landowner

Figure 31. *Symptoms of oak pit scale feeding on Oregon white oak in Klickitat County.*

Oak pit scales are among several species of scale insects in the *Asterolecanium* genus (family Asterolecaniidae) that feed on numerous species of oaks. They are well known in California where valley oak, *Quercus lobata* Née, is most frequently infested. Less is known about OPS effects on Oregon white oak, *Quercus garryana* Douglas ex Hook., because damage has been less common where that host grows in Oregon, Washington and British Columbia.

Amy Ramsey-Kroll, Washington DNR

Figure 32. *Late-expanding leaves appear clumped on branches damaged by oak pit scale feeding.*

Amy Ramsey-Kroll, Washington DNR

Figure 33. *Green-colored scale insects attached to bark.*

Animals

Bear Damage / Root Disease

Aerial survey records scattered, pole sized, newly dead trees of any species 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. In spring, bears strip tree bark to get at nutritious tissue below, primarily from the lower trunk. 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, bears are more likely to feed on trees as an alternative when their preferred food plants are not mature. Also, a wet spring 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 in spring and age of trees.

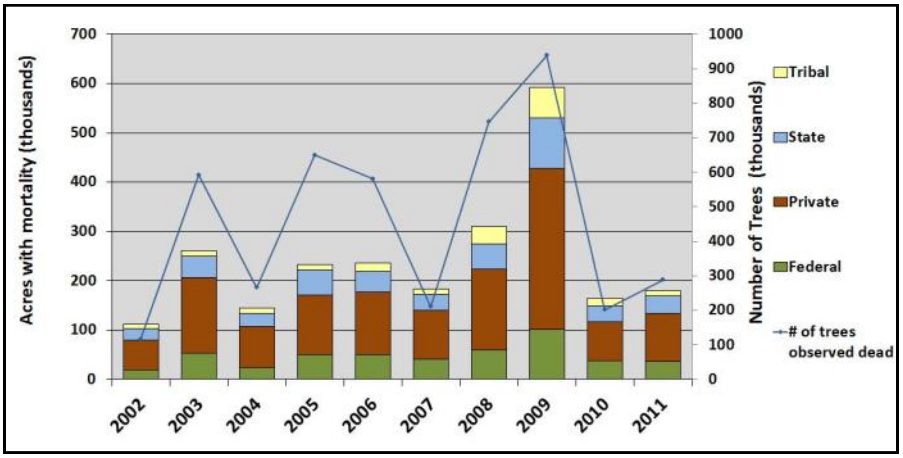


Figure 34. *Ten year trend for acres and number of trees affected by bear damage in Washington.*

Approximately 180,000 acres with bear damage mortality were observed in 2011, primarily in western Washington. This was slightly more than the 164,000 acres mapped in 2010. The ten year average of acres with bear damage in Washington is 242,000. The average number of trees per acre (TPA) killed was higher in 2011 (1.60 TPA) than 2010 (1.45 TPA). The estimated total number of trees killed was approximately 290,000 which was almost one third higher in 2011 than 2010.

In most of the state, acres with bear damage decreased except in Whatcom, Skagit and Snohomish Counties. In those counties, observers mapped 28,000 total acres with bear damage which is typical, but significantly more than the 5,300 acres mapped in 2010. In 2010 aerial survey flights over this area were delayed into October, when fading signatures and unfavorable visibility may have contributed to lower observed bear damage.

Due to a growing concern about elevated levels of bear damage, the Quinault Indian Reservation was surveyed with greater intensity (on a two mile grid). In 2011, 22,892 acres with bear damage were mapped in this area, which is only slightly more than the 22,192 acres mapped in 2010 on the standard four mile grid.

Quaking Aspen Health Monitoring

In 2010 and 2011, WDNR and the Oregon Department of Forestry cooperated to assess the stand conditions and causal agents affecting quaking aspen (*Populus tremuloides* Michx.) health in the Pacific Northwest. The newly described sudden aspen decline (SAD) phenomenon that has been described in the Rocky Mountains has raised awareness of aspen health throughout North America. Previous studies have documented conifer encroachment and animal damage as important drivers of aspen dieback and decline in Oregon and Washington. This is the first region-wide assessment incorporating aerial survey data.

Figure 35. Conifer encroachment and cattle browse in a declining aspen stand in eastern Washington.

Aspen condition was monitored at 71 locations in eastern Washington and Oregon identified through aerial survey and ground reports. The majority of stands had some level of conifer competition, animal damage and chronic overstory mortality. However, two-thirds of stands were deemed "stable" with some aspen regeneration. Ungulate damage, woodboring insects, stem cankers and stem decays were the most common causes of damage to mature aspen. Aspen regeneration was most affected by ungulate browse, defoliating insects and foliage diseases. These factors, in addition to stand age and changing site conditions, contribute to slow, successional decline and mortality. Findings of this study do not appear consistent with the rapid overstory mortality and lack of regeneration characteristic of SAD in Arizona, Colorado, Utah and Wyoming.

Figure 36. *Stem canker on aspen.*

Figure 37. *Poplar borer damage on aspen.*

Historically, damaged aspen stands have been recorded in aerial survey as 'hardwood decline' or 'satin moth.' As a result of this recent assessment, 'hardwood decline, aspen' (HDA) was adopted as a new aerial survey code by USFS Region 6. HDA can be used to more accurately record aspen mortality and differentiate it from defoliation by satin moth.

Using LiDAR to Assess Forest Health Risk

In 2008, WDNR received funding from the USFS to obtain aerial laser mapping data, also known as "LiDAR" data, on approximately 75,000 forested acres in northeastern Washington. Our goals were to introduce this technology to partnering landowners, to create a high quality forest inventory and to determine whether this system could be used to interpret forest health conditions.

LiDAR data are collected with airplanes carrying instruments that rapidly shoot pulses of light towards the ground and measure the ones that are reflected back. This system collects precise information about the distances the pulses travelled, creating a "point cloud" shaped like the land, vegetation, and objects the light pulses strike. Computer software is used to smooth out the shapes, distinguishing the surface of the land and the size and arrangement of the vegetation. Standard forestry measurements collected on ground plots help interpret forest conditions, such as tree heights and stand densities, to calibrate the LiDAR patterns.

The USFS Pacific Northwest Research Station confirmed the quality of the LiDAR data and combined it with ground data collected by WDNR, the Confederated Tribes of the Colville Reservation and the Spokane Tribal Forestry staff. High quality GIS information about the ground topography, tree heights and stand density were developed and shared with cooperators (Figure 38).

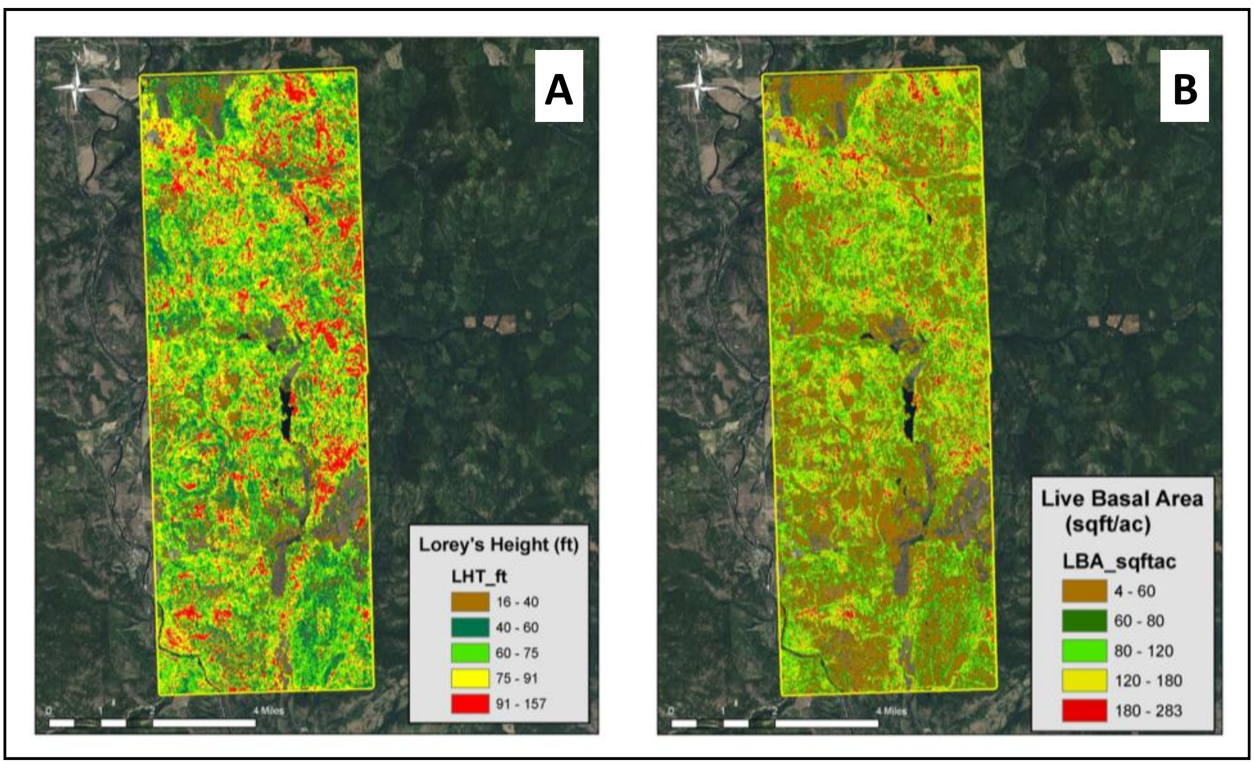


Figure 38. *Pierre Lake area LiDAR acquisition in Stevens County showing tree height (A) and basal area (B) outputs.*

Although the specific landowners have not succeeded at mastering the software or techniques for analyzing the LiDAR data themselves, they have benefited from these GIS products. For example, the ground surface information helps identify geologic features and old road beds (Figure 39). The forest information has been used by WDNR's Landowner Assistance staff to identify properties that might benefit from cost-share programs to thin overcrowded young forests.

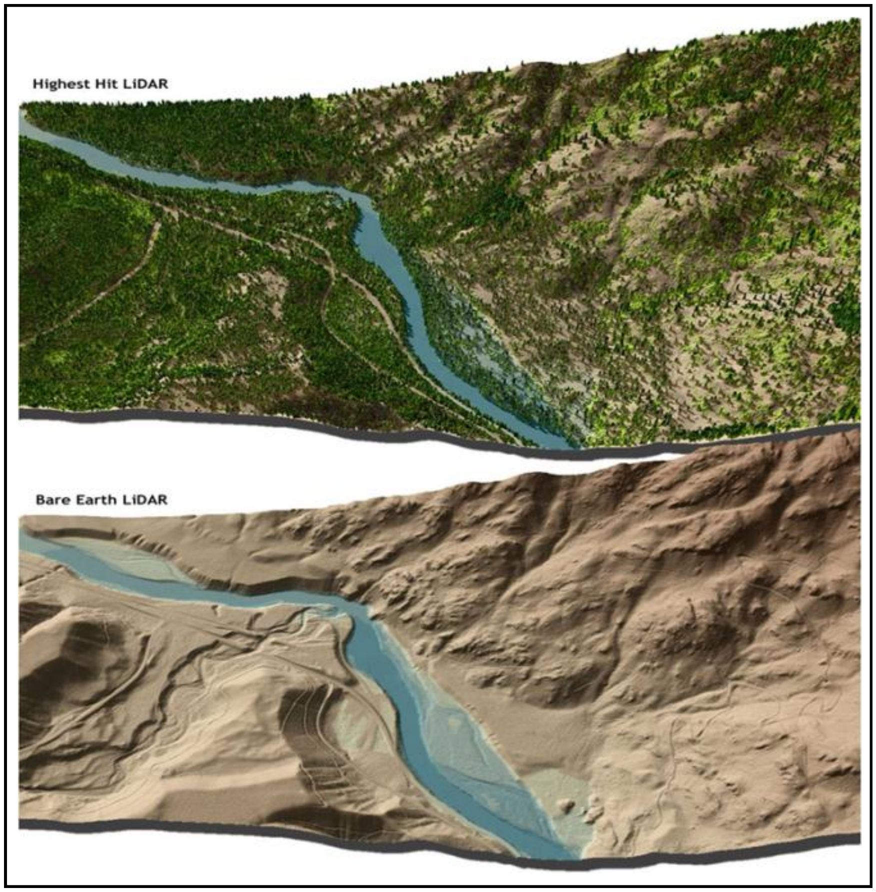


Figure 39. *Pierre Lake area LiDAR acquisition in Stevens County showing three-dimensional reconstruction of canopy and topography.*

Beyond using tree height and density indicators, we have not yet succeeded in using this technique for making detailed forest health assessments. One key problem is that the LiDAR methods we used do not enable us to discern the tree species. Tree species has a critical relationship with vulnerability to specific pests or pathogens. Another weakness of this tool is that LiDAR pulses do not penetrate the tree foliage. The architecture and layering of tree crowns indicate vulnerability to defoliating caterpillars. Those features are hidden inside the LiDAR point cloud. Additional ground data have been collected and provided to the Pacific Northwest Research Station to evaluate whether dwarf mistletoe infections can be identified from tree crown shapes.

The LiDAR data from this project, plus 105,000 acres collected at the same time using the same methods on the Colville National Forest, have been added to the Puget Sound LiDAR Consortium's library and are available for additional study (www.pugetsoundlidar.org).

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 2011, 5,700 acres of whitebark pine mortality were observed throughout the high elevation mountainous areas of eastern Washington, 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 (500 acres). This was considerably less whitebark and western white pine mortality than what was observed in 2010 (19,300 acres). The Washington aerial survey records very little area affected specifically by white pine blister rust (WPBR) (145 acres in 2010) because mortality signatures can be difficult to distinguish from mountain pine beetle from the air.


Brian Luis, US Forest Service

Figure 40. *White pine blister rust canker on western white pine branch.*

A cooperative rust resistant western white pine field trial between WDNR and the Dorena Genetic Resource Center of the USFS continued this year. All trees on the six study sites were examined for the presence of WPBR cankers. Rust was found on all six sites, with site means ranging from 5.3% to 31.0% of the trees infected, depending on the site. The average WPBR incidence was 11.8% among all sites, over three times greater than the average in 2010 (3.8%).


Brian Luis, US Forest Service

Figure 41. *Rust resistant western white pine field trial site in southwest Washington.*

Cronartium ribicola caused the mortality of two seedlings on one site and no mortality on the other five sites. Monitoring will continue on the six long term study sites in an effort to illustrate to western Washington land managers that western white pine can be a viable component to reforestation practices, even in the presence of WPBR.

Root Diseases and Stem Decays

Root Diseases

Amy Ramsey-Kroll, Washington DNR

Figure 42. *Armillaria root disease infected ponderosa pine near Glenwood, Washington.*

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 and promote diverse stand structure and habitat conditions. 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. 626 acres were recorded as affected by root disease only in 2011 and 180,000 acres were recorded as bear damage/root disease (see page 20 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.

Stem Decays

Stem decay fungi are found throughout Washington and all species of trees are hosts to at least one species of stem decay fungus. They soften the wood of trees, facilitating the excavation of stems by cavity nesters. Some stem decay fungi consume the heartwood of a tree and create hollow stems. Decayed stems frequently break, creating unique stem structures, broken tops and downed wood, all of which can be useful to wildlife.

Daniel Omdal, Washington DNR

Figure 43. *Douglas-fir with broken top near Ashford, Washington.*

Daniel Omdal Washington DNR

***Figure 44.** An inoculated trunk section of a sampled Douglas-fir. Note the white mycelium on the colonized dowel (right) and the plastic pipe inserted partway into the drilled hole (left). Only a small amount of decay associated with the colonized dowel after 10 years is shown here.*

A cooperative study between the USFS and WDNR examining the effects of artificially inoculating living conifers to promote stem decay and subsequent wildlife use in forests was concluded this year. Douglas-fir, western larch, grand fir and ponderosa pine were Inoculated with stem decay fungi between 1996 and 2003 on 19 sites in eight different geographical areas in Washington and Oregon. Eight difference species of stem decay fungi were used in the inoculations, including *Fomitopsis pinicola* (Sw.:Fr.) P. Karst. and *Porodaedalea pini* (Brot.) Murrill. (= *Phellinus pini*) in western Washington and *Fomitopsis officinalis* (Vill.) Bondartsev & Singer in eastern Washington. There was very little decay associated with the inoculated trees and no nesting cavities were found on any of the sampled trees associated with the inoculations. However, live-tree inoculations with stem decay fungi may be continued, but after substantial modification. The study report can be found at http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5327687.pdf.

Foliar Diseases

Cottonwood Foliar Diseases (*Septoria* spp. and *Venturia* spp.)

Very visible leaf damage and defoliation in black cottonwoods along Interstate 90 west of Cle Elum and along the White River Valley, north of Lake Wenatchee, were reported by numerous people in late spring, 2011. USFS pathologists identified the cause of damage as foliar diseases caused by *Septoria* spp. and/or *Venturia* spp., pathogens that favor wet and mild weather conditions. Using these reports as a 'heads up,' aerial survey crews mapped approximately 100 acres of foliar disease in *Populus* spp. along Interstate 90 and in Wahkiakum County. Some concerned landowners were advised not to salvage what they thought were dead trees.

Karen Ripley, Washington DNR

***Figure 45.** Cottonwood foliar diseases,* Septoria *spp. and/or* Venturia *spp..*

Andy Perleberg, Washington State University

***Figure 46.** Cottonwood foliar diseases (*Septoria *spp. and/or* Venturia *spp.) near Leavenworth, Washington.*

Larch Needle Cast (*Meria laricis* Vuill.)

Mike Johnson, Washington DNR

Defoliation from larch needle cast disease (LNC), caused by *Meria laricis*, was recorded on 4,028 acres in eastern Washington in 2011, primarily in Kittitas and Pend Oreille counties. LNC was more widespread in 2010, affecting approximately 22,000 acres. Continued incidence of LNC is likely associated with a second year of unusually wet spring and summer weather in 2011. The signature for this disease is yellow to orange foliage in the lower crown, but can be confused with whole crown defoliation caused by larch casebearer. Approximately 16,000 acres with larch casebearer defoliation in some of the same areas may have obscured LNC signature.

Mike Johnson, Washington DNR

Figures 47 and 48. *Larch needle cast (*Meria laricis*) near Boulder Pass, Chelan County, in spring, 2011.*

Swiss Needle Cast (*Phaeocrytopus gaeumannii* (Rohde) Petrak)

In western Washington, Swiss needle cast (SNC) is a common foliage disease of Douglas-fir caused by *Phaeocryptopus gaeumannii*. It occurs on sites with abundant spring and/or summer precipitation and where mild winter temperatures favor growth and reproduction of the pathogen. The Washington aerial survey records very little area affected by SNC (none in 2011) because symptoms are not evident during the summer survey flight season. However, on the ground survey work is conducted each year to monitor the incidence and severity of the disease.

Amy Ramsey-Kroll, Washington DNR

Figure 49. *Douglas-fir branch with one year old needles in the upper portion of the photo and two year old needles with fungal pseudothecia in the stomata in the lower portion of the photo.*

In 2011, thirty-seven sites were surveyed in coastal Washington. *Phaeocryptopus gaeumannii* pseudothecia (fungal fruiting structures that occlude the stomata of Douglas-fir needles) were counted on one and two year old needles. Pseudothecia on one year old needles averaged 1.8% and pseudothecia on two year old needles averaged 20.2% (Figure 49). Needle abscission and premature needle loss can occur when approximately 50% of the stomata are occluded by pseudothecia (Hansen et al. 2000). These data indicate that one and two year old needles are not likely experiencing premature needle loss from *P. gaeumannii*. Needle retention, by year, was also recorded and ranged from 1.5 to 3.1 years among the sites (Figure 50). Detectable growth loss can occur in Douglas-firs when needle retention is less than 3 years (Maguire et al. 2002) and nearly all the sites surveyed (35/37) had an average of less than 3 years of needles. Future studies are needed to determine SNC impacts on Douglas-fir growth in Washington.

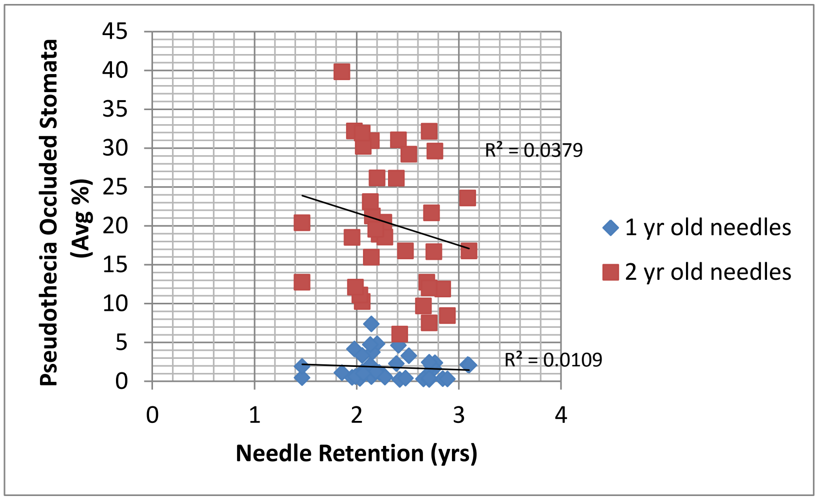


Figure 50. *Douglas-fir needle retention in years and average percentage of stomata occluded by* Phaeocryptopus gaeumannii *pseudothecia by age of needles.*

References

Hansen, E.M., Stone, J.K., Capitano, B.R., Rosso, P., Sutton W., Winton L., Kanaskie A., and M.G. McWilliams. 2000. Incidence and impact of Swiss needle cast in forest plantations of Douglas-fir in coastal Oregon. Plant Disease. 84: 773-779.

Maguire, D.A., Kanaskie, A., Voelker, W., Johnson, R., and Johnson, G. 2002. Growth of young Douglas-fir plantations across a gradient in Swiss needle cast severity. Western Journal of Applied Forestry. 17:86-95.

Other Diseases

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

Phytophthora ramorum is the causal agent of Sudden Oak Death (SOD), ramorum leaf blight and ramorum dieback. 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. In Washington, Sudden Oak Death mortality or damage are 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 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 previously reported positive *P. ramorum* nurseries. In 2011, sixteen *P. ramorum* stream baiting traps were placed in nine western Washington waterways (Figure 51). Positive samples were found in five waterways. Four of those were associated with the Sammamish River in King County, a river where positive samples have been found since 2007. The other positive waterway was a creek located in a forested area in Lewis County. The source of the *P. ramorum* inoculum remains uncertain, but in the waterways associated with the Sammamish River, genetic evidence is pointing to previously positive nurseries. There have been no *P. ramorum* streamside plant infections found in association with the waterway positives, indicating that *P. ramorum* is not spreading from the waterways into the surrounding vegetation.

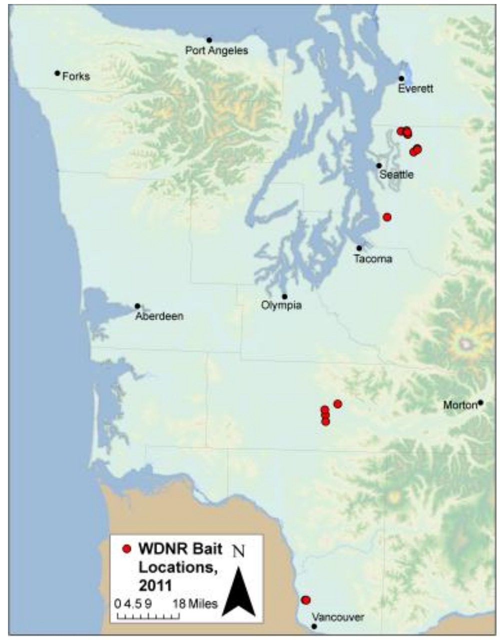


Figure 51. *WDNR stream baiting locations for* Phytophthora ramorum.
Map by: Amy Ramsey-Kroll, Washington DNR

Bigleaf Maple Dieback

Amy Ramsey-Kroll, Washington DNR

Figure 52. *Crown dieback in bigleaf maple sampled for Verticillium wilt.*

Bigleaf maples (*Acer macrophyllum* Pursh) are an important ecosystem component in the forests of western Washington, providing shade, food, habitat and structural diversity in riparian and upland areas. Over the past several years, concerned landowners, the general public and forest land managers have contacted University of Washington, WDNR and USFS forest health specialists about increased levels of bigleaf maple decline and dieback observed in western Washington. Symptoms include yellow flagging of large branches, small leaf size, and partial or entire crown dieback. A limited number of site visits and drive-by observations have been made without any conclusive evidence about what is causing the dieback.

Verticillium albo-atrum Reinke and Berthold and *Verticillium dahlia* Klebahn, causal agents of Verticillium wilt, are reported as damaging agents of bigleaf maple (Minore and Zasada 1990). *V. albo-atrum* and *V. dahliae* are soilborne fungi that invade the xylem of host trees and can cause leaf drying, leaf curling, defoliation, wilting, dieback and tree death (Sinclair et al. 1987). In 2011, WDNR investigated whether or not Verticillium wilt was the primary cause of bigleaf maple decline and dieback in western Washington.

Based on the 2011 sampling results from sixty one sites (Figure 54), we conclude that the dieback occurring in bigleaf maple in western Washington is being caused by something other than Verticillium wilt. None of the samples we submitted for analysis were positive for *Verticillium* spp. Signs of other root diseases were found in a portion of the trees surveyed, but those results did not suggest that either Armillaria or Ganoderma root diseases were the primary causal agents of bigleaf maple dieback in western Washington.

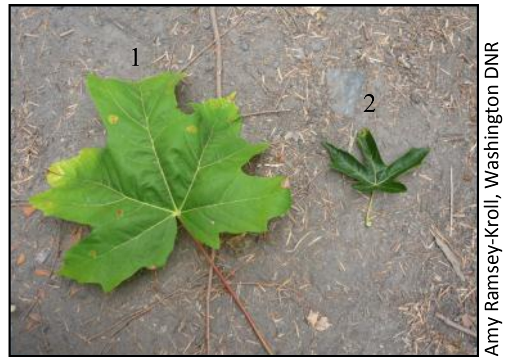


Figure 53. *Healthy (1) vs. symptomatic (2) bigleaf maple leaves.*

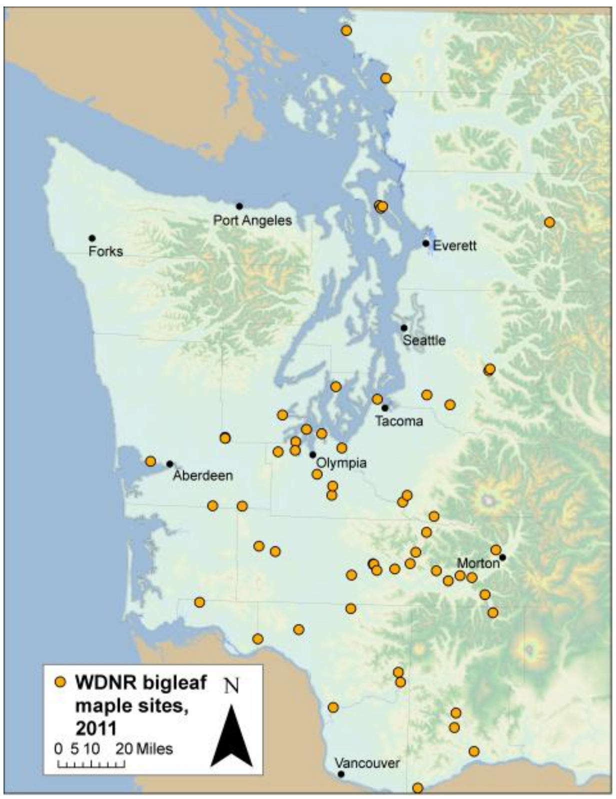


Figure 54. *WDNR symptomatic bigleaf maple survey sites.* *Map by: Amy Ramsey-Kroll, Washington DNR*

Dialogue among WDNR and USFS forest health specialists in California, Oregon and Washington about the bigleaf maple dieback issue, has raised awareness of another pathogen affecting bigleaf maple in California, *Xylella fastidiosa* Wells et. al*.* This bacteria is causing maple leaf scorch in northeast California (Woodruff 2011). *Xyllela fastidiosa* is transmitted from diseased to healthy plants by insects with piercing and sucking mouthparts. The bacteria is limited to the xylem and can cause blockage in the water conducting system of the plant. A limited number of samples from the bigleaf maple survey were sent for *Xyllela* analysis and two were positive.

Monitoring and survey work will continue in a cooperative effort among WDNR, USFS and ODF in 2012 to try and determine if *X. fastidiosa* is causing the bigleaf maple dieback in western Washington and Oregon, or if there is another cause.

References

Minore, D. and J.C. Zasada. 1990. *Acer macrophyllum*. Pp. 33-40 in R.M. Burns and B.H. Honkala (technical coordinators) Silvics of North America, Vol. 2. Agri. Handbook 654, USDA For. Serv., Washington, D.C.

Sinclair, W. A., H. H. Lyon, and W. T. Johnson. 1987. Diseases of trees and shrubs. Cornell. University Press, Ithaca, New York. 574 p.

Woodruff, B. 2011. *Xylella fastidiosa* confirmed on bigleaf maple in Northern California. USDA Forest Health Protection, Report # NE11-16.

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.

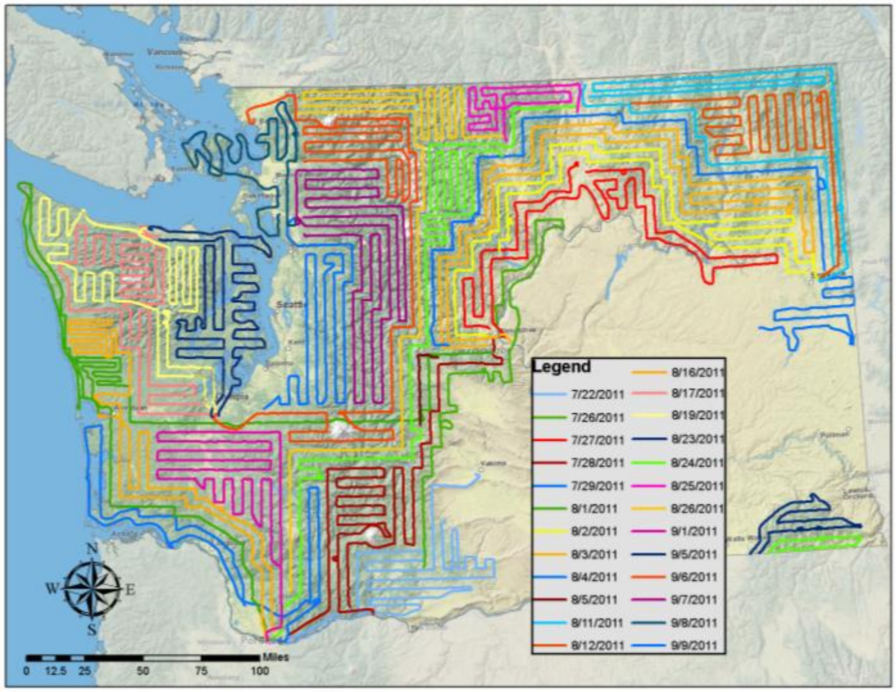


Figure 55. *Washington insect and disease aerial survey flight lines for 2011. Map by: Aleksandar Dozic, Washington DNR*

Electronic PDF Maps Available for Download

Traditional insect and disease survey quadrangle maps from 2003 to 2011 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.

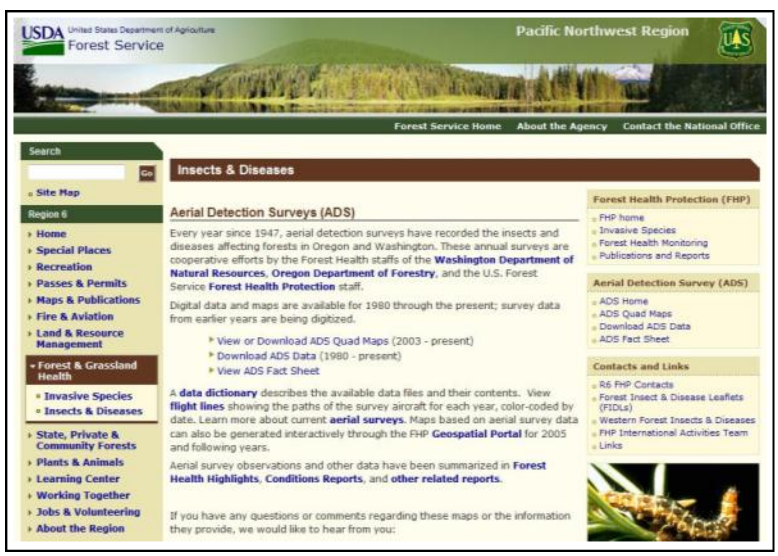


Figure 56. *Downloadable aerial survey maps and data on USFS Region 6 Forest Health Protection website.*

GIS Data Available for Download

Current and historical aerial survey spatial data from Oregon and Washington from 1980 to 2011 are available as downloadable ZIP files at:
www.fs.usda.gov/goto/r6/fhp/ads/data

Washington DNR also maintains downloadable GIS datasets, including aerial survey data for Washington State from 1980 to 2011, 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, DNR 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://bookstore.cfs.nrcan.gc.ca/detail_e.php?recid=35377

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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