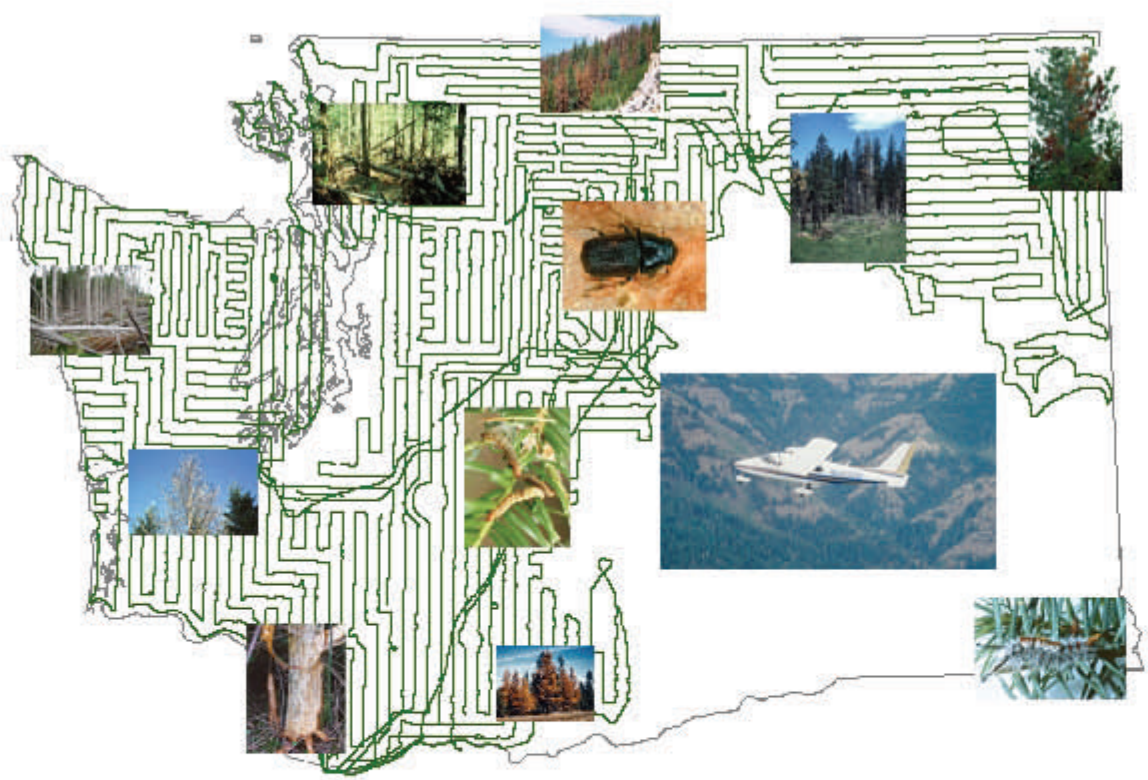
Forest Health Protection
Pacific Northwest Region
USDA Forest Service

WASHINGTON STATE DEPARTMENT OF
Natural Resources

# Forest Health Highlights in Washington—2007



Washington State Department of Natural Resources
Forest Health Program
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# Forest Health Highlights in Washington—2007

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## Summary

Washington has more than 22 million acres of forestland. In 2007 approximately 1.4 million acres of this land contained elevated levels of tree mortality, tree defoliation, or foliar diseases. This is a decrease from the 1.9 million acres of forest disturbance mapped in 2006. Some of this year's significant highlights include:

- Fir engraver beetle mortality increased across all forest ownerships (235,958 total acres affected)
- Douglas-fir beetle mortality nearly doubled (78,840 total acres affected)
- Western spruce budworm defoliation decreased for the first time since 2002 (355,362 total acres affected)
- Pine bark beetle mortality decreased for the second consecutive year (255,376 total acres affected)

## Weather and Forest Health

Figure 1. Windthrown timber on Capitol State Forest.

The weather of 2006 significantly influenced forest health conditions in 2007. Last summer was one of the driest on record for Washington and the prolonged drier-than-normal weather induced water stress in many trees. The loss of tree vigor can cause dieback, reduced growth, and susceptibility to bark beetle attacks. Another significant weather event that affected forest health in 2007 was the December 14-15 , 2006 windstorm . The powerful storm that hit western Washington brought the highest wind speeds experienced in the region since 1993. Storms of this type may produce extensive windthrow that Douglas-fir beetles use as breeding habitat. Extensive windthrow can lead to population outbreaks that attack a substantial number of trees the following year. Aerial survey cannot detect successfully attacked trees until one year later (2009) when they dry out .

In 2007, western Washington experienced near-normal precipitation and temperatures during the January-May period. However, much of eastern Washington received less than 50% of normal precipitation during this same period, with the driest areas being the Okanogan region and the Yakima Valley. By June, eastern

Washington was rated as “abnormally dry” by the U.S. Drought Monitor. Summer brought record breaking heat across the state in July and below normal precipitation for eastern Washington. In contrast, western Washington received seven consecutive days of precipitation in the second half of July – an unusual event that may have helped many water stressed trees.

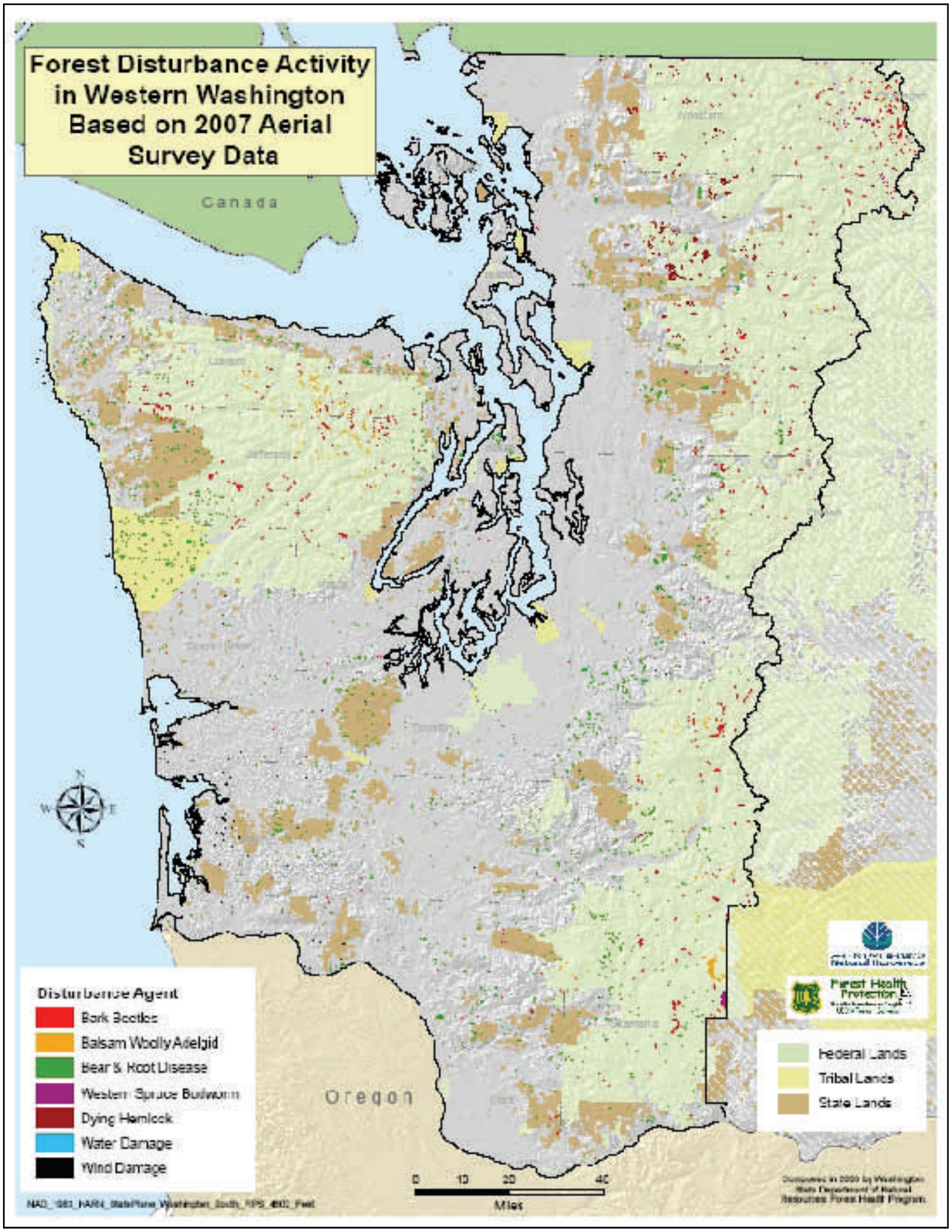


Figure 2. Forest disturbance map composed from 2007 aerial survey data.

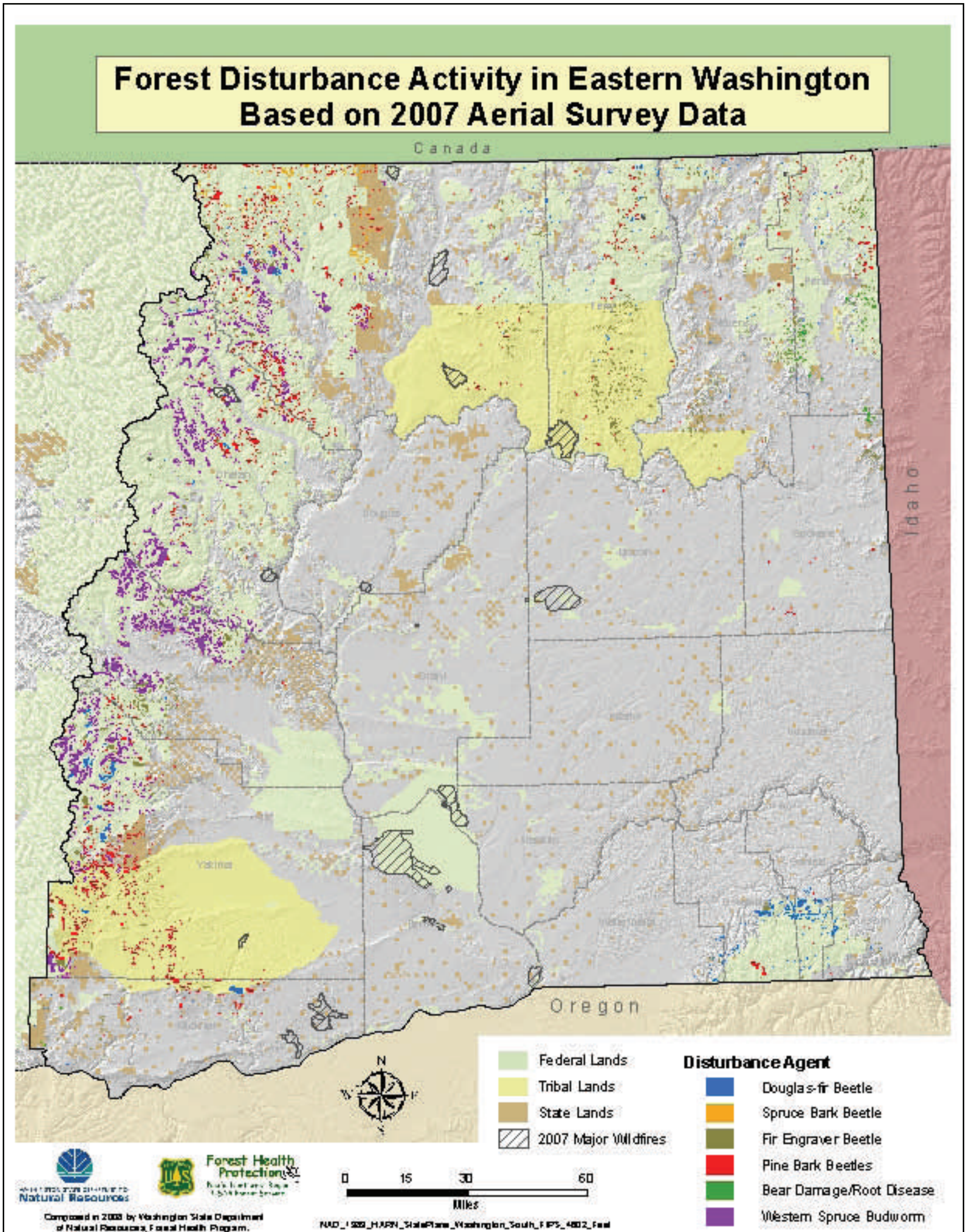


Figure 3. Forest disturbance map composed from 2007 aerial survey data.

# Fire

Washington experienced an active wildfire season in 2007. In total there were 1,259 fires that burned 216,995 acres, a significant decrease from the 462,000 acres burned in 2006. Low precipitation, low humidity, frequent winds, lightning, and concentrations of insect-killed dead and dying trees created extremely dangerous conditions. By early August, 1000-hour fuel moistures had reached their season low of 8%.

Figure 4. Domke Lake Fire 2007.

# Insects

## Bark Beetles

### Fir Engraver Beetle *(Scolytus ventralis)*

Scattered true fir mortality was mapped throughout Washington again this year. Mortality due to fir engraver was mapped on 235,958 acres statewide with most of the disturbance on federal forests. The total area affected increased by 96,130 acres from 2006 (Fig. 5) and was likely due to decreased tree vigor induced by the dry conditions in 2006. The dead trees did not dry out and become apparent to aerial surveyors until 2007. (Figures 6 and 7 on next page show the fir engraver beetle and tree mortality caused by the fir engraver beetle).

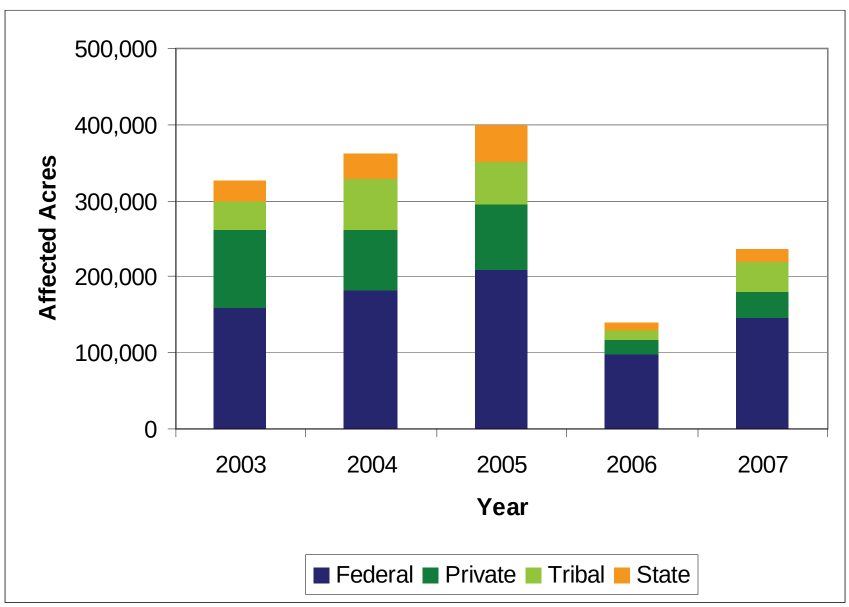


Figure 5. Five year trend for total acres affected by fir engraver beetle in Washington.

Figure 6. Adult fir engraver. *Photo: USDA Forest Service*

Figure 7. Grand fir killed by the fir engraver. *Photo: USDA Forest Service*

## Douglas-fir Beetle *(Dendroctonus pseudotsugae)*

The 78,840 acres of Douglas-fir beetle mortality mapped in 2007 represent the highest levels observed since 2003 (Fig. 8). Most of the new mortality occurred on federal and private forests. Areas with the most extensive Douglas-fir beetle mortality coincided with recent western spruce budworm defoliation. Reduced tree resistance to bark beetle attack has allowed high Douglas-fir beetle populations to develop.

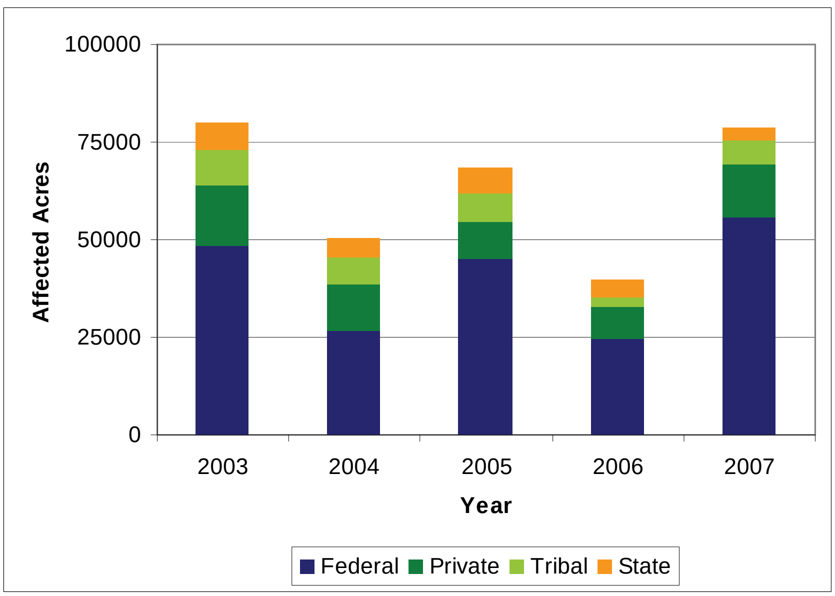


Figure 8. Five year trend for total acres affected by Douglas-fir beetle in Washington.

Figure 9. Adult Douglas-fir beetle. *Photo: USDA Forest Service*

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

Pine bark beetle populations continue at epidemic levels at the landscape level with 255,376 acres of mortality mapped statewide (Fig. 10). Mountain pine beetle continues to kill large numbers of lodgepole pine trees in the North Cascades where there are extensive areas of mature, overstocked forest. A massive mountain pine beetle outbreak is occurring in British Columbia. Furthermore, in the Cascades there was yet another marked increase in activity by mountain pine beetle in whitebark pine with 31,812 acres of mortality mapped, up from the 24,000 acres mapped in 2006.

These trees have been weakened by white pine blister rust for many years, and the current high populations of mountain pine beetle in lodgepole pine combined with warm and droughty conditions have increased the susceptibility of whitebark pine and allowed beetles to flourish.

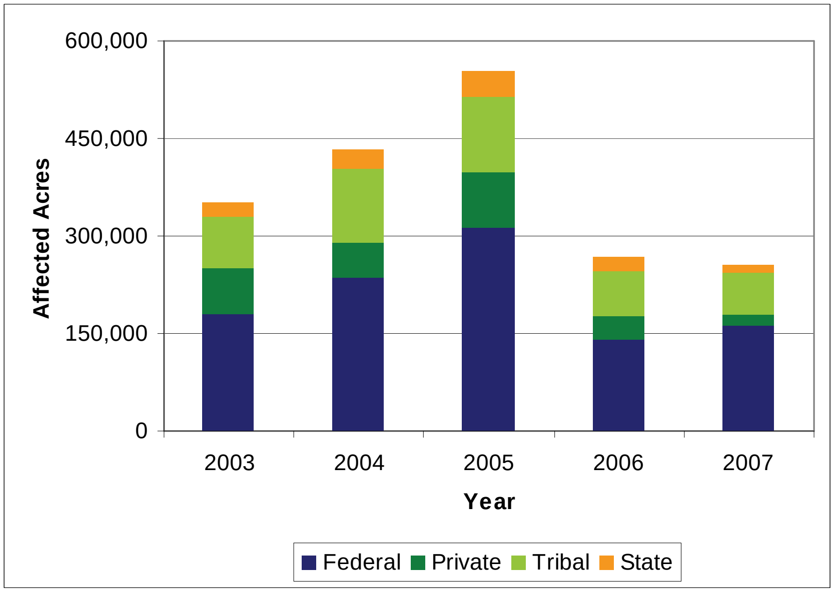


Figure 10. Five year trend for total acres affected by pine bark beetles in Washington.

## Spruce Beetle *(Dendroctonus rufipennis)*

Most of the spruce mortality observed in 2007 was in high elevation forests east of the Cascade crest in Okanogan County. The 30,454 acres of mortality mapped in 2007 was virtually unchanged from the damage observed in 2006 (Fig. 11). Spruce is an important riparian species that becomes susceptible to beetle attacks during periods of drought. Spruce beetle outbreaks may also occur following windthrow events.

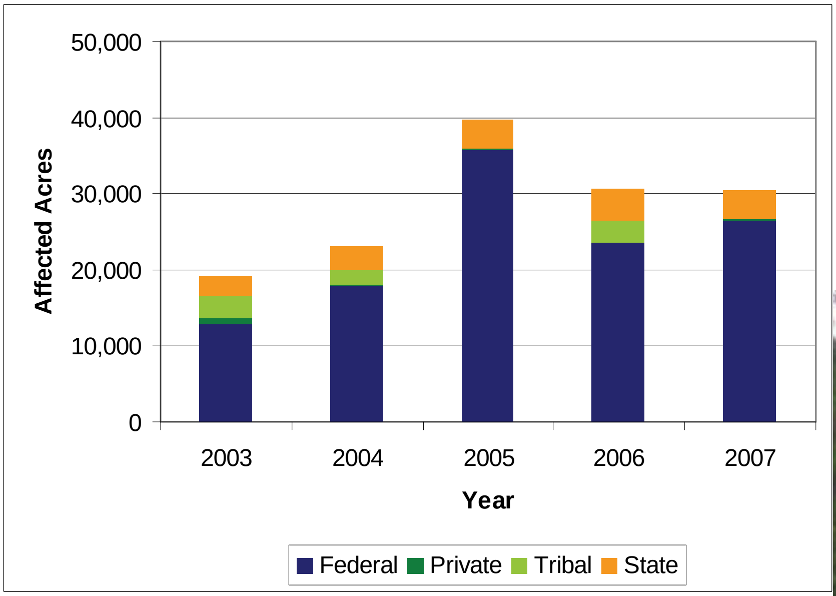


Figure 11. Five year trend for total acres affected by spruce beetles in Washington.

Figure 12. Adult spruce beetle.
*Photo: USDA Forest Service*

Figure 13. Spruce beetle outbreak in eastern Washington.

# Defoliators

## Western Spruce Budworm *(Choristoneura occidentalis)*

Defoliation by western spruce budworm decreased from a recent high of 555,748 acres in 2006 to 355,362 acres in 2007 (Fig. 16). The majority of defoliation (89%) continues to occur on federal forests. Defoliation mapped in 2007 tended to occur in areas where defoliation was mapped in 2006. These areas are located just east of the Cascade crest in Okanogan, Chelan, Kittitas, and Yakima counties. Results from the DNR budworm moth trapping program predict patchy to moderate defoliation in previously affected areas of Okanogan County and moderate to heavy defoliation in previously affected areas of Kittitas County (Fig. 18). Three consecutive years of defoliation in trees may cause topkill. Four or more years may cause mortality. Douglas-fir beetle is active in many areas where repeated defoliation has weakened trees. However, this often goes undetected because the aerial survey identifies recently killed trees with red needles whereas these trees have had their foliage eaten.

Figure 14. Western spruce budworm larvae. *Photos: USDA Forest Service*

Figure 15. Budworm defoliation in eastern Washington.

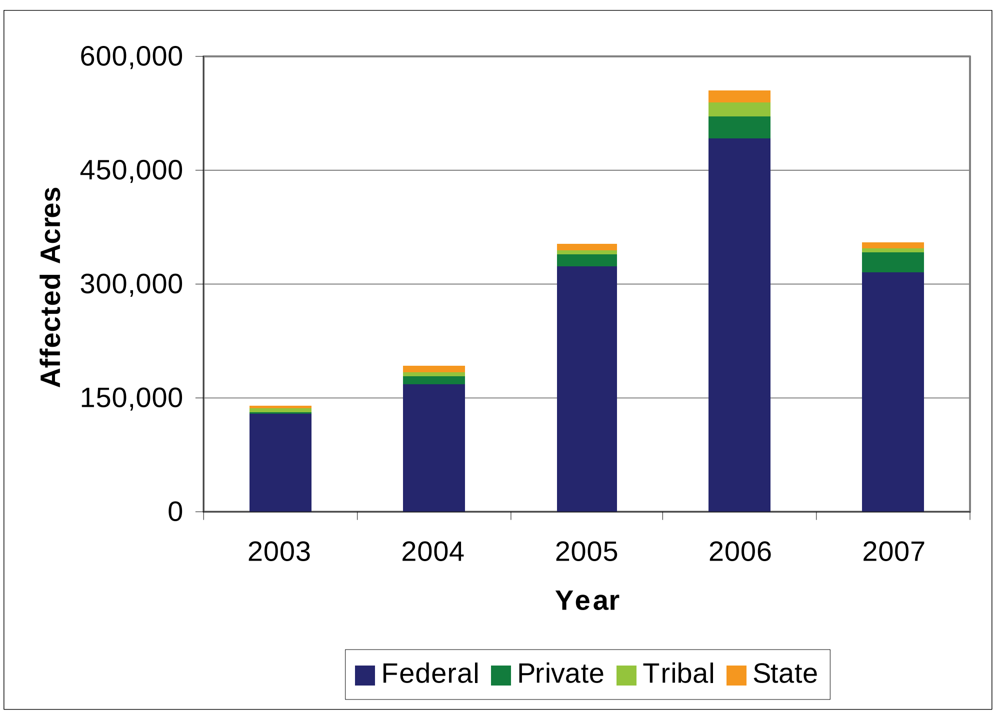


Figure 16. Five year trend for total acres affected by spruce budworm in Washington.

Figure 17. Douglas-fir needles fed on and webbed together by western spruce budworm larvae, turn reddish brown in early July. *Photo: USDA Forest Service*

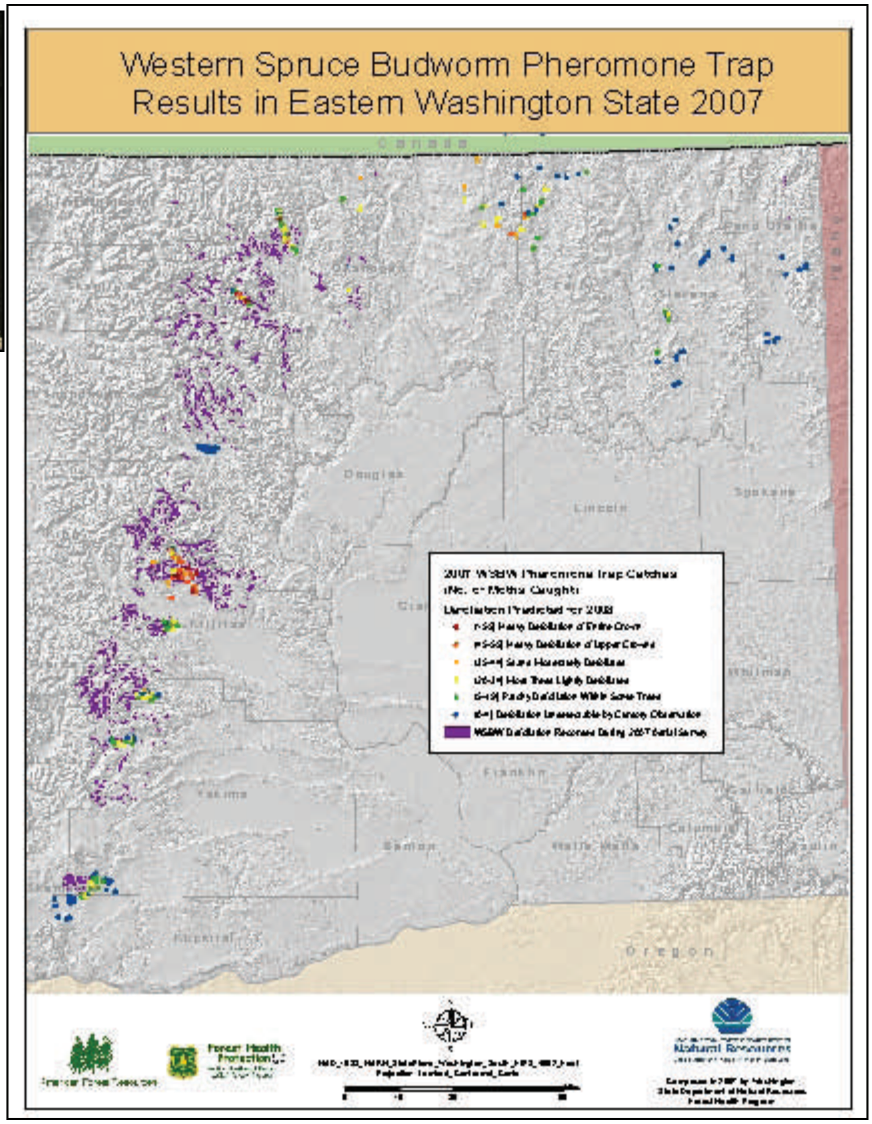


Figure 18. Results from the 2007 budworm trapping project. The map shows 2008 predicted defoliation based on the number of moths caught in 2007. Pheromones are chemical attractants that female moths excrete to attract males. Therefore, only male moths are caught in the traps. Forest Health staff deploy the traps in host trees (Douglas-fir and grand fir) in June-July when the adult moths are seeking mates. In September, the traps are retrieved so the moths can be counted.

Figure 19. Pheromone "delta" trap used to catch spruce budworm moths.

Figure 20. Western spruce budworm moth. *Photo: WSU Extension*

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

The Douglas-fir tussock moth is a native defoliator of Douglas-fir and grand fir, primarily in the dry forests of eastern Washington. It has a cyclical population growth and decline pattern, with high population levels occurring somewhere in its range approximately every nine years. The last major outbreak in Washington occurred in approximately 2000 and 2001 affecting parts of the Blue Mountains, Tekoa Mountain, and Okanogan County. Some tussock moth defoliation was observed in eastern Oregon in 2007, which usually precedes forest defoliation in Washington. Moreover, pheromone trapping occurs annually throughout the western states to predict population changes. Pheromone trapping conducted by DNR and the Forest Service in 2007 indicates rising population levels in Washington. Highest numbers of moths were collected in Okanogan County. Some defoliated ornamental trees near drier parts of NE Washington forests (Tonasket, Davenport, Republic) have been observed, but no defoliated forest areas have been identified at this time. People who observe tussock moth caterpillars, egg masses or defoliation are encouraged to contact the DNR Forest Health Program.

Figure 21. Douglas-fir tussock moth. *Photo: WSU Extension*

### Gypsy Moth *(Lymantria dispar)*

Figure 22. Gypsy moth larva. *Photo: Colorado State University Extension*

The gypsy moth originated in Europe and Asia and is capable of causing serious defoliation to many of Washington's tree and shrub species. It is established in the eastern US. Gypsy moth is frequently accidentally introduced into Washington. The Washington State Department of Agriculture (WSDA) is responsible for vigilant gypsy moth detection and eradication efforts in Washington. In 2007, there were 24 moths caught in pheromone-baited detection traps. Three sites (Wauna, Kitsap County; Kent, King County; and Birch Bay, Whatcom County) had more than one moth per trap, and seven sites had single moths caught. In addition to standard detection trapping efforts, intensive trapping will be implemented at these sites in 2008. No eradication efforts are planned for 2008. More information is available at the WSDA website: http://agr.wa.gov/PlantsInsects/InsectPests/GypsyMoth/default.htm

## Branch and Terminal

### Balsam Woolly Adelgid *(Adelges picaea)* NON-NATIVE

The balsam woolly adelgid (BWA) is an exotic (European-origin) aphid-like insect that feeds on the stems and twigs of trees in the genus Abies. In Washington, BWA has likely been fairly widespread since the 1950's. Subalpine fir, Pacific silver fir, grand fir and noble fir are affected. The most serious effects are extreme reactions to the adelgids' saliva that cause growth deformities, reduced foliage, reduced vigor and tree death.  A link is suspected between BWA-caused weakness and persistent defoliation by western spruce budworm in some parts of the east Cascades.

Figure 23. Swelling (gouting) around buds and branch.

Trees that are being grown outside their native range, or are growing at lower elevation portions of their native range are most susceptible to BWA damage.   Over the long term, susceptible trees will die off and hopefully, the remaining trees will be more tolerant of BWA.  Unfortunately, warmer climate and longer growing seasons are likely to be beneficial to BWA and detrimental to its host trees.

Figure 24. "Wool"-covered females as they appear during summer. *Photo: Ladd Livingston, Idaho*

## White Pine Weevil *(Pissodes strobi)*

The white pine weevil kills the terminal leader of Sitka spruce trees, causing growth losses and mis-shapen trees.  In many cases, damage has been so significant that Sitka spruce has been abandoned as a commercially grown tree species.

Information is increasingly available about the sites and climatic factors that allow weevils to thrive, development of weevil-resistant spruce seedlings, and silvicultural methods to grow spruce that will be less damaged by weevils. Landowners interested in cultivating Sitka spruce should seek more information in order to reduce the risk of damage.

Figure 25. Sitka spruce damaged by weevil attack.  *Photo: Scott Tunnock, USDA Forest Service.*

# Diseases

## Cankers

### Alder Canker (*Neonectria major*)

Stem defects of red alder (*Alnus rubra*) were initially noted in Washington state in 1998 on privately managed timberlands. The symptoms were commonly found on red alder stands in southwest Washington, ranged in severity from spot-like bark lesions to severely canker-caused tree mortality,  and tended to be most associated with trees approximately 13 years old and in stands with basal densities greater than 400 trees per acre.

After further investigation, the fungal pathogen *Neonectria major* was found in association with the cankers on the stems and branches of living and recently killed trees, as well as recently thinned slash. A comprehensive survey of red alder stands in western Washington will be conducted in spring, 2007, in order to further evaluate the incidence and severity of the *Neonectria* cankers.

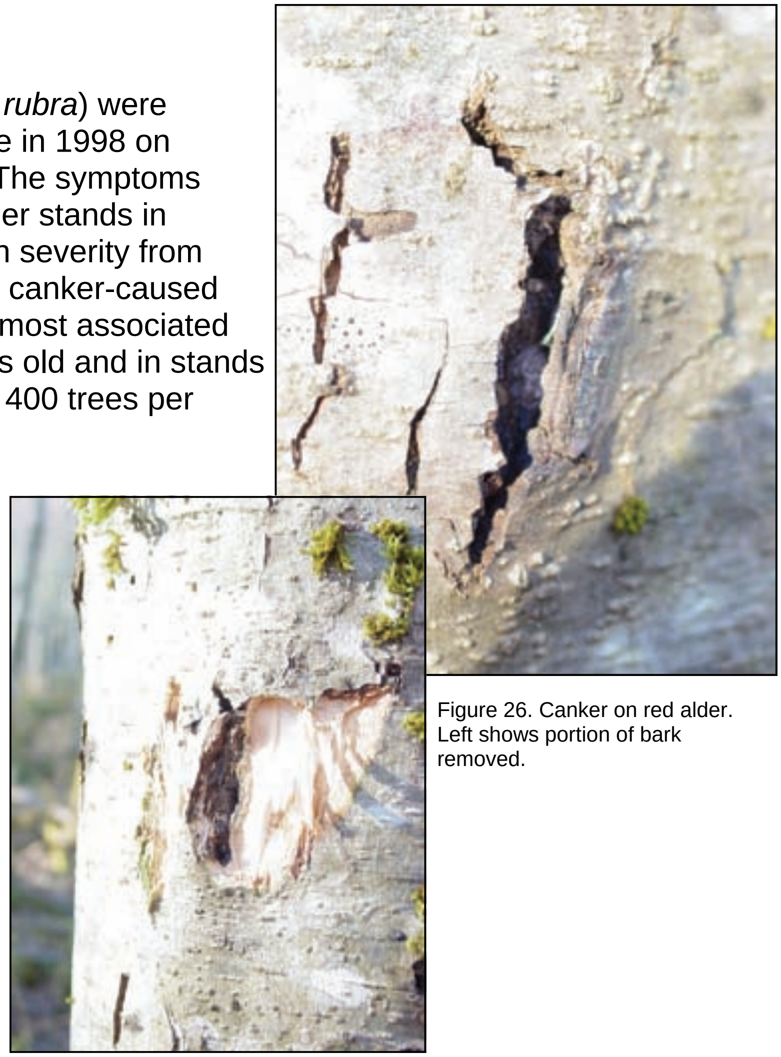

Figure 26. Canker on red alder. Left shows portion of bark removed.

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

Around 1910, *Cronartium ribicola*, the causal organism of white pine blister rust, was introduced into western North America. All five-needle pines are susceptible to this disease, including whitebark pine (*Pinus albicaulis*) and western white pine (*Pinus monticola*) in Washington.  Widespread mortality of both species has and continues to occur.

Whitebark pine populations are typically located at high elevation alpine areas in the

Figure 27. White pine blister rust canker on western white pine.

Cascade Mountains. The species is ecologically important, with the seeds serving as food for a variety of squirrels, rodents, bears and the Clark's nutcracker. The species is slow growing and there are several ecological limitations for successful reproduction. These factors, combined with increased mortality by white pine blister rust and mountain pine beetle attacks, makes whitebark pine a species of concern. The USDA Forest Service continues to actively work with this species in order to conserve its presence on the landscape.

Western white pine was once an integral part of the forest ecosystems of Washington, but populations have significantly declined in Washington due to white pine blister rust. Populations tend to grow in habitats that are much less extreme than the alpine areas of the whitebark pine, usually in mid to low elevation mountains, extending all the way to sea level in some locations. In the last two decades the USDA Forest Service and the University of Idaho have established breeding programs to genetically enhance western white pine for resistance to white pine blister rust. The Washington Department of Natural Resources (DNR) has been outplanting western white pine seedlings, including those genetically enhanced (F2 progeny), on state lands.

Monitoring of 22 sites planted with F2 progeny has revealed that white pine blister rust infection levels are increasing in most areas with tree age. However, the mortality level remains below 2% across all sites. F3 progeny families, which are the 3rd generation of resistance-bred trees, were planted in 2007 across six sites in Washington. These sites will be monitored into the future for the development of white pine blister rust cankers and tree mortality.

## Root Diseases

### Annosus Root and Butt Rot (*Heterobasidion annosum*)

*Heterobasidion annosum* causes root and butt-rot in many tree species growing Washington, but recent research work has focused on western hemlock forests near the Pacific Ocean coast on the Olympic peninsula. The form present in those forests in the "S type", which causes internal wood decay, but is typically not a tree killer. Spores of the fungus infect freshly cut stumps surfaces or fresh basal stem wounds, both of which are created during forest clear-cuts and thinnings. New infections can also occur when uninfected roots come into contact with infected roots.

Figure 28. Western hemlock research stand with Annosus root and butt disease.

264 western hemlock stumps were sampled for *H. annosum* in 2004 and 82.3% of the stumps were infected. Borax is a powder detergent applied to freshly cut stumps in efforts to reduce the number of new *H. annosum* infections. Borax was applied immediately following the sampling in 2004, then the stumps were resurveyed in 2006. Out of the 40 (17.7%) of the stumps not infected in 2004, 75% of those did not have new infections. In summary, Borax was a relatively effective treatment, but due to the high incidence of Annosus in the stand, the potential impact of wind events does cause concern.

The forests near the coast on the Olympic Peninsula are prone to tree blow down when storms and high winds move through the area. High winds can cause stem breakage in trees with *H. annosum* because the internal stem decay column can extend several meters above the level of the ground. High winds can also cause complete tree blow down, root ball and all, because Annosus also can severely decay the roots of trees.

## Armillaria Root Disease (*Armillaria* sp.)

Both conifer and hardwood trees in Washington are susceptible to Armillaria root disease. There are many plant species that can be infected and there are many species of *Armillaria* that can infect. While several species of *Armillaria* are found on the wet, western side of the Cascade Mountains of Washington, these species are generally less aggressive saprophytic decomposers that only kill trees that are under some form of stress. There are also several species of *Armillaria* found on the dry, eastern side of the Cascade Mountains in Washington and *Armillaria ostoyae* tends to be the most virulent and in some cases, does cause tree mortality.

Figure 29. *Armillaria* mushrooms on young Douglas-fir.

### Laminated Root Rot (*Phellinus sulphurascens) (*may also be known as *Phellinus weirii)*

Laminated root rot is the most common root disease in western Washington. It appears to be widespread throughout the range of Douglas-fir. While most conifers are susceptible to laminated root rot, different species are more susceptible than others. Douglas-fir is one of the most susceptible species, while hardwoods can not be infected. Laminated root rot often increases the water stress of a tree and can predispose larger and older trees to Douglas-fir beetle attack.

Laminated root rot infections can cause mortality in trees of all sizes and ages. When infected trees die or are cut, the fungus may live saprophytically for decades in colonized stumps. If seedlings of susceptible species are planted near previously infected stumps, they are very likely to get infected. The disease incidence will likely increase over time if a diseased site is naturally seeded or replanted with Douglas-fir or another susceptible species following a event.

Figure 30. Delamination of wood, characteristic of laminated root rot.

Figure 31. Brown, crust-like fruiting structures on roots of young Douglas-fir.

## Foliar Diseases

### Swiss Needle Cast (*Phaeocrytopus gaeumannii)*

Swiss needle cast affects only Douglas-fir and occurs across the Douglas-fir region where climatic conditions are cool and moist. Trees infected by *P. gaeumannii* may exhibit yellowing and browning of infected previous year's needles shortly after current needles emerge. One- and two-year-old needles are lost in summer with needle loss beginning in the bottom of the crown and progressing upward. Severely infected trees may have only current season's needles left in fall. Close examination of infected needles reveals rows of tiny black fruiting bodies (pseudothecia) in the stomatal openings on the underside of the needles. The individual fruiting bodies are black and spherical (up to 0.1mm or 0.004 in diameter) and heavy infections appear as two black streaks on the underside of the needle along each side of the mid-rib. Fruiting bodies are easily seen with a hand lens.

Surveys in western Washington have been conducted in western Washington since 1999 to monitor the incidence and severity of Swiss needle cast (Figures 32 and 33). The exact reasons for yearly increases and decreases in infection levels remain unclear, but temperature, precipitation and aspect have been shown to influence Swiss needle cast incidence and severity levels. While the Swiss needle cast conditions in coastal Oregon are considered to be at epidemic levels, Douglas-fir on Washington state lands do not appear to be as heavily infected.

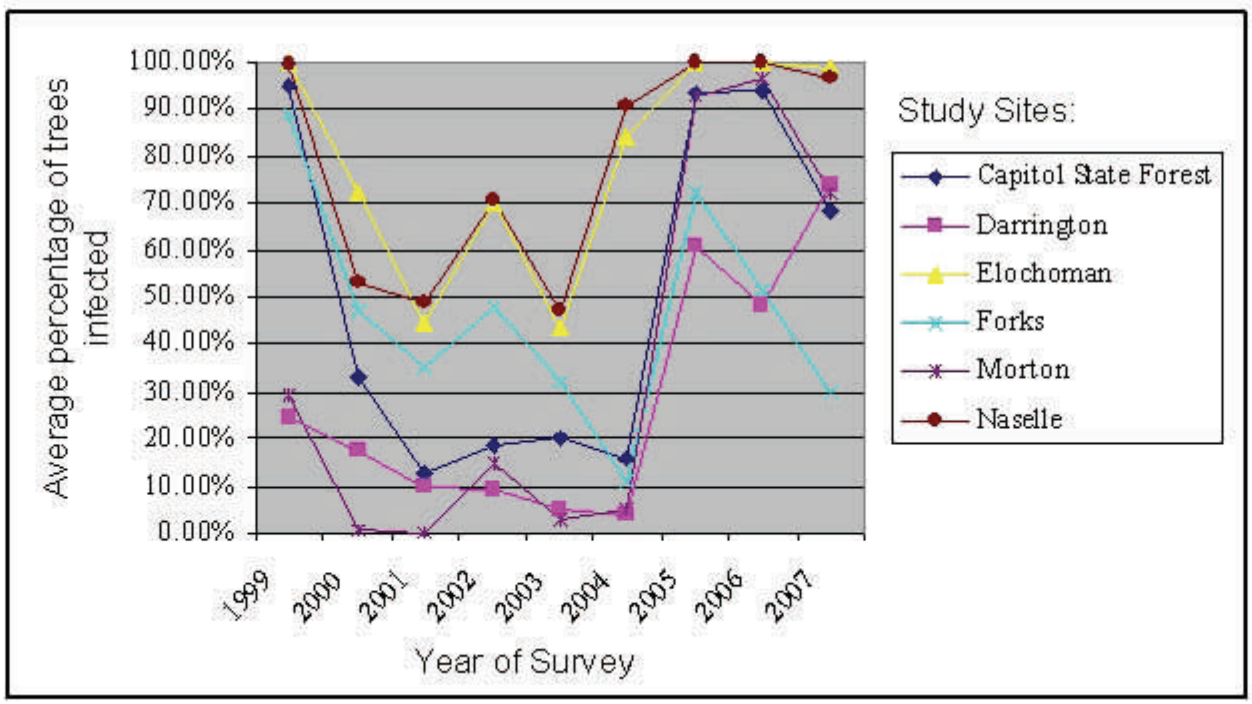


Figure 32. Average percentage of trees infected each year of the Swiss needle cast survey.

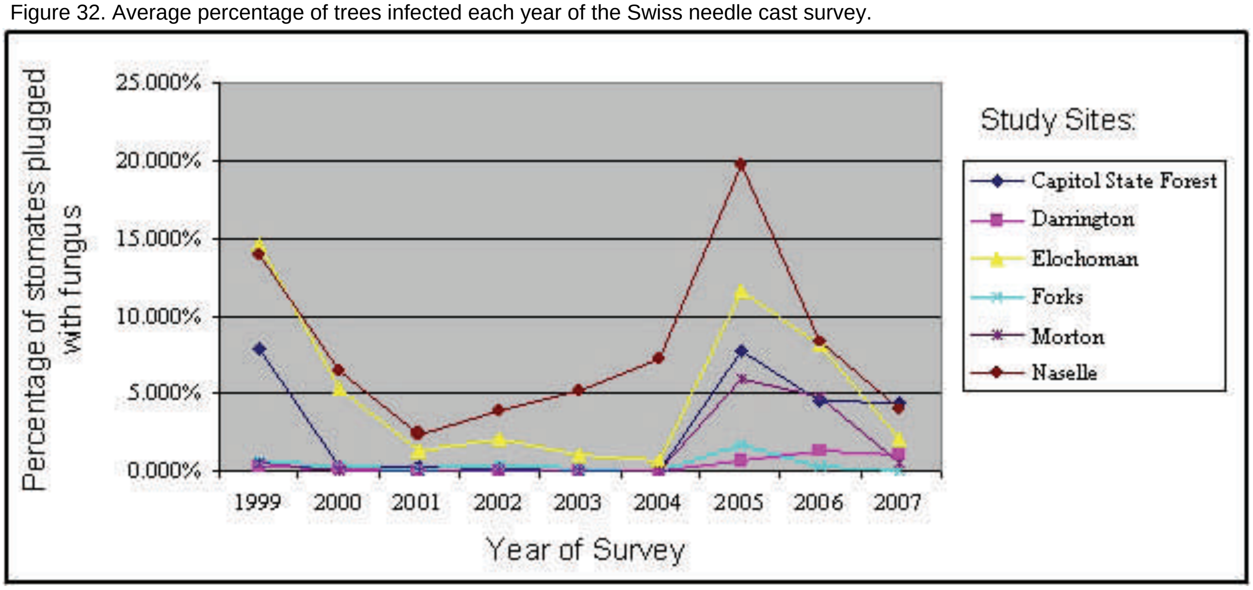


Figure 33. Average percentage of stomata on each needle with perithecia (fruiting bodies).

Growth loss can occur in Douglas-fir that are severely infected with *P. gaeumannii* and economic damage to Douglas-fir growing in plantations and Christmas tree farms may occur. Management strategies include ensuring that local zone and elevation Douglas-fir seeds are used when planting, targeting infected Douglas-fir when conducting thinning operations and harvesting and replanting a species other than Douglas-fir in severely infected areas. Swiss needle cast can be controlled by using a fungicide in Christmas tree farms, however, fungicides are not recommended operationally in forest environments at this time.

## Other Diseases

### Sudden Oak Death (*Phytophthora ramorum*) NON-NATIVE

*Phytophthora ramorum*, the causal agent of Sudden Oak Death (SOD), ramorum leaf blight, and ramorum dieback, is responsible for killing native oak and tanoak trees in California and Oregon. Western Washington is at high risk for SOD 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 positively identified *P. ramorum* host stock. While Washington's native oak species (Oregon White Oak) is not threatened by *P. ramorum*, Pacific madrone, maple, cascara, huckleberry, rhododendron, grand fir, and Douglas-fir are some of the susceptible native hosts.

In 2007, ten aquatic sites in western Washington were established and monitored for the presence of *P. ramorum* (Fig. 34). Aquatic monitoring is the most sensitive test available to date for detecting *P. ramorum* on a landscape scale. One positive sample was detected and subsequently five more stream-baiting sites were established in efforts to detect the originating location of the *P. ramorum* infected material.

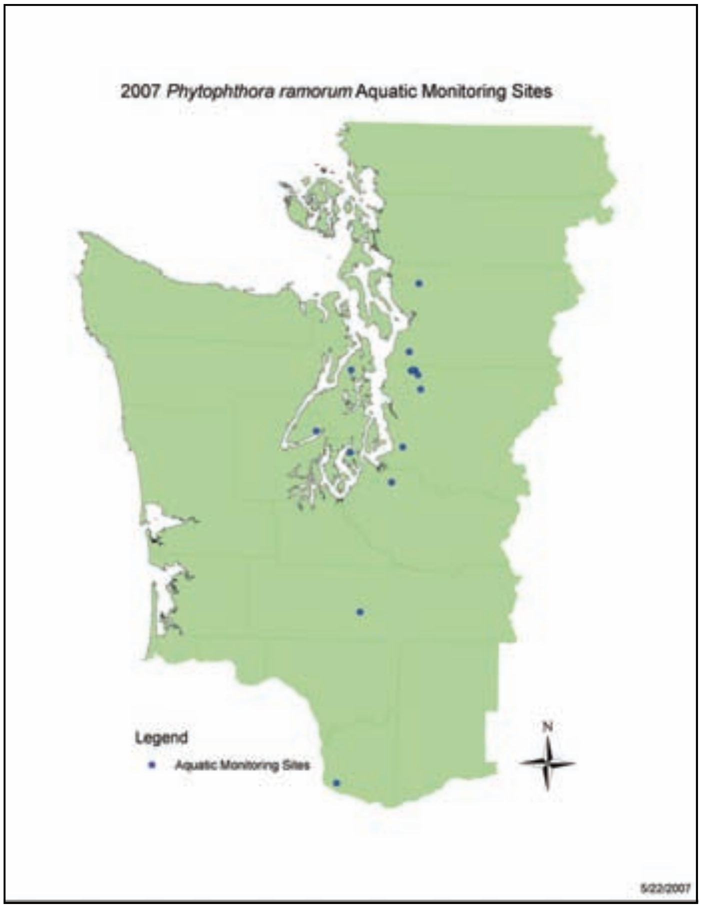

Figure 34. *Phytophthora ramorum* 2007 aquatic monitoring sites.

The Washington Department of Natural Resources continued to monitor streams throughout the summer and into the fall and the Washington Department of Agriculture continued their surveys of vegetation in nurseries and stream-side vegetation. Two more positive *P. ramorum* samples were found in 2007 and early 2008 in the Sammamish River, the same river that the first positive sample was found in. While aquatic monitoring continues, it remains unknown where the *P. ramorum* inoculum is originating from.

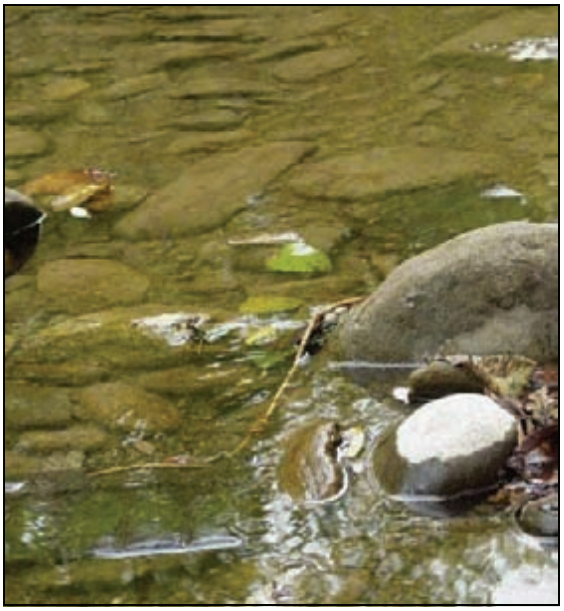

Figure 35. Aquatic monitoring site baiting traps.

## Animals

### Bear Damage *(Ursus americanus)* / Root Disease

Black bears damage trees during the spring by peeling the bark and eating the cambium. Aerial surveyors mapped 183,857 acres with bear mortality in 2007. This represents a decrease from the approximately 235,000 acres mapped in 2005 and 2006 (Fig. 36.) During the aerial survey, we assign groups of scattered, similar, pole-sized, newly dead trees the name “Bear Damage”. Based on ground checking

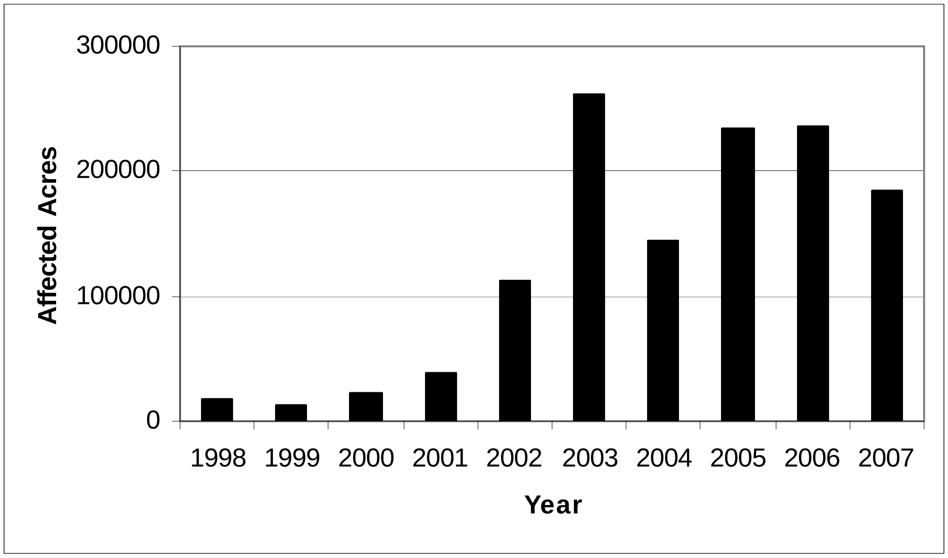


Figure 36. Ten year trend in bear damage in Washington.

observations of over 100 “Bear Damage” polygons in 2004 and an additional 40 polygons in 2005, this code should really be thought of as a complex of bear girdling, root disease, drought stress, and mountain beaver girdling. Bear feeding activity is likely still the primary mortality agent even though most areas checked contained at least some root disease, and sometimes root disease was the sole agent.

Figure 37. Black bears damage trees during the spring by peeling the bark and eating the cambium.

## Aerial Survey

The aerial survey is flown at 90-120 mph about 1,500 feet above ground level. Two observers (one on each side of the plane) look out over a two-mile swath of forestland and mark either on a digital touch screen or a paper map any recently killed or defoliated trees they see. They then record 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. No photos are taken. It is very challenging to accurately identify and record damage observations and errors may occur. Sometimes the wrong pest is identified. Sometimes the mark on the map is off target. Sometimes damage is missed. The goal is to correctly identify and accurately map within ¼ mile of the actual location at least 70% of the time. To support this effort, increasingly helpful background imagery has been obtained for the digital sketchmapping system. Satellite imagery showing recent management activity allows observers to place 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.

## Data and Services

The aerial survey is very cost effective for the amount of data collected. These maps are great tools for a quick look at what might be going on in specific areas. They produce excellent trend information and historical data. You can now download and print out draft survey maps almost as soon as they are flown. Go to:

http://www.fs.fed.us/r6/nr/fid/as/quad07/index.shtml

and click on the map you want to view. For cartographers and GIS users, the aerial survey data sets, plus historical data, trend analysis, and summary statistics are available electronically. This information is available as far back as 1980. The data shapefiles are in ESRI format. For Oregon and Washington together go to:

http://www.fs.fed.us/r6/nr/fid/data.shtml

Additional forestry-related GIS data is available for download at:

http://www.dnr.wa.gov/BusinessPermits/Topics/Data/Pages/gis_data_center.aspx

- aquatic resources
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- habitat
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In addition, our annual forest health highlights reports are available on-line at:

http://www.dnr.wa.gov/ResearchScience/Topics/ForestHealthEcology/Pages/rp_foresthealth.aspx

This site will be updated annually with the latest information on exotic pest problems, insect and disease outbreaks and recent trend information for Washington. Major insect and disease identification and management information, damage illustrations, and graphical trend analysis of Washington's various forest health issues are also included.

A new publication "Field Guide to Diseases and Insect Pests of Oregon and Washington Conifers" (Goheen & Willhite), produced by the US Forest Service Northwest Region, is now available. It is an excellent reference, and you can purchase a copy by calling toll free at (866) 720-6382. You can also order the book online at:

http://bookstore.gpo.gov

Find the book here by searching on title or stock number (001-000-04731-1)

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