2005 WASHINGTON FOREST HEALTH HIGHLIGHTS
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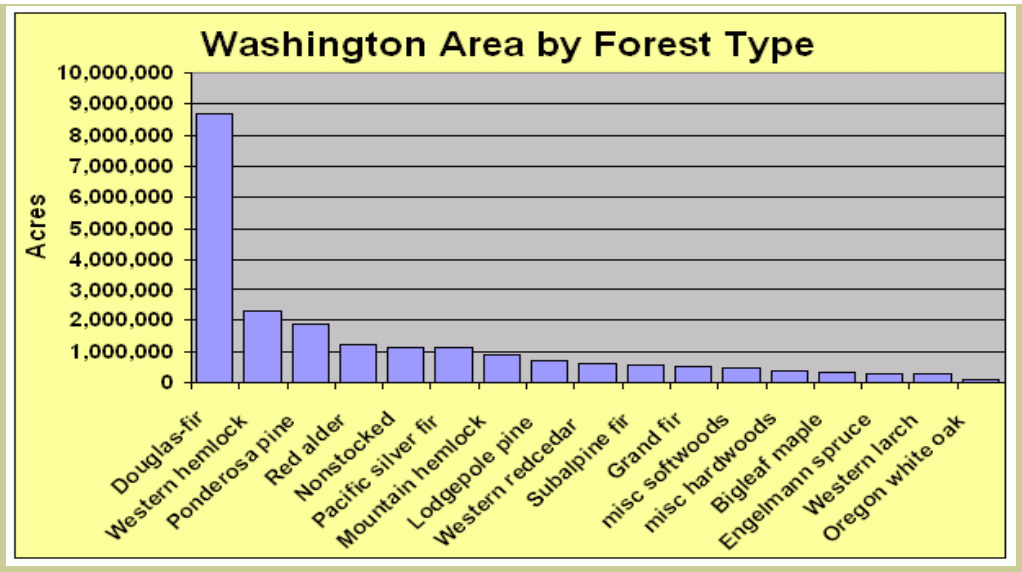
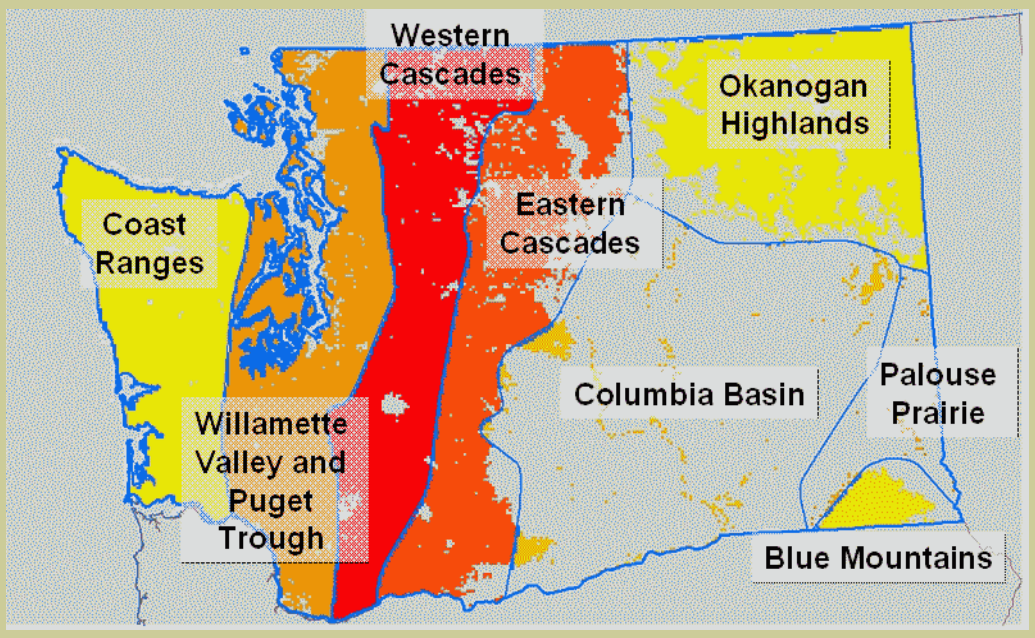
General Forest Conditions

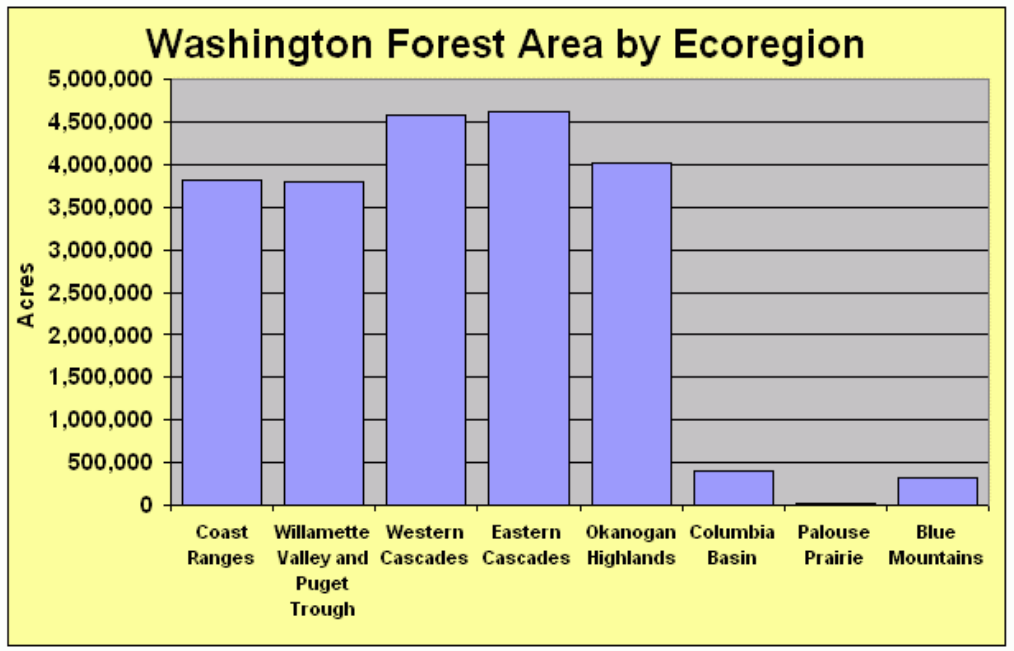
The USDA Forest Service Forest Inventory and Analysis (FIA) program measures and monitors Washington's forests for current forest condition, growth, and trends. They remeasure a portion of a statewide grid of permanent plots annually. They also analyze remotely sensed data such as aerial photographs.

FIA information indicates that Washington has approximately 22 million acres of forest land which are mostly dominated by conifer species such as Douglas-fir, western hemlock and ponderosa pine. Red alder, bigleaf maple and cottonwood are the most prevalent broadleaf species. Forests are classified by "forest type" named for the dominant tree on the site.

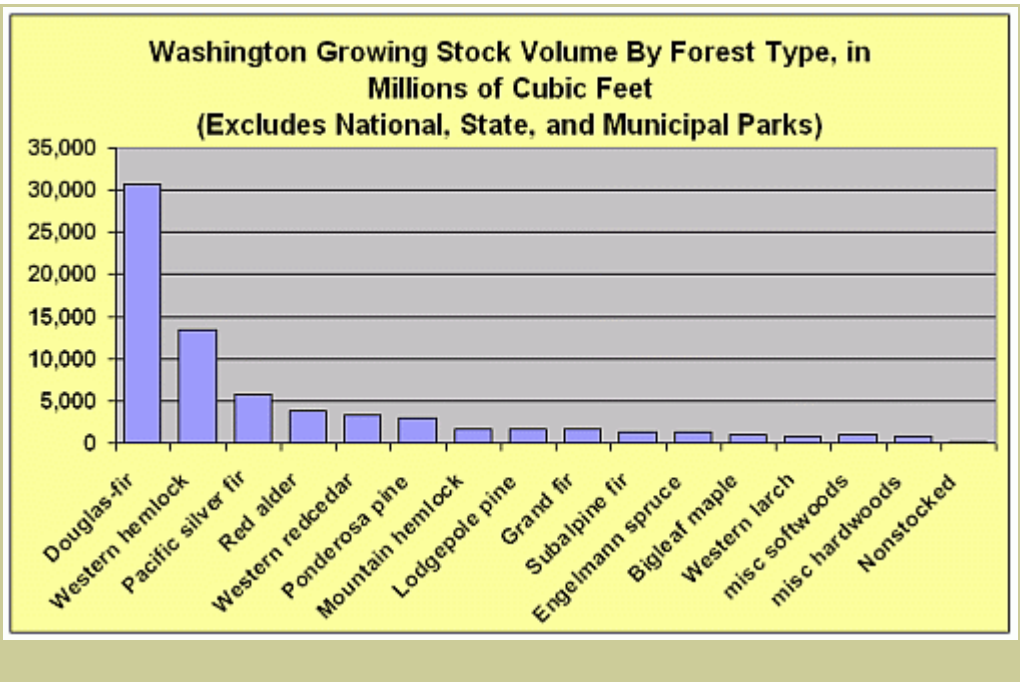


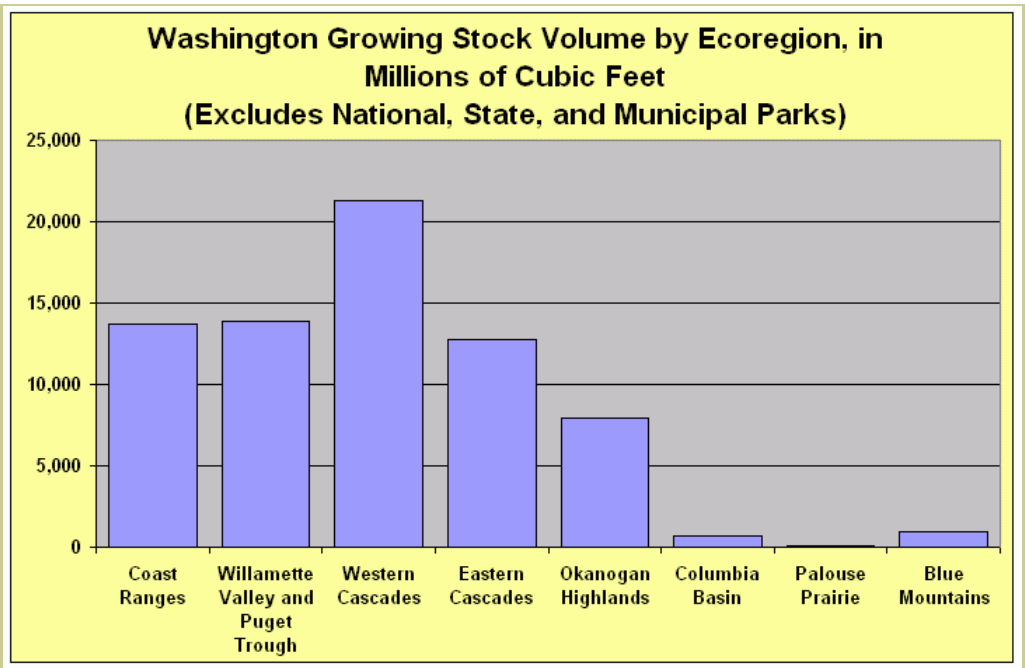
Map of Washington's Eco-Regions





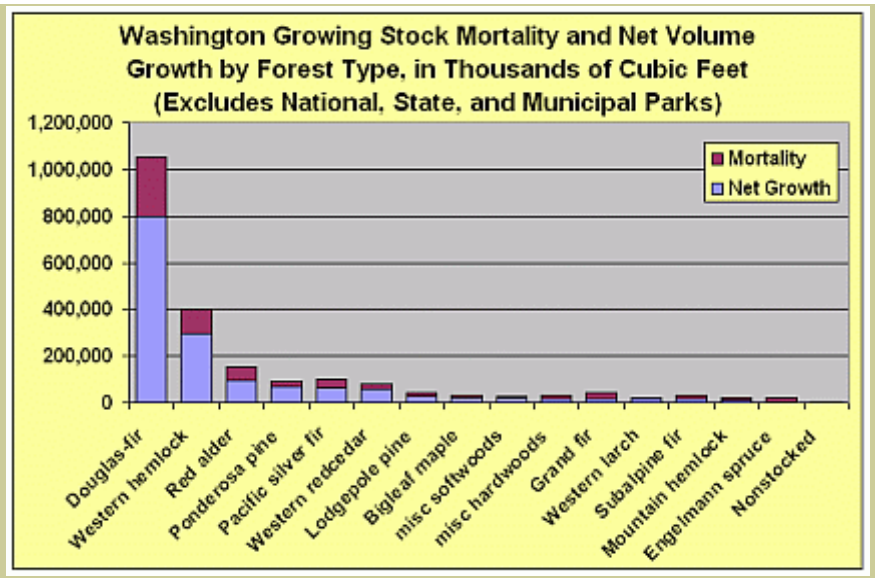
In addition to the number of acres covered, forests are also measured by the volume of wood present. A "cubic foot" of wood represents a piece of wood that is one foot tall, one foot wide, and one foot thick. For example, an eight-inch diameter log that is ten feet long contains about 3.5 cubic feet of wood.

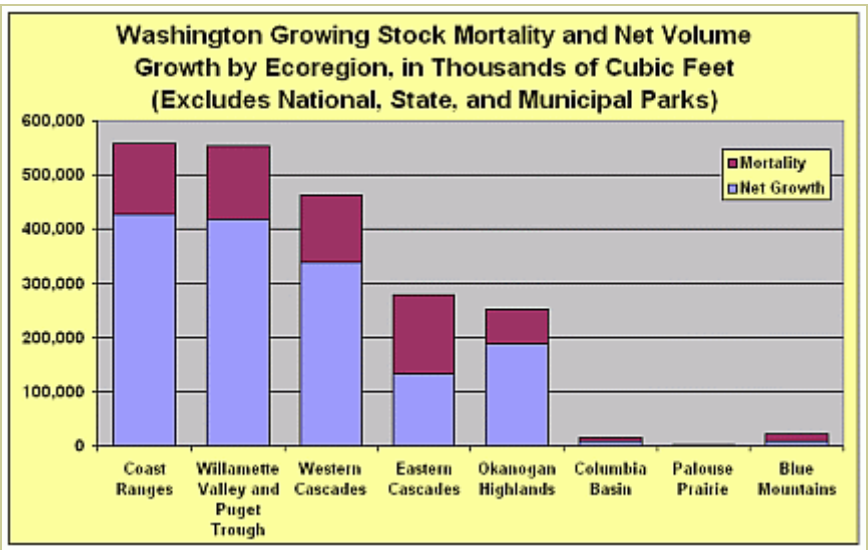




The live trees in Washington's forests total approximately 72,256 million cubic feet of wood. Sixty percent of this wood is Douglas-fir (29,514 million cubic feet, 40.8%) and western hemlock (13,904 cubic feet, 19.2%). The major eastern Washington conifers are ponderosa pine, grand fir and western larch. The relatively dry eastern Washington forests contain much less wood because they have fewer, smaller trees and cover less land area.

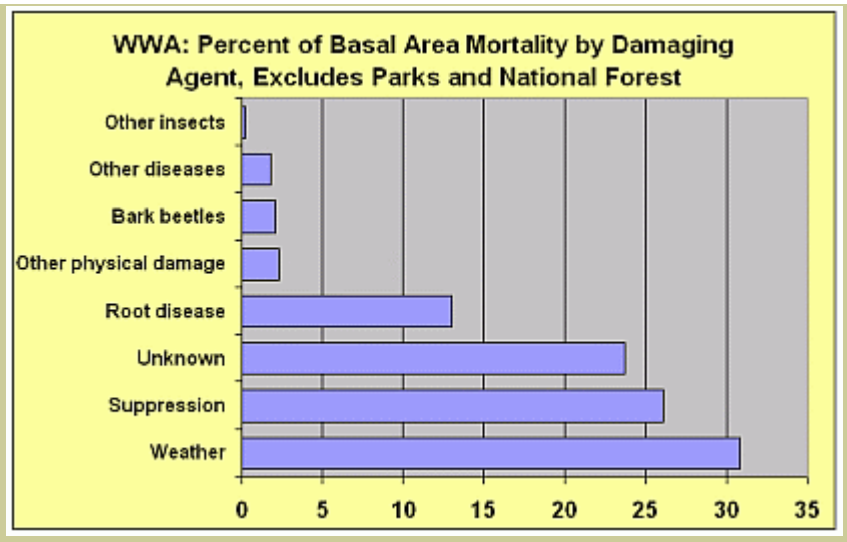
Forest Mortality: As most forest trees continue to grow, a few also die. The ratio of mortality (death) to growth provides information on whether forests are increasing or decreasing in different ways. If growth is greater than mortality then this ratio is greater than one and the forest volume is increasing. If growth equals mortality then this ratio equals one, and the forest volume is unchanged. If mortality is greater than growth then this ratio is less than one, more trees are dying and the forest live volume is decreasing.

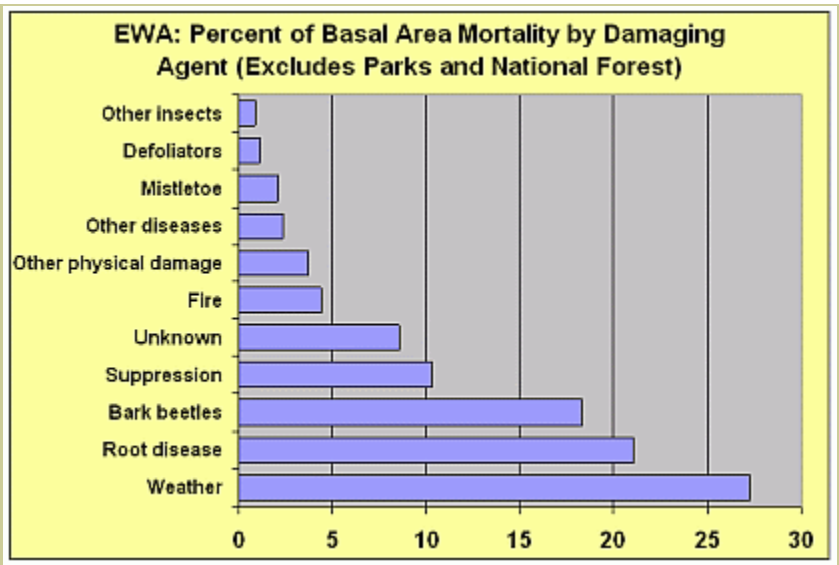




FIA data indicate that some forest types are increasing in volume and some are declining. The average ratio of mortality to net growth in Washington, outside national, state, and municipal parks is 2.68, indicating that growth is more than twice as large as mortality. In Douglas-fir, western hemlock, western redcedar and bigleaf maple forests, growth is about four times mortality. Lodgepole pine, grand fir and mountain hemlock forests have growth that is about equal to mortality. Mortality exceeds growth in Engelmann spruce and subalpine fir forests.

In addition to those removed by logging and land clearing, trees are also killed by insects, diseases, fire, wind and a variety of other agents. In western Washington, when the cause of death could be determined, it was most often attributed to physical damage or fire, weather damage, and root disease. In eastern Washington trees were most often killed by physical damage or fire, bark beetles, and root disease.





Land Conversion: Changing forest land to non-forest uses such as urbanization is of great concern in Washington. Recent FIA measurements provide the following conversion estimates. They indicate that forest land conversion rates were higher in the 1990's than the 1980's and that private timberland is being converted at a higher rate than public lands.

Conversion Estimates	1980-1990	1990-2001
Percent of private timberland converted to nonforest:	2.83	3.28
Percent of non-National Forest converted to nonforest:	1.87	2.12
Percent of all forestland converted to nonforest:	1.19	1.33

Laws and policies limit the sale or reduction of the state and federal forest land base so the number of publicly owned forested acres tends to remain fairly constant. Some categories of forest land are adjusted when general forest is shifted to preserved status, but the forest condition itself persists.

In Washington, there have been major changes in the pattern of private forest land ownership in recent years as large timber companies have sold large tracts of land to small private landowners. This can result in a loss of forest land to roads and development, reduced timber production, wildlife habitat fragmentation, and increased cost for landowner services such as road maintenance and fire protection. Small privately owned forest lands are considered most at risk of conversion to non-forest uses such as development because of their proximity to existing urban areas, popularity of woodland home sites, and diversity of owner objectives. Additional information will be available as the patterns are measured in future years.

For more information:
http://www.treesearch.fs.fed.us/pubs/9865

2005 Survey Results

Washington has about 21 million acres of forestland. In 2005, over 2.5 million acres of this land contained elevated levels of tree mortality, tree defoliation or foliar diseases. This is a substantial increase from previous years. In 2004 and 2003, approximately 1.9 million acres were mapped each year.

- In 2005, over 7.3 million trees were recorded as recently killed. This is up remarkably from almost 3.8 million trees recorded in 2004, about 3.0 million trees in 2003 and over 1.8 million trees in

2002. Eastern Washington has higher levels of insect and disease activity than western Washington. Many eastern Washington forest health problems relate to overcrowded forests that are dominated by late successional conifer species.

- Western spruce budworm activity increased dramatically along the eastern slopes of the Cascades, most notably in Chelan and Okanogan counties.
- Mountain pine beetle outbreaks continue along the eastern slopes of the Cascades and populations continue to rise throughout Northeastern Washington.
- Recent bear-killed and root disease-killed trees were identified on approximately 233,000 acres, primarily in western Washington in 2005. Root disease is a highly persistent fungus problem that kills trees and slows growth. Recent Forest Service surveys have detected root disease on about 19% of forest sample points in the western Cascades and 15% of forest stands in the eastern Cascades ecoregions.
- Sudden Oak Death (SOD, *Phytophthora ramorum*) is an exotic plant disease with the potential to kill susceptible hosts. It has already resulted in quarantines of nursery products, timber products and Christmas trees. Although SOD has been detected in horticultural nurseries in Washington, DNR Forest Health program's ground and water surveys indicate that SOD is not present in general forests.

Aerial Survey Overview

The Washington Department of Natural Resources and USDA Forest Service strive to help landowners identify and manage forest insect and disease problems.

An annual, aerial sketch mapping survey is key to monitoring forest insect and disease activity levels across the state. The survey is flown at 90-130 mph, about 1,500 feet above ground level. In recent years we have incorporated a new digital system utilizing GPS linkup with touch screens for recording damage. We have been consistently incorporating newer and better satellite imagery as well.

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 on a paper map, groups of recently killed or defoliated trees.

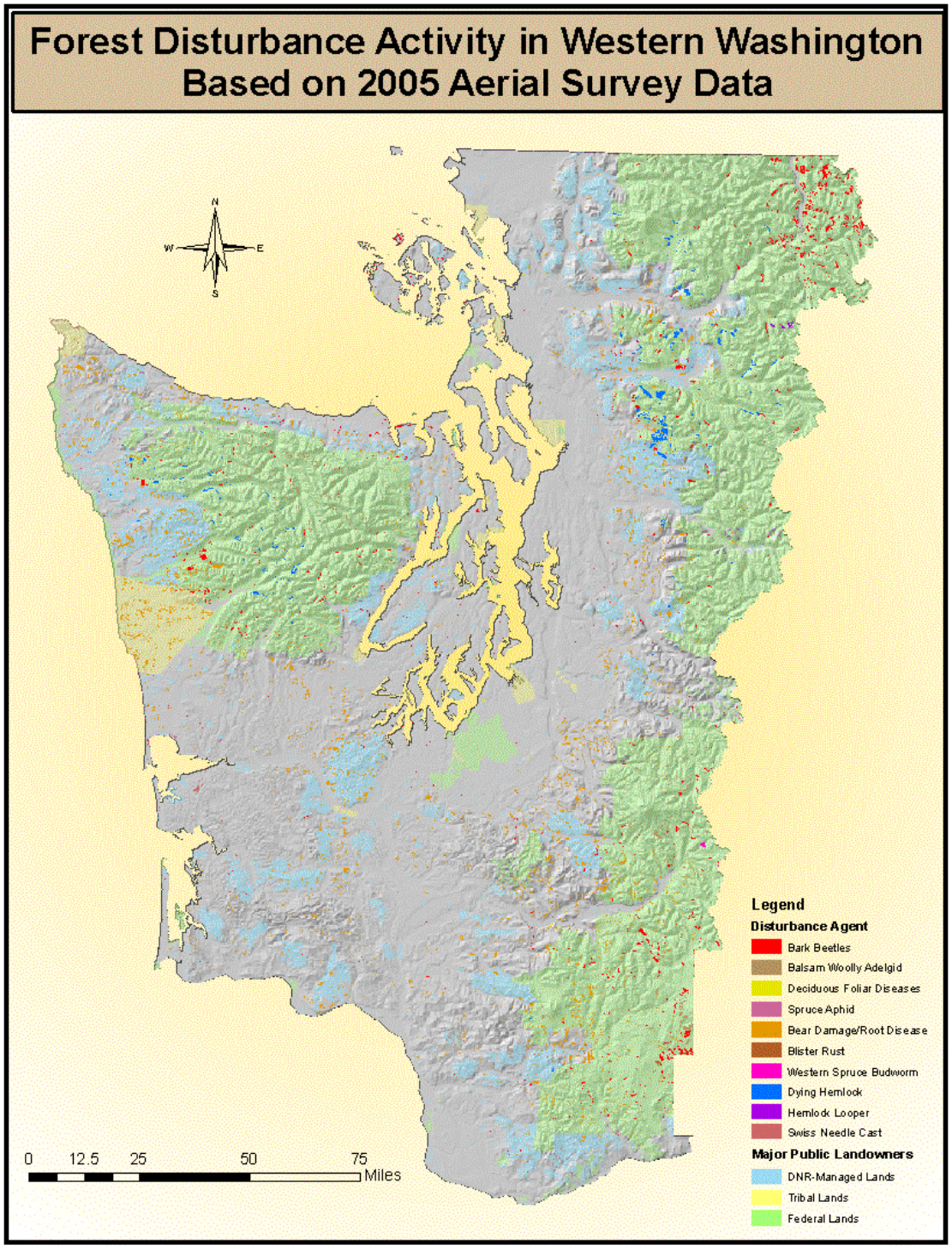
They then record a code for the agent that likely caused the damage (usually inferred from the size and species of trees and the pattern or “signature” of the damage) and the number of trees affected. Not every tree on affected acres is dead or damaged. No photos are taken.

The results are then made available to interested landowners as maps, electronic data, and summary reports. Covering nearly all of Washington’s forests with the aerial survey costs only about 1/3 of a cent per acre (that’s three acres for a penny!).

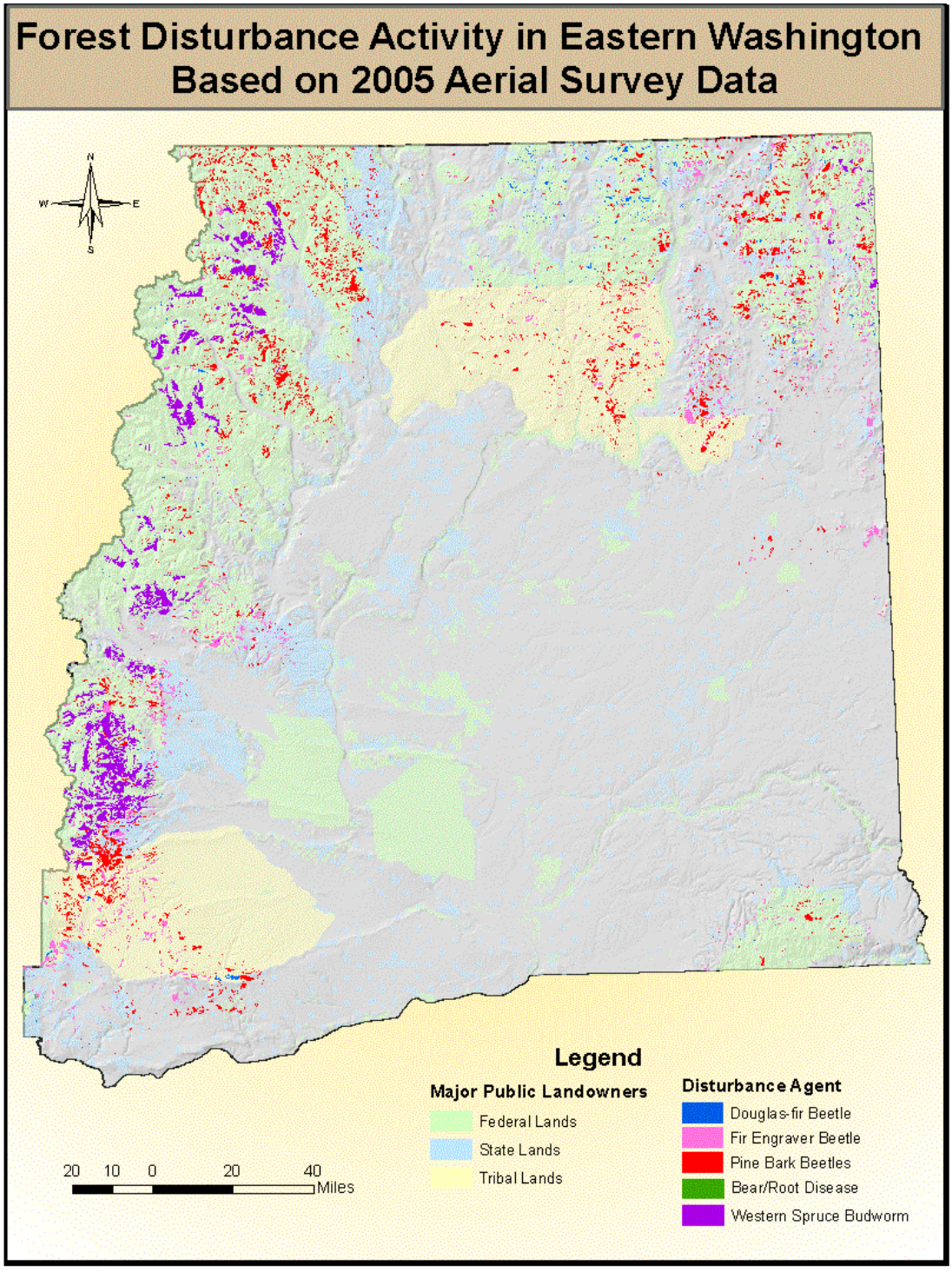
Here is the breakdown of the acres flown during the survey in 2005:

- Washington fed = 7,968,493
- Washington other fed. = 1,520,149
- Washington tribal = 1,570,955
- Washington State = 2,128,965
- Washington Private = 7,015,755
- Washington total = 20,204,317

These maps and reports produce excellent trend information and historical data. Moreover, they represent a great tool for a quick look at what could be going on in your neck of the woods.



Survey maps are now available almost as soon as they are flown! Just go to http://www.fs.fed.us/r6/nr/fid/as/quad05/index.shtml and click on the map you want to view. These pages can take one to several minutes (depending on your connection speed) to load because they are memory intensive. From there you can plot out the entire map or you can zoom in and view an area of particular interest. To print just the scene showing on your computer screen, press Alt+Print Screen, open up a graphics friendly program such as Paint or Word, paste it in and print it on a field-handy sheet of paper. This resource can provide timely information for pest evaluations and forest management work.



For cartographers or GIS users, this data set is available for employees of the Department of Natural Resources via our Citrix Quick Data Loader under Forest Disturbance.

Historical data going back to 1980 are also available on request.

Some Speculation

Several key factors will influence forest susceptibility to insects and diseases:

- Mild winter temperatures enhance insect pest overwintering success.

- Droughty summer conditions stress host trees and make them more susceptible to pathogens.
- Outbreak populations of insect pests already occur throughout much of Eastern Washington.
- Stand stocking levels need to in balance with site conditions.
- Tree species composition should favor drought tolerant pine and larch rather than Douglas-fir and true fir.

Predicted forest disturbance trends:

- Populations of bark beetles have been on the rise throughout Eastern Washington and this will continue.
- Populations of the Western spruce budworm are rising throughout much of the Eastern slopes of the Cascades.
- Incidence and severity of root disease increases in drought years.
- Populations of the Douglas-fir tussock moth will likely remain low statewide for at least the next two to three years.

Disclaimer

Aerial observers are familiar with forest trees, insects and diseases. They are trained to recognize various pest signatures. There is always at least one observer in the plane who has three or more years of sketch mapping experience. However, it is very challenging to quickly and accurately identify and record damage observations. Aerial survey does not allow much time for second-guessing or second chances. 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. Ground checking and landowner feedback generally indicate excellent success at detecting major occurrences of insect and disease activity. Please provide us feedback if you encounter errors or have problems obtaining the maps or data.

Diseases

Sudden Oak Death (SOD)
Phytophthora ramorum

***Phytophthora ramorum* (*P. 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.**

Phytophthora ramorum was found in 25 western Washington nurseries in 2004 and 16 nurseries in 2005. This organism was brought to the Washington nurseries on plants (mostly camellia, rhododendron, pieris, and viburnum) shipped from other states. The infected plants within the nurseries were destroyed to prevent further spread of the organism. However, much remains unknown about *P. ramorum*, including whether or not it can be transported to new locations in ways other than the shipping and receiving of infected plant stock.

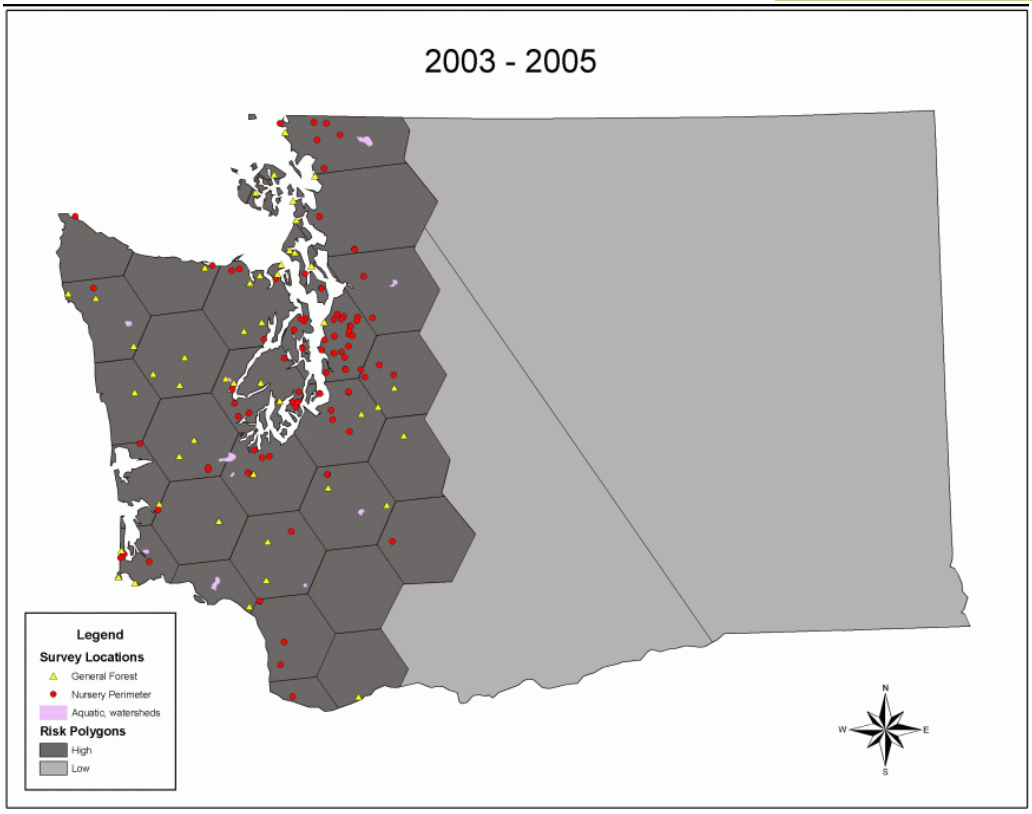
As more is learned about *P. ramorum*, the list of hosts susceptible to the disease continues to grow. Sudden Oak Death suggests that the disease primarily affects oak trees, however, our only native oak species, Oregon white oak, is not highly susceptible. Native plant species in Washington that are hosts of *P. ramorum* include:

- rhododendron
- big leaf maple
- vine maple
- Douglas-fir
- grand fir
- Pacific yew
- cascara
- evergreen huckleberry
- Pacific madrone
- Manzanita
- Woods' rose
- maidenhair fern
- salmonberry
- poison oak
- Oregon ash
- pink honeysuckle
- false Solomon's seal
- California hazelnut
- American cranberry
- California wood fern

For a complete host list go to:
http://www.aphis.usda.gov/plant_health/

For SOD Photos go to:
http://www.wadnr.gov:81/htdocs/rp/forhealth2005highhlights/sodhostphotos.pdf

Shoot die-back on Douglas-fir caused by *Phytophthora ramorum* on Douglas-fir in California. Notice how it looks much like frost damage.



Surveys were conducted in 2003, 2004, and 2005 to try and detect *P. ramorum* in western Washington. Susceptible and potential host plant materials were examined around the perimeters of nurseries, in state parks, national forests, and general forested areas. Aquatic monitoring plots were also established to try and detect *P. ramorum*.

Since 2003, 94 nursery perimeters, 55 general forest, and ten aquatic areas have been surveyed. A total of 728 susceptible and potential host plant material samples were collected and sent to the Washington State Department of Agriculture's plant pathology laboratory for analysis. All samples have tested negative for *P. ramorum*, suggesting it has not spread beyond nursery perimeters or northward from Oregon.

For additional information go to this website:

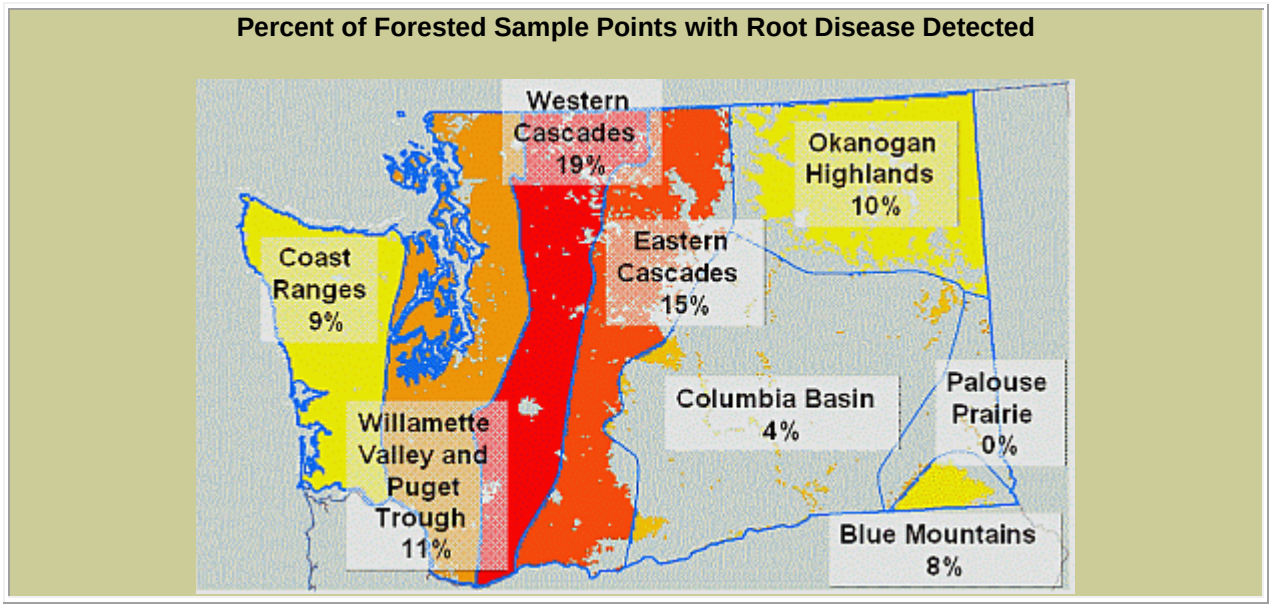
http://www.fs.fed.us/r6/nr/fid/widweb/wid-rd.shtml#rd-7

Root Disease

Root diseases, caused by fungi that eat the roots of living trees, are an important forest health problem in Washington. They kill trees, slow tree growth and can persist to infect new trees until decaying roots and stumps rot away. Often, affected trees tend to blow over before they die. The most important root diseases in Washington are laminated root rot (*Phellinus weirii*), Armillaria root disease (*Armillaria ostoyae*), and Annosum Root and Butt Rot (*Heterobasidion annosum*).

Root diseases can be difficult to identify because they are underground or inside the tree's tissues. Damage can develop over a long period of time, mimicking other causal agents such as drought or other types of root injury. In 2004, a DNR ground survey of sites with scattered dead trees attributed in the aerial survey to "Bear Damage" revealed that 46% actually had root disease as the primary tree killer.

In a variety of recent comprehensive forest inventory plots, the USDA Forest Service Forest Inventory and Analysis group detected root disease on approximately 13% of forested sample points statewide.



In this image:

- Gray areas are not forested.
- Within National Forests, all forestland was sampled using a 50' search radius between 1993 and 1997.
- Outside National Forests, root disease sampling was done in 2000 and 2001 and excluded national, state, and municipal parks.
- Outside National Forests, root disease sampling used a 55.8' search radius west of the Cascade crest and a 32.8' search radius east of the Cascade crest.

For more information: go to: http://www.fs.fed.us/r6/nr/fid/pubsweb/rootdiseases.shtml

Dwarf Mistletoe (*Arceuthobium spp.)*

Dwarf mistletoes are parasitic plants that grow on Washington conifer trees. They slow tree growth, cause conspicuous growth deformities called witches brooms, and can kill trees. Some birds and animals use dwarf mistletoe plants and seeds for food or nest in the brooms. Dwarf mistletoe plants spread by emitting seeds that fall onto other hosts or are incidentally carried from tree to tree by birds and small mammals. The infections are slow to develop, but are very persistent. Aerial survey does not detect dwarf mistletoe infections or impacts. In recent years a variety of USDA Forest Service Forest Inventory and Analysis (FIA) projects have used ground surveys to assess dwarf mistletoe infection levels.

Eastern Washington has several dwarf mistletoe species that are quite host specific. Western dwarf mistletoe (*Arceuthobium campylopodum*) infects ponderosa and lodgepole pine. Lodgepole pine dwarf mistletoe (*Arceuthobium americanum*) infects only lodgepole pine. Douglas-fir dwarf mistletoe (*Arceuthobium douglasii*) infects only Douglas-fir. Larch dwarf mistletoe (*Arceuthobium laricis*) infects western larch, subalpine fir and several other conifers.

This young ponderosa pine is so infected with dwarf mistletoe that it will likely not live long

Notice the dwarf mistletoe induced witches brooms on this mature hemlock

There is just one species of dwarf mistletoe in western Washington, the hemlock dwarf mistletoe (*Arceuthobium tsugense*) which infects western and mountain hemlock; Pacific silver, subalpine and noble firs; coastal lodgepole, western white and whitebark pine.

FIA data indicate that approximately 26% of the western hemlock basal area in the Coast Range is dwarf mistletoe infected, 22% of the western hemlock basal area in the Western Cascade Ecoregion is infected, and 17 % of the western hemlock basal area in the Puget Trough is infected. On state and private forest

lands, these may be lower than historic levels because much of the oldest hemlock where dwarf mistletoe infections would have been well-established has been harvested.

FIA has identified very high levels of dwarf mistletoe infection in Douglas-fir, ponderosa pine, and western larch in the Columbia Basin Ecoregion where approximately 30 to 40% of the basal area of these species are infected. High infection levels are also observed in the Eastern Cascades Ecoregion where approximately 20-28% of the basal area of western larch, lodgepole pine and Douglas-fir are dwarf mistletoe infected. In eastern Washington forests, dwarf mistletoes are likely much more prevalent than was historically normal because of selective harvesting practices that left mistletoe infected trees on the landscape and because of the reduction in low severity fires that naturally kept trees less crowded and killed highly flammable dwarf mistletoe infected trees.

For more information: http://www.fs.fed.us/r6/nr/fid/widweb/wid-mt.shtml

Swiss Needle Cast (SNC)
Phaeocryptopus gaumanni (Rohde) Petrak

Swiss needle cast is a fungus with small fruiting bodies that in large quantities looks like soot on the underside of Douglas-fir needles. In severe cases, the needles become chlorotic (yellow) and fall off prematurely. This slows the growth of the tree and gives it a sparse appearance.

Swiss needle cast was found along the coastal areas of Washington again this year, but in the last few seasons, the disease has not seemed to be as severe as in previous years. Additionally, in Oregon where the SNC problem is more widespread and severe, the Oregon Department of Forestry has found no significant difference in incidence or severity over the past few years and have found an overall decrease since the mid 1990's.

Several factors influence the potential severity of Swiss needle cast for any given site. These include:

- Proximity to the coast
- South facing slopes
- Valley bottoms

Swiss needle cast causes yellowing and early needle drop. Notice the absence of older interior needles and the chlorotic appearance of new foliage on these young saplings near Mount Pilchuck.

In areas at risk of high levels of SNC, it is crucial to select local tree sources and to diversify forest plantations with alternate species such as western hemlock, western redcedar, Sitka spruce or red alder.

For additional information go to: hhtp://www.fs.fed.us/r6/nr/fid/mgmtnote/swissnc.pdf

White Pine Blister Rust (WPBR)
Cronartium ribicola (J. C. Fisch.)

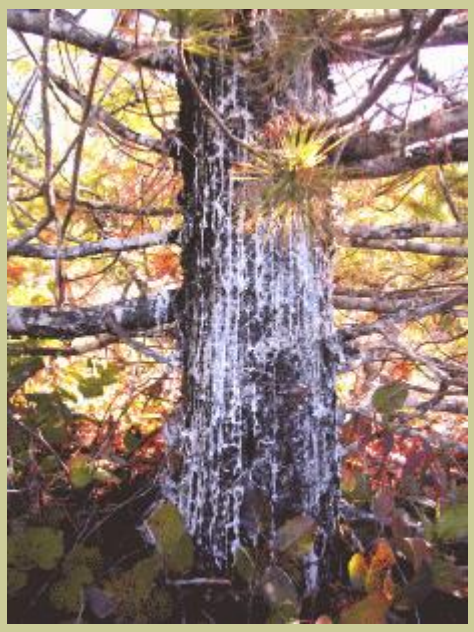
White pine blister rust is the most destructive disease of 5-needle (white) pines in North America. Since its introduction into Washington in the early 1900's, it has caused widespread mortality throughout the range of its hosts. White pine blister rust infects all 5-needle pines, including

western white pine and whitebark pine, and requires an alternate host such as currants (Ribes spp.) or Indian paintbrush.

White pine blister rust causes cankers on branches and main stems of infected pines. Cankers on smooth-barked trees will often have a rough center surrounded by a diamond-shaped orange lesion of infected bark. On older trees with rough bark, the leading edge of infection is not apparent. Older cankers are rough and blistered in appearance.

Girdling cankers are often resinous. Main stem cankers eventually result in top kill or whole tree mortality.

Branch flagging (dead branches with red needles) is the most obvious symptom of white pine blister rust. It is caused by girdling cankers that kill branches rapidly.



This exotic disease has already depleted western white pine across much of its range. The surviving widely scattered western white pines are still dying, but are not well recorded by aerial survey because they often do not meet the threshold of groups of five or more recently killed trees.

Recent surveys of the western white pine resource in Washington revealed infection levels of up to 100% in some geographical regions. The Washington DNR is currently studying WPBR in juvenile white pine (less than 5 years old) with increased genetic resistance to WPBR.

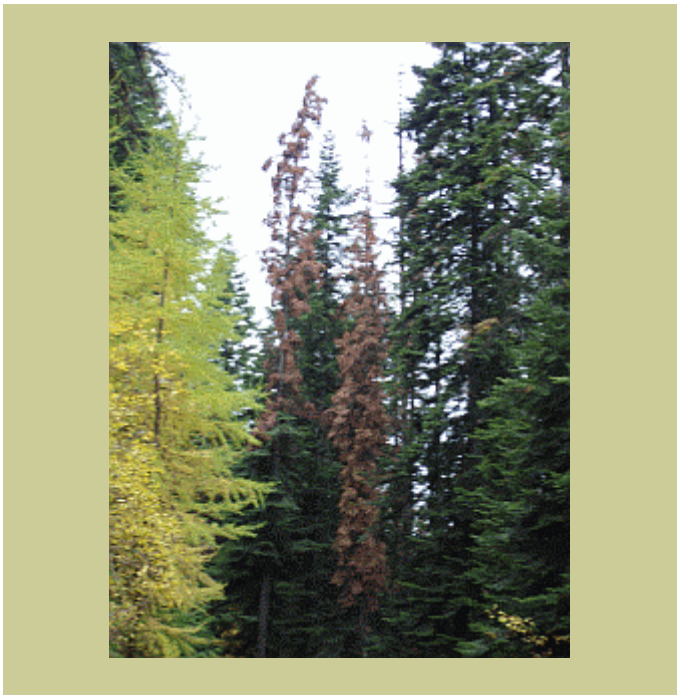
Washington's other five-needle susceptible host whitebark pine, grows in high elevation alpine areas. These trees provide a critical role in watershed protection and wildlife habitat. White pine blister rust has been slower to spread into these areas, but widespread infection is now occurring. Drought and blister rust have weakened whitebark pine to the point that mountain pine beetle is causing widespread mortality.

For additional information go to: http://www.fs.fed.us/r6/dorena/rust/

Insects

Fir Engraver Beetle
Scolytus ventralis (LeConte)

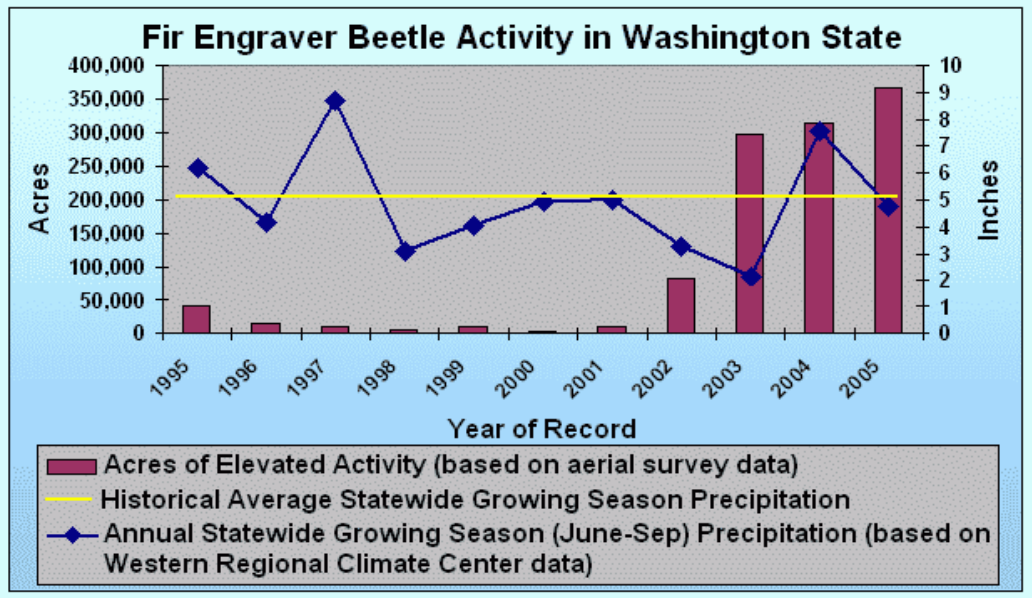
Fir engraver beetle is a native bark beetle that attacks and kills, or strip kills, weakened true fir trees. “True firs” are tree species in the genus “Abies”. Scattered true fir mortality was mapped throughout Eastern Washington again this year. Droughty conditions likely precipitated and exacerbated this event. Most of the affected trees were in the understory, but larger trees were also affected. True fir mortality will likely increase where western spruce budworm is active.



Over 368,000 acres with scattered true fir mortality were mapped throughout Eastern Washington in 2005 up from 313,000 in 2004, almost 300,000 acres in 2003, 82,750 acres in 2002 and almost none in years prior.

For additional information go to: http://www.fs.fed.us/r6/rogue/swofidsc/beetles/firengraver.html

Historical Activity and Drought Correlation



Pine Bark Beetles

Mountain Pine Beetle
***Dendroctonus ponderosae* (Hopkins)**

Western Pine Beetle
***Dendroctonus brevicomis* (LeConte =*barberi* Hopkins)**

Pine Engraver Beetles
Ips species

Pine bark beetle populations continue at epidemic levels with more than 554,000 acres with elevated mortality mapped in 2005. This is a continuation of gradual increases over the last several years with 430,000 acres mapped in 2004 and 330,000 acres in 2003. Mortality increases are most pronounced in Northeastern Washington. Lodgepole pine, whitebark pine and ponderosa pine are all affected.

This outbreak is being fueled from a combination of droughty summer conditions, large beetle populations, and expansive areas of suitable host, mild winter temperatures and susceptible forest conditions.

Mountain pine beetle continues to kill lodgepole pine even up to its western extent in the North Cascades. Areas around Ross Lake, within the North Cascades National Park, were again heavily affected.

This view is from west of Oroville, looking into British Columbia.

Furthermore, in the Cascades there were increasing levels of mountain pine beetle activity in whitebark pine with over 38,000 acres with elevated mortality mapped in 2005, up from almost 7,000 acres in 2004, 30,000 acres in 2003, 1,700 acres in 2002 and almost none in years prior. These trees have been weakened by white pine blister rust for many years. Current droughty conditions, high populations of mountain pine beetle in nearby lodgepole pine and mild winter temperatures have increased the susceptibility of whitebark pine to mountain pine beetle.

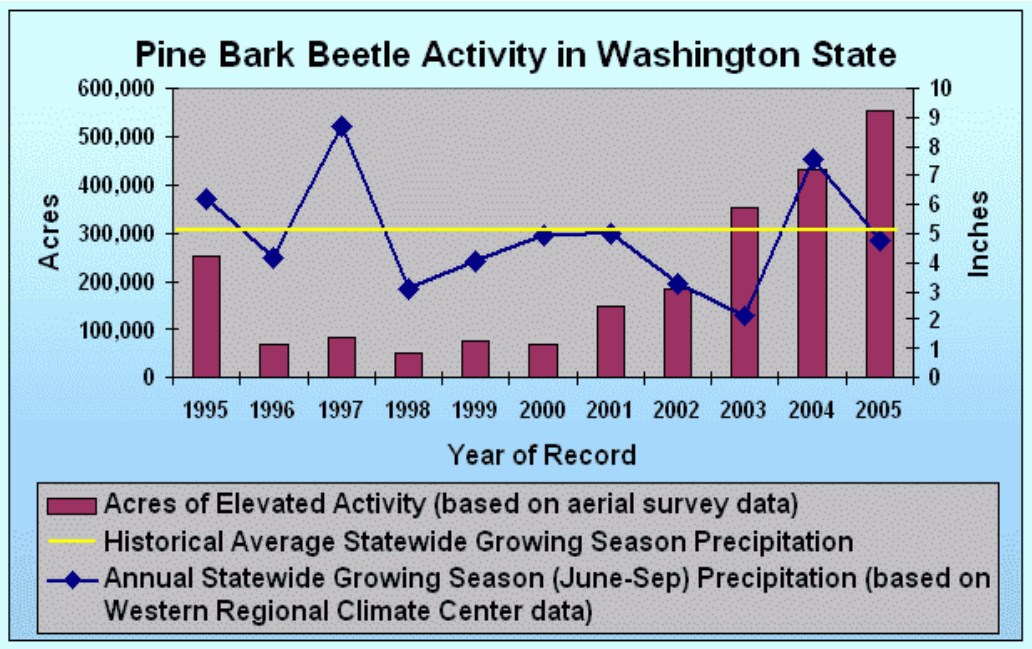
Extensive areas of scattered overstory ponderosa pine mortality were again mapped north and west of Spokane at lower intensities than in previous years. These beetles tend to be killing overcrowded or otherwise weakened trees.

High Ips beetle populations are associated with events (fires, snow breakage) and activities (thinning) that create large amounts of slash. Several beetle species may be involved in the tree killing. The affected trees are often small and crowded, and therefore it is rare to identify Ips damage in aerial surveys. Still, over 17,000 acres with mortality were recorded in 2005.

Mountain pine beetle activity in northeastern Washington showed a pronounced increase in activity and this trend is likely to continue.

For additional information go to: http://www.ext.colostate.edu/pubs/insect/05528.html

Historical Activity in WA correlated with Drought Correlation



Citrus Long-horned Beetle (CLB)
Anoplophora chinensis

The Citrus Long-horned beetle is a wood-boring insect native to Asia where it is a major pest. It is a close relative of the Asian Long-horned beetle (ALB), which is having a huge impact in New York, Chicago, Jersey City, Toronto and a newly discovered separate infestation in Carteret, New Jersey.

The Citrus-longhorned Beetle was found in two different locations in Washington in 2001. In Tukwila, where some beetles were actually seen escaping into the surrounding greenbelt, a massive tree removal, inspection, quarantine program was initiated.

More than 20,000 trees were again inspected in 2005 for signs of the woodboring pest with completely negative results!

An adult CLB. Notice the speckled pattern on its back vs. the banded pattern of our native banded alder borer, which only attacks weakened and dead trees.

Monitoring efforts and other precautions are still ongoing as part of a five year monitoring commitment. If this wood-boring pest were to become established here with no natural controls such as predators, parasites or diseases, many hardwood trees such as bigleaf maple, cottonwood, ash and horse chestnut would be damaged.

Western Spruce Budworm (WSBW)
Choristoneura occidentalis (Freeman)

Western spruce budworm activity increased in 2005 throughout the east side of the Cascades. Activity began just north of the Yakama Nation lands and was recorded sporadically almost to the Canadian border. Many of these areas, although isolated, exhibited severe defoliation. There was also a small area of ongoing activity in Pend Oreille County along the Idaho border.

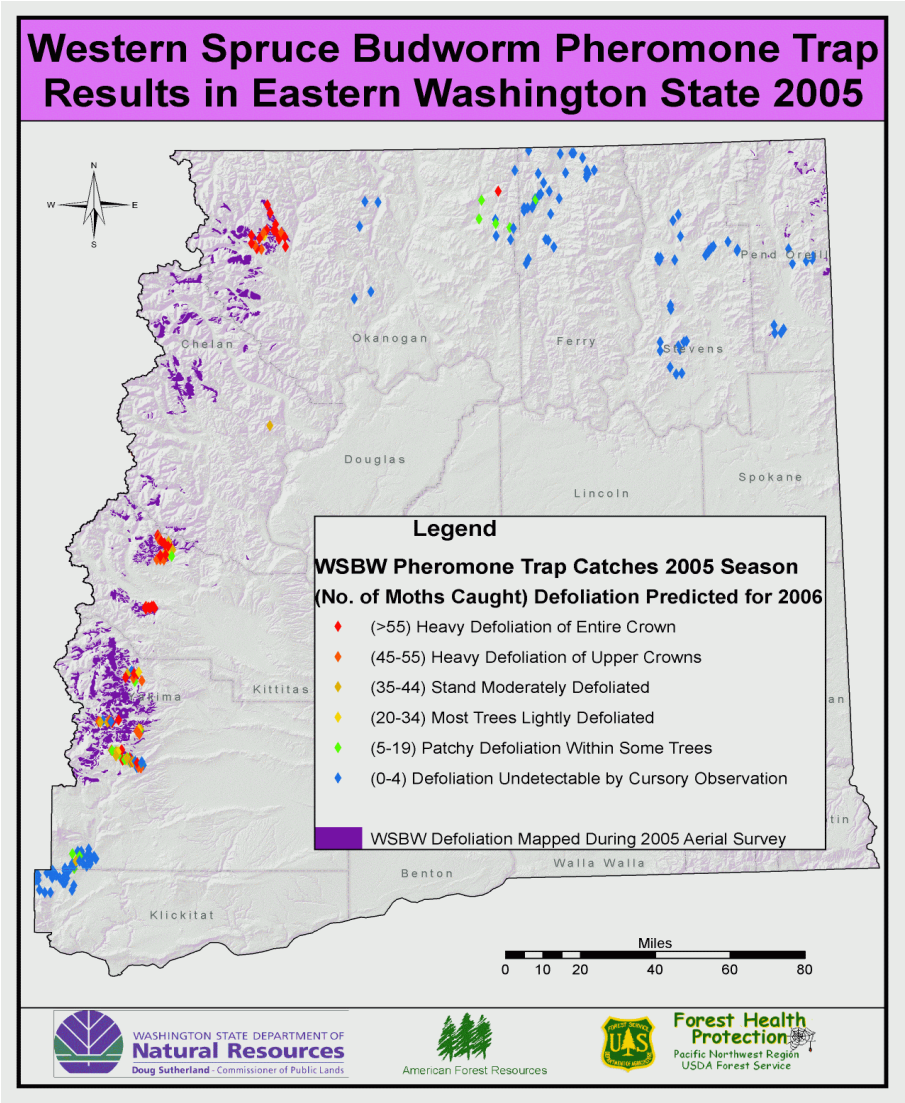
Douglas-fir beetle is active in many areas where repeated defoliation has weakened trees. Areas around Bumping Lake and Rimrock Lake showed continued severe defoliation with large amounts of mortality. Bark beetle activity often goes undetected in areas of repeated heavy defoliation since these trees are denuded of foliage and die without being readily visible to aerial observers.

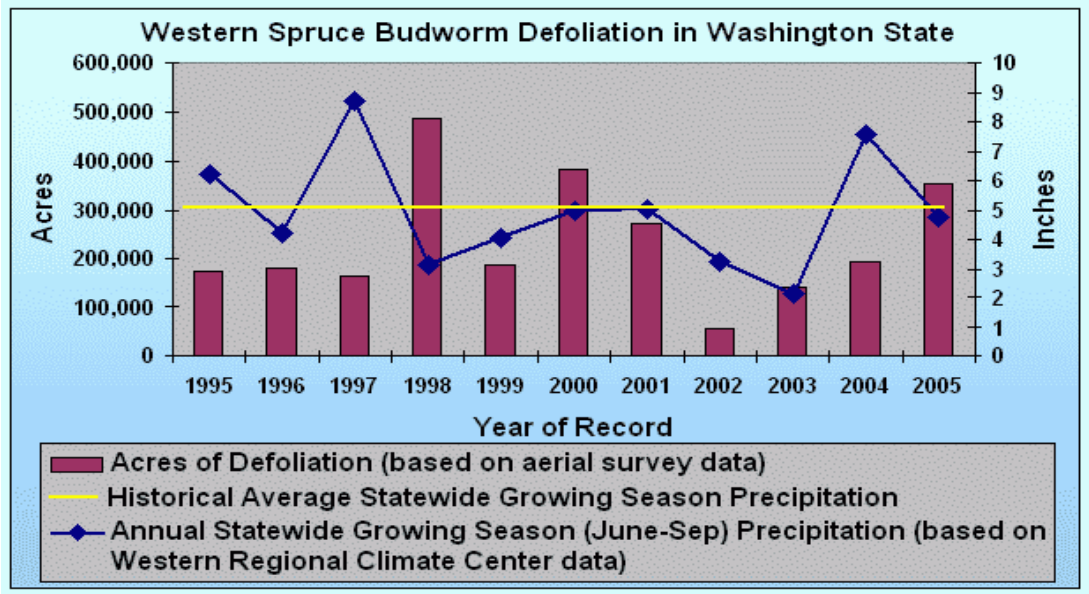
Additional areas of light defoliation were likely present but not mapped because it is very difficult to detect lightly defoliated trees from the air.

The DNR and other cooperators have used pheromone traps in recent years to predict defoliation activity for the coming season. In 2005, this system was expanded to include areas further north and east. This system predicts continued heavy defoliation in many areas of the East Cascades, but the far South and most of Northeastern Washington will not be affected by significant budworm defoliation in 2006.

The total number of affected acres mapped in Washington over the last several years are:

- 1999: 189,700
- 2000: 383,000
- 2001: 236,000
- 2002: 56,567
- 2003: 138,797
- 2004: 193,191
- **2005: 352,000**





Historical Activity and Drought Correlation

For Additional Information go to:
http://www.forestry.ubc.ca/fetch21/FRST308/lab5/choristoneura_occidentalis/budworm.html

Douglas-fir Beetle
Dendroctonus pseudotsugae (Hopkins)

Outbreaks of Douglas-fir beetle have been ongoing for the last several years. Defoliated, overstocked, drought-stressed, mature trees allow populations of beetles to persist.

Almost 69,000 acres with elevated Douglas-fir mortality were mapped in 2005. This is up from the 50,000 acres recorded in 2004, but down slightly from the 74,000 acres mapped in 2003. In previous years, damage was mostly concentrated in the northeastern corner of the state, but in 2005, it was more widespread and widely scattered throughout many areas of Eastern Washington. Western Washington experienced a few small isolated areas of activity.

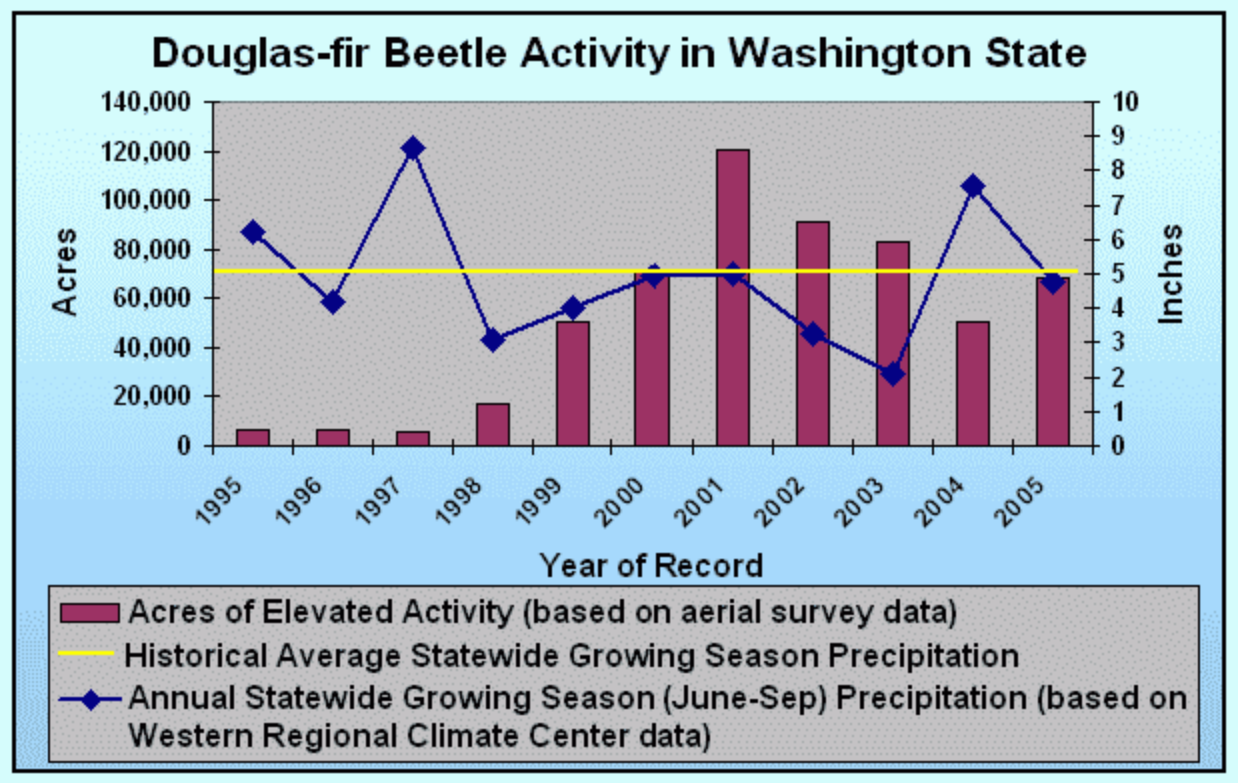
The Douglas-fir bark beetle outbreak in northeastern Washington has mostly subsided, but not without the loss of significant numbers of mature trees. Tree damage from the ice storm of 1996-1997, followed by prolonged summer droughty conditions and additional storm damage in 2001 maintained this outbreak for several years.

Aerial view near Omak WA. The yellow/red trees are recent mortality and the gray trees were killed in previous years. These older dead trees are not mapped during aerial survey.

In the southeastern Cascades, forests previously defoliated by the Western spruce budworm are experiencing widespread bark beetle mortality which is under reported since these trees often lack enough foliage to be seen from the air.

In coming years, Douglas-fir beetle caused mortality is expected to further increase in the eastern Cascades as Western spruce budworm defoliation increases.

A December 2003 windstorm in the Cedar River Watershed (King County) triggered elevated Douglas-fir beetle activity. The extent of that activity will be evaluated in the 2006 aerial survey.



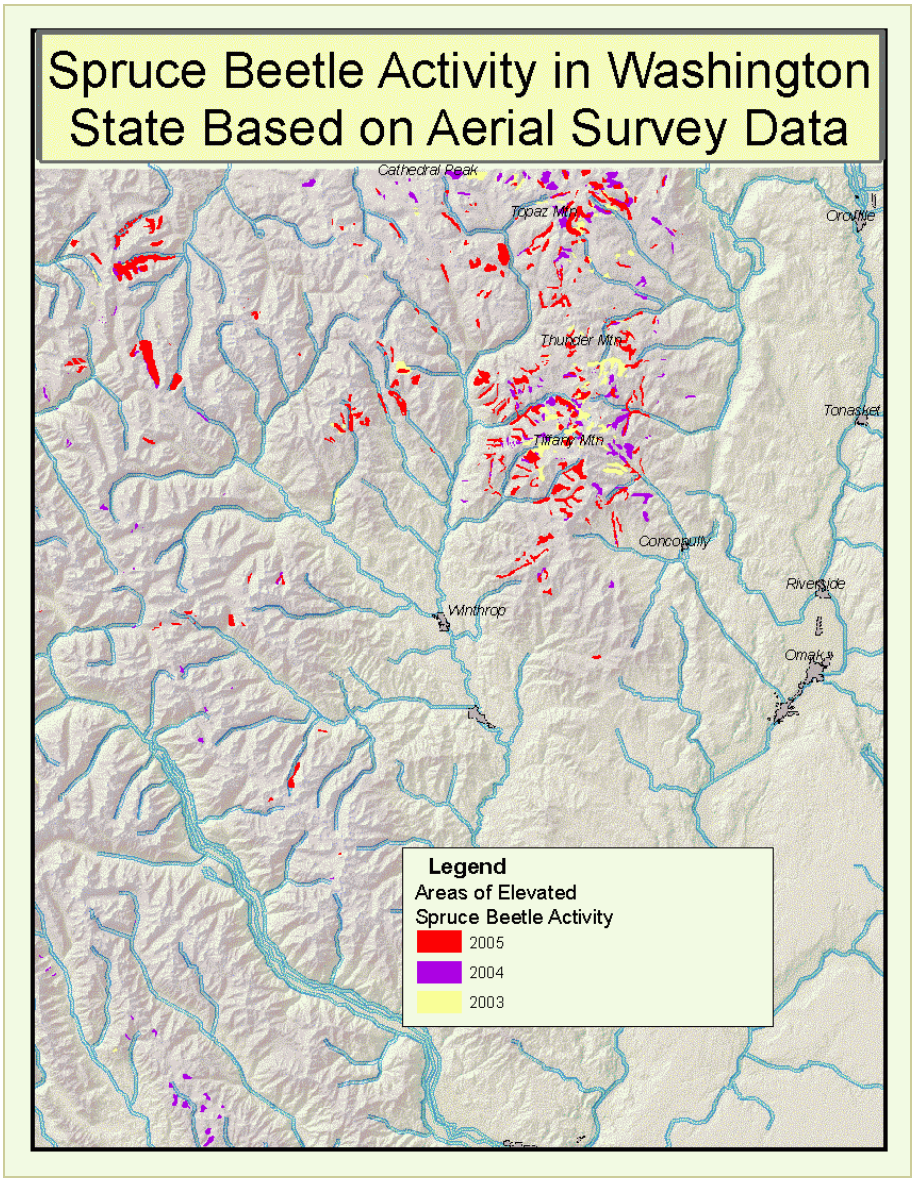
Historical Activity and Drought Correlation

For additional information go to: http://www.fs.fed.us/r6/rogue/swofidsc/beetles/douglasfir.html

Spruce Beetle
Dendroctonus rufipennis (Kirby)

The spruce bark beetle is usually present in small numbers in weakened and wind-thrown spruce trees. However, periodic outbreaks can occur where extensive windthrow events or large areas of overmature spruce exist. Spruce beetles typically need two years to complete their life cycle, but can mature in one year if conditions are mild.

The spruce beetle outbreak of the last few years in the northeast Cascades near Tiffany Mountain continues at a decreasing intensity. This is because most of the suitable host trees have already been killed. However, there were several new areas of activity in surrounding areas all the way to the Canadian border and beyond.



The recent statewide acres with elevated mortality are:

2001: 24,272
2002: 27,527
2003: 19,106
2004: 23,207
2005: 39,604

When spruce beetle populations reach epidemic levels, wholesale mortality occurs rapidly.

For additional information go to: http://www.na.fs.fed.us/spfo/pubs/fidls/sprucebeetle/sprucebeetle.htm

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

Douglas-fir tussock moth is a native defoliator of Douglas-fir and true fir trees. It typically exists at low numbers, but periodically irrupts into huge populations which can completely defoliate trees in a single season, producing widespread mortality and top kill.

Defoliation from DFTM on Tekoe Mountain south of Spokane, August 2002.

DFTM outbreaks throughout the northwest have mostly subsided from 2000-2002. No defoliation from DFTM was mapped in 2005.

In order to anticipate DFTM population trends, DNR annually monitors about 190 DFTM pheromone trap sites in Washington. These results are compiled with those of other landowners to provide early warning of rising DFTM populations (see map at: http://www.fs.fed.us/r6/nr/fid/dftmweb/maps/wa05.pdf). Overall, 2005 trap catches were very low, indicating low populations through 2006.

The last outbreak of DFTM in Washington followed outbreaks in California by two years. California is again experiencing such outbreaks near Yosemite national Park, and we could start experiencing rising population trends and defoliation by 2007 or 2008.

For additional information go to:
http://www.forestnet.com/timberwest/archives/March_April_05/battling_bugs.htm

Western Hemlock Looper
Lambdina fiscellaria lugubrosa (Hulst)

The Western hemlock looper is a native defoliator of hemlock and interspersed conifers. An ongoing outbreak has been occurring in the Mt. Baker area for several years.

The outbreak north and east of Mt. Baker continues at low levels. This ongoing outbreak peaked in 2002 with 35,000 acres of defoliation and has mostly subsided. Only 1207 acres were mapped in 2005 in a continuing downward trend of activity.

Increasing levels of scattered hemlock mortality have been mapped where hemlock looper defoliation has occurred in recent years.

Bark beetles and root diseases combined with the direct effects of defoliation likely contributed to tree death.

Acres of Defoliation in the Mt. Baker area:

2001: 17,000
2002: 35,000
2003: 1,411
2004: 2,200
2005: 1,207

For additional information go to:
http://www.pfc.cfs.nrcan.gc.ca/entomology/defoliators/loopers/west_hemlock_e.html

Gypsy Moth
Lymantria dispar (L.) (Goodwin)

Gypsy moth is a non-native defoliator of many broadleaf trees and shrubs. The Asian variety can also significantly damage conifers.

Gypsy moth is not established in Washington. Each year the Washington State Department of Agriculture deploys pheromone traps to detect new introductions. Eradication efforts follow if populations appear to be breeding.

The European gypsy moth has become established in the eastern US where it continues to spread and cause extensive damage. The Asian gypsy moth, an even greater threat, is not yet established in North America. In 2004, an adult male Asian gypsy moth was trapped in Idaho along the I-90 corridor near the Washington border. Six hundred acres were sprayed in an attempt to eradicate this pest even though other life stages were not found. Intensive trapping in 2005 has shown the eradication effort to be successful so far.

In Washington, thirty-one moths were trapped statewide in 2005. This number is much lower than the sixty-eight moths trapped last year, and the ten-year average of 76 moths. All catches were in western Washington and all multiple catches were in King County. Two were in the Seattle neighborhoods of Crown Hill (site of a 2002 eradication project) and Madrona Park (for the second year in a row). The other multiple catch traps were in Bellevue (for the third year in a row) and Kent.

At no time were more than two moths caught in any one trap. Eradication projects are proposed for Madison/Madrona Park (Seattle) and Bellevue for 2006.

Two eradication projects were undertaken in 2005, one in the Eastlake area of Seattle and another in Keyport, north of Bremerton.

Intensive trapping in the Port Ludlow and Bellevue areas showed that the 2004 eradication treatments there have been successful so far.

For additional information go to:
http://www.forestry.ubc.ca/fetch21/FRST308/lab5/lymantria_dispar/gypsy.html

Other Defoliators

Tent Caterpillar *Malacosoma spp.*

Almost no tent caterpillar activity was recorded in 2005 and it appears that the recent outbreak has subsided. Many areas of hardwoods (alder, willow, fruit trees) around the Puget Sound were repeatedly defoliated from 2001-2004. Substantial top kill and dieback of alder has resulted in some areas.

Many suburban areas that were the most intensely affected by this outbreak are not systematically surveyed due to various flight restrictions in central Puget Sound.

It is very challenging to detect hardwood defoliation because sometimes affected trees produce a secondary crop of leaves masking the defoliation and/or it closely resembles tree top kill or dieback from other causes.

For additional information go to:
http://www.forestry.ubc.ca/fetch21/FRST308/lab5/malacosoma_disstria/tent.html

Western tent caterpillar nest. Arrows indicate bodies of diseased and parasitized larvae.

Spruce Aphid *Elatobium abietinum* (Walker)

A fairly extensive spruce aphid outbreak was detected along the Washington coast from Grayland sporadically to Neah Bay. This aphid is thought to be originally from Europe and populations periodically irrupt in winter. Branches prematurely drop their older needles giving them a sparse appearance the following summer.

If outbreaks continue for several years, spruce aphid can cause significant amounts of mortality, top kill and branch dieback.

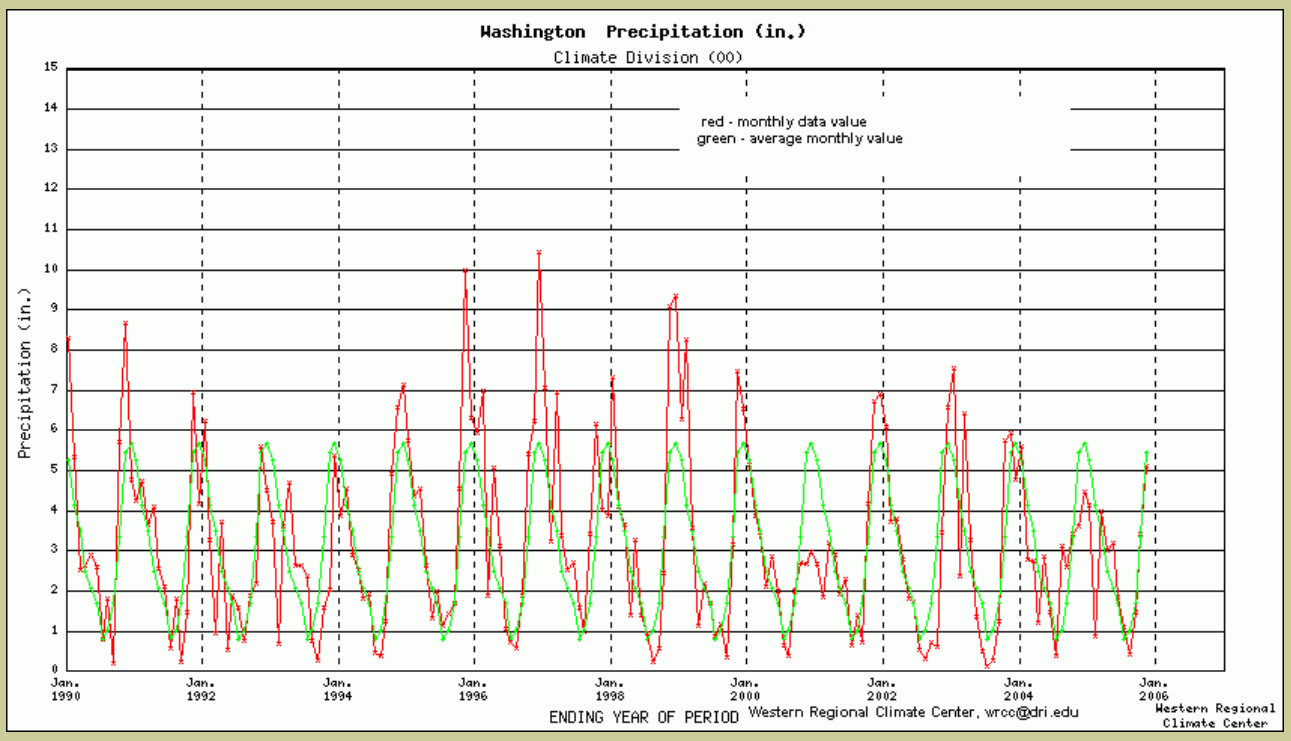
Unusually hot weather caused damage to newly elongating spruce twigs along the Oregon Coast. Loss of this new growth along with spruce aphid damage to older foliage may result in significant damage. The extent or occurrence of similar damage in Washington is not known.

For additional information go to:
http://www.aenews.wsu.edu/June03AENews/June03AENews.htm#spruceaphid

Animal and Abiotic

Drought

The winter of 2004-2005 was unprecedented. It was the driest winter in recorded history with record low snow packs of only 26% of average and stream flows as low as 22% of average in many areas! The droughty conditions culminated in a February with no measurable precipitation in many parts of the state. The situation was so severe that the governor declared a state of emergency, directing municipalities to adopt strict conservation practices and requesting individuals do the same.



Starting in March, however, the water deficit began to lessen. Widespread worries began to ease as spring brought unusually cool and wet conditions. A few summer storms included needed precipitation. 2005 ended as a near normal “water year” (October 2004 through September 2005).

Washington has an annual summer drought climate pattern. Little of the yearly precipitation falls in late summer, limiting tree growth until moisture is replenished in late September or October. Many insects and diseases have evolved to take advantage of water-stressed trees, so the “growing season” precipitation (June through September) can indicate both tree stress and insect or disease success. The last ten years (1996-2005) have included two growing seasons of above normal precipitation, three growing seasons of near normal precipitation, and five growing seasons of below normal precipitation statewide (see charts below). A five-year period of low growing season precipitation (1998 through 2003, with intense effects in 2002 when the fall rains did not arrive until early November) caused significant direct drought effects such as tree death and top kill. Growing season drought damage eased in 2005.

Globally (according to researchers), 2005 will likely be the warmest year recorded in the past 10,000 years.

For Washington State, long term drought, identified by below normal annual precipitation levels and low soil moisture levels, continues to affect forests and insect and disease populations. Landscape levels of tree defoliation and mortality are likely to continue. Trees on dry sites with thin soils are most likely to be affected. Western hemlock, with shallow roots, is very susceptible to drought. Overcrowded forests and trees with injured roots are also highly susceptible.

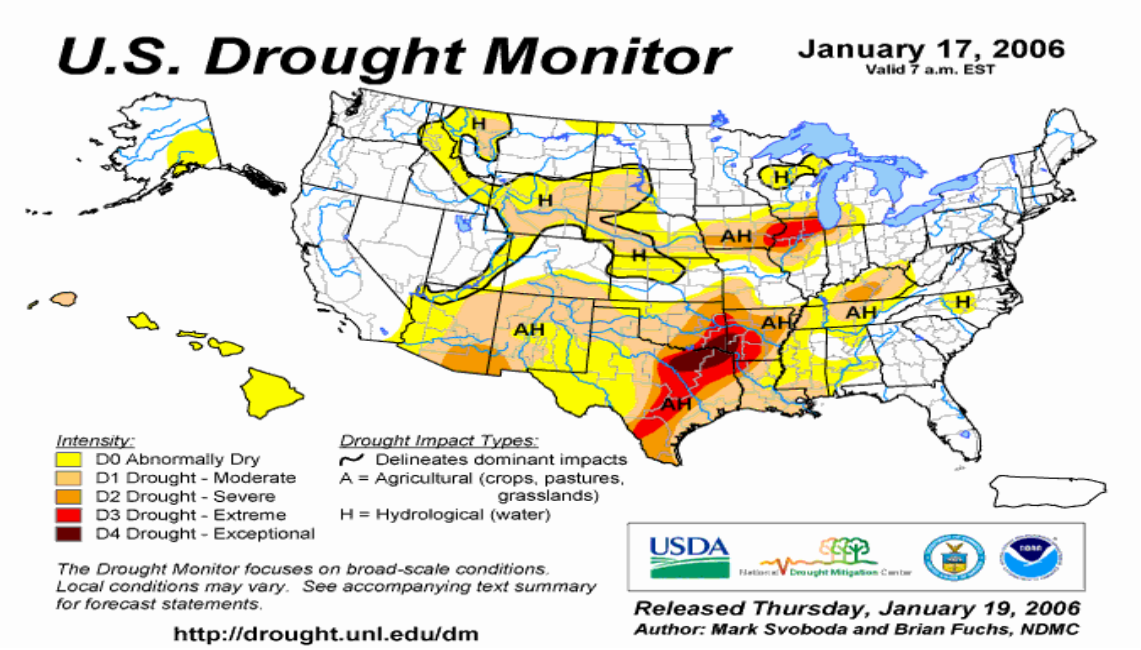
How drought conditions correlate with historical activity of key disturbance agents:

For Douglas-fir beetle go to: http://www.wadnr.gov:81/htdocs/rp/forhealth/2005highlights/chartdfb05.gif

For pine bark beetles go to: http://www.wadnr.gov:81/htdocs/rp/forhealth/2005highlights/chartpbb05.gif

For fir engraver go to: http://www.wadnr.gov:81/htdocs/rp/forhealth/2005highlights/chartfe05.gif

For Western spruce budworm go to:
http://www.wadnr.gov:81/htdocs/rp/forhealth/2005highlights/chartwsbw05.gif



Current Loop of Washington Drought Conditions

Fire

The 2005 fire season for Washington State was brief but intense. Smoke, haze and numerous temporary flight restrictions hindered our survey efforts for several days in early August. 1000-hour fuel moisture levels plummeted to 8% in many areas of Eastern Washington. However, there was very little lightning and mid August rains benefited firefighting efforts and brought an early end to the fire season.

There were 11 major fires in 2005. The School fire in Southeast Washington was the largest at over 52,000 acres. All told there were approximately 1000 fires, which is a little below average. A total of 185,000 acres (including grasslands and other fuel types in addition to forest) burned in 2005

For additional information go to: http://www.wadnr.gov:81/base/fire.html

Bear Damage/Root Disease
Ursus americanus (Pallus)/*Phellinus weirii* (Murr.) Gilb.

In 2005, the aerial survey identified about 233,000 acres with recent scattered mortality of young plantation Douglas-fir as "Bear Damage". Field studies have shown that some of this mortality is actually caused by root disease. In fact, in 2004, 103 polygons were ground checked by finding the first ten freshly killed trees in the area and then determining what killed them. Based on these ground checks, 54% were found to be primarily bear damage and 44% were found to be primarily root disease! Although there are many types of root diseases, laminated root rot (*P. weirii)* was the most commonly identified.

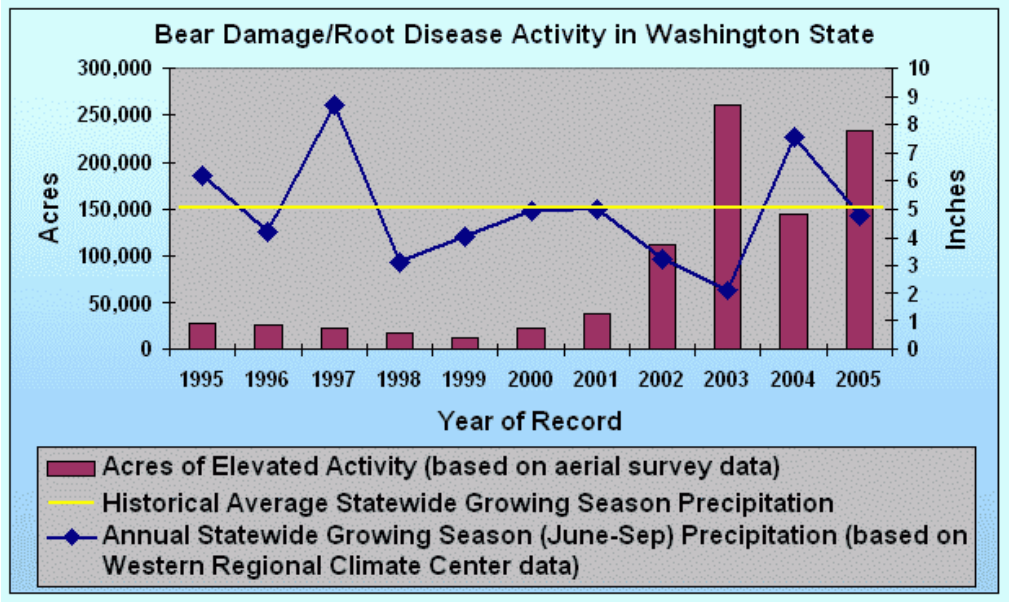
Black bears damage trees when they feed on the soft cambial tissues inside the bark of plantation saplings and small trees. This feeding occurs from April through September, but is highest in April through the peak month of June as hungry bears come out of hibernation and other forage is lacking. Bark is more loosely held on to the tree during this time in order to accommodate the fast growing, early sapwood. Tree feeding is higher in areas that lack salmonberry or false dandelion which are preferred forage during this time period (Poelker and Hartwell, 1973).

A single bear can injure or kill hundreds of trees in a single season. Bears tend to choose the biggest and healthiest trees to feed on and will often injure two or more trees for every one they kill.

Since legal restrictions on bear hunting were increased in 1996, black bear populations in Washington State have nearly doubled and the incidence of bear damage to trees has steadily increased.

Root disease incidence is likely also on the increase as Douglas-fir is replanted into areas containing significant root disease inoculum and droughty summer conditions make trees more susceptible.

Historical Bear Damage Activity



For additional information go to: http://www.wdfw.wa.gov/wlm/game/blkbear/blkbear6.htm