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**Pacific
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Forest Insect and Disease Conditions and Forest Pest Management Activities

Pacific Northwest Region, 1993

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Pacific Northwest Region
Natural Resources
Forest Insects and Diseases

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Pacific Northwest Region

Forest Pest Management

Regional Office

333 S.W. First Avenue
Portland, OR 97204
(503) 326-2728
FAX (503) 326-5569

Max M. Ollieu	Group Leader/Entomologist
David Bridgwater	Entomologist
Tommy Gregg	Biometrician
Diane Hildebrand	Plant Pathologist
Julie Johnson	GIS Coordinator
Iral Ragenovich	Entomologist
Roger Sandquist	Entomologist
Katharine Sheehan	Entomologist
Fay Shon	Planning
Gary Smith	Integrated Pest Management
Suzanne Wiley	Forestry Technician

Southwest Oregon Technical Center
J. Herbert Stone Nursery

2606 Old Stage Road
Central Point, OR 97529
(503) 858-6125

Don Goheen	Plant Pathologist/Entomologist
Ellen Michaels Goheen	Plant Pathologist

Blue Mountains Pest Management Zone
Forest Sciences Laboratory

1401 Gekeler Lane
LaGrande, OR 97850
(503) 962-6544/6545

Craig Schmitt	Plant Pathologist
Donald Scott	Entomologist

Westside Technical Center

333 S.W. First Avenue
P.O. Box 3623
Portland, OR 97208
(503) 326-6820
FAX (503) 326-5569

Jerome Beatty	Plant Pathologist
Bruce Hostetler	Entomologist
Keith Sprengel	Forestry Technician
Elizabeth Willhite	Entomologist

NOTE: This technical center is located in the Portland Regional Office until the new Mt. Hood National Forest Headquarters building is completed.

Central Oregon Pest Management Zone
Deschutes National Forest

1645 Highway 20 East
Bend, OR 97701
(503) 383-5591/5701

Andris Eglitis	Entomologist
Helen Maffei	Plant Pathologist

Eastern Washington Forest Health Office
Forestry Sciences Laboratory

1133 North Western Avenue
Wenatchee, WA 98801
(509) 664-2749
FAX (503) 664-2701

Paul Flanagan	Entomologist
Paul Hessburg	Plant Pathologist
James Hadfield	Operations/Plant Pathologist

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Introduction

This report summarizes activities of the Forest Pest Management (FPM) staff and the status of forest insects and diseases in the Pacific Northwest Region for 1993, and looks at some trends leading up to 1993. Estimates of tree mortality, locations of major insect activity and acres affected are shown in tables and figures. Narratives reflect existing field conditions and, to a certain degree, the level of participation by area pathologists and entomologists in the preparation of this report.

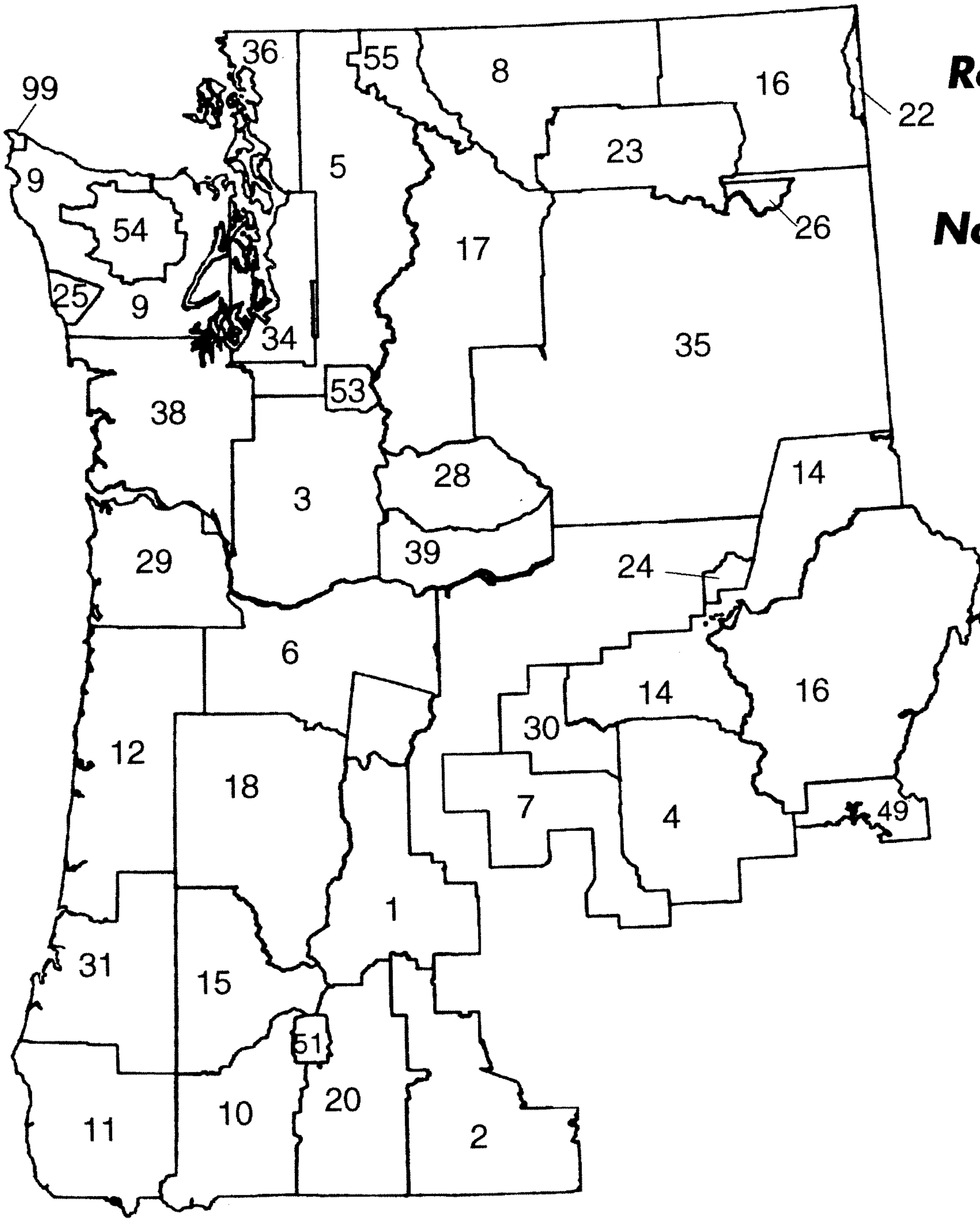
Trees affected by forest insects and diseases were detected and recorded during aerial and ground surveys made cooperatively by personnel from the USDA Forest Service, the Oregon Department of Forestry, and Washington Department of Natural Resources. Detection flights were conducted over approximately 55,000,000 forested acres in Oregon and Washington.

Data included in this report are based on sketchmaps prepared during aerial survey. These sketchmaps provide an estimate of conditions on the ground, and may differ from those observed on the ground.

The aerial survey provides information on the current status of insect activity, and is important in examining insect activity trends by comparing previous and current survey data.

Figure 1

Reporting Areas, Pacific Northwest Region



1 Deschutes N.F.
2 Fremont N.F.
3 Gifford Pinchot N.F.
4 Malheur N.F.
5 Mt. Baker-Snoqualmie N.F.
6 Mt. Hood N.F.
7 Ochoco N.F.
8 Okanogan N.F.
9 Olympic N.F.
10 Rogue River N.F.
11 Siskiyou N.F.
12 Siuslaw N.F.
14 Umatilla N.F.
15 Umpqua N.F.
16 Wallowa-Whitman N.F.
17 Wenatchee N.F.
18 Willamette N.F.
20 Winema N.F.
21 Colville N.F.
22 Kaniksu N.F.
23 Colville I.R.
24 Umatilla I.R.
25 Quinault I.R.
26 Spokane I.R.
27 Warm Springs I.R.
28 Yakima I.R.
29 Northwest Oregon
30 Central Oregon
31 Coos-Douglas
34 Puget Sound
35 Northeast Washington
36 Northwest Washington
38 Southwest Washington
39 Glenwood
49 Lookout Mountain
51 Crater Lake N.P.
53 Mt. Rainier N.P.
54 Oympic N.P.
55 North Cascades N.P.
99 Makah I.R.

Insect conditions in the Pacific Northwest are assessed, in large part, by annual aerial insect activity detection flights. Information and ground checking are provided by personnel from FPM, National Forest offices, and other federal and state agencies.

During 1993 mountain pine beetle activity in lodgepole, ponderosa, western white, and whitebark pines increased from 1992 levels. Although, more acres were affected in ponderosa pine, only a third the number of trees were killed (355,200 trees in 1992, 119,500 in 1993). Most of the activity in Oregon was reported on the Deschutes, Fremont and Malheur National Forests. In Washington over 437,000 trees were killed in all host types within the Okanogan National Forest reporting area. Much of the area affected in the lodgepole pine type was in the Loomis block of the Okanogan reporting area.

Large tree mortality associated with the western pine beetle decreased from approximately 102,000 trees killed in 1992 to 41,200 in 1993. Small tree mortality attributed to this insect increased from 48,500 trees killed to 191,500. Information obtained from ground surveys concluded that small tree mortality associated with bark beetles in areas of northeastern Washington were attributable to western pine beetle. The decrease in reported tree mortality caused by mountain pine beetle in pole-sized ponderosa pine is, in part, offset by the increase in reported western pine beetle activity.

A substantial reduction in Douglas-fir beetle activity was noted in 1993 (218,600 trees killed in 1992, compared to 30,500 in 1993). The largest infestation occurred on the Gifford Pinchot National Forest in Washington.

Fir engraver continued to cause extensive mortality of true firs with 592,300 trees killed in 1993 compared to 483,100 in 1992. Approximately 82% of the reported mortality occurred on the Fremont National Forest in Oregon.

Defoliation caused by western spruce budworm decreased from 3,267,200 acres in 1992 to 331,500 acres in 1993. Most activity occurred on the Colville National Forest, Yakima Indian Reservation and Mt. Hood National Forest reporting areas.

Douglas-fir tussock moth caused defoliation occurred on 46,500 acres in 1993, compared to 7,600 acres in 1992. Defoliation was detected primarily on the Burns Ranger District of the Malheur National Forest.

Western hemlock looper activity detected on the Mt. Baker-Snoqualmie National Forest increased from approximately 500 acres in 1992 to over 49,200 acres in 1993.

Disease conditions in the Pacific Northwest are assessed by routine stand examinations and surveys conducted by Agency personnel or during ground-based surveys and permanent plot monitoring sponsored by Forest Pest Management.

Quantifying ecosystem changes due to tree diseases in terms of tree growth reduction, mortality, and decay volume is difficult to accurately assess beyond the stand level. Forest-wide estimates of these effects have not yet been approximated because of the incomplete database of accurate information on disease occurrence. This information could probably be approximated as a result of applying average disease effects for plant communities within a matrix of different levels of management. Completion of the operational geographic information system database could allow this to be done.

Root diseases, caused by several species of fungi, have significant effects on vegetation in forests of the Pacific Northwest. Root disease severity and occurrence are dependent upon site and stand history variables. In general, east of the Cascade crest, stands in late-successional stages with high proportions of shade tolerant species and histories of multiple stand entries have the highest levels of activity. West of the Cascade crest, site disturbance and regeneration of stands with susceptible species contribute to high levels of incidence and severity.

Root diseases alter forest structure and can change species composition. Their effects may be subtle and are often difficult to detect. Root disease pathogens can persist for several decades in woody material in the soil so they may be present from one generation to the next on a site. They are often difficult to control. Reports of root disease incidence increase as stand examinations become more accurate in detection root disease becomes more common. Approximately 8.5% of the acreage of commercial forest land on all ownerships is affected by root disease. Local reports may be as high as 17%.

Laminated root rot is the most serious disease of forests west of the Cascade crest and accounts for 60% of all root disease caused mortality. Douglas-fir, grand fir, white fir, and mountain hemlock are readily infected and killed or windthrown when affected by this disease. Regeneration of these highly susceptible species usually does not survive beyond the sapling and pole stages. The causal fungus is very adept at surviving in the wood of roots and may remain viable for up to 50 years. Bark beetles are often found in association with laminated root rot pockets. Tolerant, resistant, or immune species are favored when stands are managed.

Armillaria root disease causes mortality of shade tolerant species on many late successional stage stands east of the Cascade crest, particularly where soil disturbance has occurred. Bark beetle activity commonly occurs in these areas. In some locations, ponderosa pine is also heavily damaged. Losses west of the Cascade crest are usually confined to stressed sites or poorly planted trees.

Annosus root disease is being found with increasing regularity in stands which were entered 15-20 years ago. Tree mortality caused by the "S" strain of the fungus is found throughout the range of grand fir and white fir in the Pacific Northwest and is greatest where stands with large components of these species were selectively harvested. It is often found in association with fir engraver. This fungus also is responsible for decay in western hemlock. It is reported with increasing frequency in high elevation mountain hemlock, noble fir and Pacific silver fir; however its impact is unknown on those sites. The "P" strain of the fungus can cause high levels of mortality in dry ponderosa pine plant communities, particularly in southcentral and northeastern Oregon and eastern Washington. It has also been found in association with low levels of mortality in lodgepole pine, Douglas-fir and western larch regeneration adjacent to infected stumps. The Annosus Root Disease Model, a new extension to the

Forest Vegetation Simulator (Prognosis) model, is now available for simulating stands infected with annosus root disease.

Black stain root disease causes mortality in precommercial thinning-aged stands in southwestern Oregon, especially along skid trails, where stands were tractor logged , or where rotary blade brush cutting equipment has been used along roadsides. This disease is reported with increasing frequency in overstocked ponderosa pine stands in southcentral Oregon.

Port-Orford-cedar root disease continues to cause substantial Port-Orford-cedar mortality on sites that are favorable in southwestern Oregon. Tree mortality is concentrated in wet areas and where water drains downslope from roads.

The impact from dwarf mistletoes changes little from year to year, however, long term effects including growth loss, topkill, distortion, and mortality are great in unmanaged stands. All conifer species are affected to some degree. Dwarf mistletoes are present on approximately 9.5 million acres, mostly east of the Cascade crest. Annual tree volume reductions are estimated at 131 million cubic feet. Douglas-fir dwarf mistletoe results in high levels of mortality in severely infected trees. Western larch dwarf mistletoe is extensive in northcentral Oregon and eastern Washington.

White pine blister rust causes mortality throughout the range of western white pine, sugar pine, and whitebark pine making the management of those species difficult on high hazard sites. Annual volume reductions are estimated at 15 million cubic feet. Rust resistant planting stock is available and being planted. Interest in pruning diseased and susceptible trees has increased.

Indian paint fungus is commonly found in older white and grand fir stands, particularly in moist grand fir and white fir plant communities. Decay caused by the fungus is extensive in older trees.

Table 1 – Regional Summary Table

Causal Agent	Host	Acres	# Trees
Balsam Wooly Adelgid		16424	10576
Bear		42205	27821
Douglas-fir Beetle		50622	30459
Douglas-fir Engraver		10	10
Douglas-fir Tussock Moth		46472	0
Engelmann Spruce Beetle		153	80
Fir Engraver		473290	592408
Fire		1874	0
Larch Bud Moth		13572	0
Larch Needle Cast		54	0
Lodgepole Needle Cast		94	0
Maple Discoloration		92253	0
Mountain Pine Beetle	Lodgepole Pine	217135	639672
Mountain Pine Beetle	Ponderosa Pine	286483	119588
Mountain Pine Beetle	Sugar Pine	2775	684
Mountain Pine Beetle	Western White Pine	35796	26085
Mountain Pine Beetle	Whitebark Pine	3926	1497
Oregon Pine IPS		23179	0
Port Orford Cedar Root Disease		4216	1327
Red Belt		52	0
Root Disease		4111	0
Satin Moth		6179	0
Saw Flies	Western Hemlock	1869	0
Saw Flies	Western Larch	57	0
Silver Fir Beetle		7053	3508
Spruce Aphid		5315	0
W. Balsam Bark Beetle		4766	2212
Water		1717	0
Western Hemlock Looper		49218	0
Western Pine Beetle	Large Ponderosa Pine	186604	41175
Western Pine Beetle	Pole-size Ponderosa Pine	189765	191621
Western Spruce Budworm		331529	0
Wind		1808	0

Defoliators

Western spruce budworm, *Choristoneura occidentalis*

Western spruce budworm is a common defoliator of conifers in the Pacific Northwest. Budworm outbreaks commonly occur in the true fir/Douglas-fir forest type. Larvae prefer new foliage, but also feed on older foliage when new foliage is in short supply. On western larch, larvae not only feed on the needles, but also mine the woody portion of the shoots. Increasingly effective fire prevention and suppression during this century have eliminated many major fires and nearly all surface fires. As a result, forests that have had no other disturbances, such as timber harvesting, have succeeded steadily toward climax and, consequently, an abundant and expanding source of the budworm's favorite food – shade-tolerant, late successional species.

After several years of budworm outbreak areas of visible defoliation continued to decline regionwide. Total acres reported for 1993 were 331,500, compared to over three million reported in 1992. Over 70 percent of the defoliation was detected in Washington with 95 percent of that being classified in the light effects category. Significant areas of detected budworm activity in eastern Washington were along Oregon City Ridge into Carson and Beaver Dam creeks and just south of Twin lakes and around Gold mountain. Several large areas were also mapped in the Huckleberry range and on the Yakima Indian Reservation southwest of Toppenish ridge. Mt. Defiance and the east slopes of Mt. Hood around Cooper Spur in Oregon showed signs of defoliation. Also on the Mt. Hood, an area from Olallie

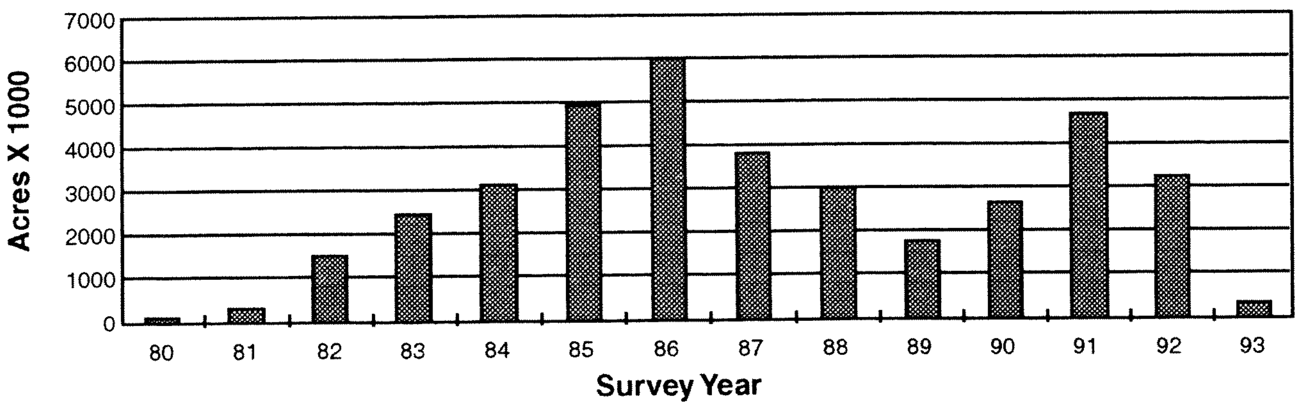


Figure 2 – Acres of Western spruce budworm-caused defoliation detected during aerial surveys in the Pacific Northwest Region, 1980 through 1993

Lakes north to Sisi Butte and from Peavine mountain east to the Warm Springs Indian Reservation had reportable acres of budworm defoliation. An aerial suppression project using *Bacillus thuringiensis* was conducted on 64,182 acres of the Warm Springs Indian Reservation. Aerial survey recorded 13,000 acres of defoliation on the Warm Springs in 1993 as compared to 85,900 acres in 1992. Populations in the Blue Mountains have been reduced to low levels resulting in no detectable defoliation. The Central Oregon area reported that even though budworm populations decreased dramatically in 1993, there was a substantial increase in tree mortality in some of the areas which have sustained repeated defoliation since the late 1980's. In previous years, most defoliated trees recovered, and cumulative mortality along the Cascade Mountain foothills was limited. In the spring of 1993, many of these defoliated trees did not recover, and mortality may now approach 40 percent in some localized areas. Most of these dead trees are found at mid to high elevations below the Cascade crest on the Sisters Ranger District of the Deschutes National Forest and the Warm Springs Indian Reservation. Affected tree species include Douglas-fir and grand fir.

Both species show signs of long-term infection by Armillaria root disease, and some Douglas-firs have also been attacked by the Douglas-fir beetle. Mortality in true firs associated with fir engraver has been detected in many areas having several years of defoliation.

Douglas-fir tussock moth, *Orgyia pseudotsugata*

The tussock moth can eat the foliage of several plant species, but only three are considered primary hosts; Douglas-fir, grand fir, and white fir. Newly hatched and early instar larvae feed on current year's foliage freshly flushed from elongating shoots. Later instar larvae feed on all foliage.

Douglas-fir tussock moth activity was detected on 46,195 acres in 1993, up from 7,546 acres in 1992. Approximately 46,000 acres of this activity occurred on the Burns Ranger District of the Malheur National Forest. The difference between 1992 and 1993 reported acres of defoliation could in part be explained by the early summer hail storm in 1992 which destroyed many of the observable signs of defoliation. Results of adult population monitoring in the summer of 1993 indicates a continuing decline in

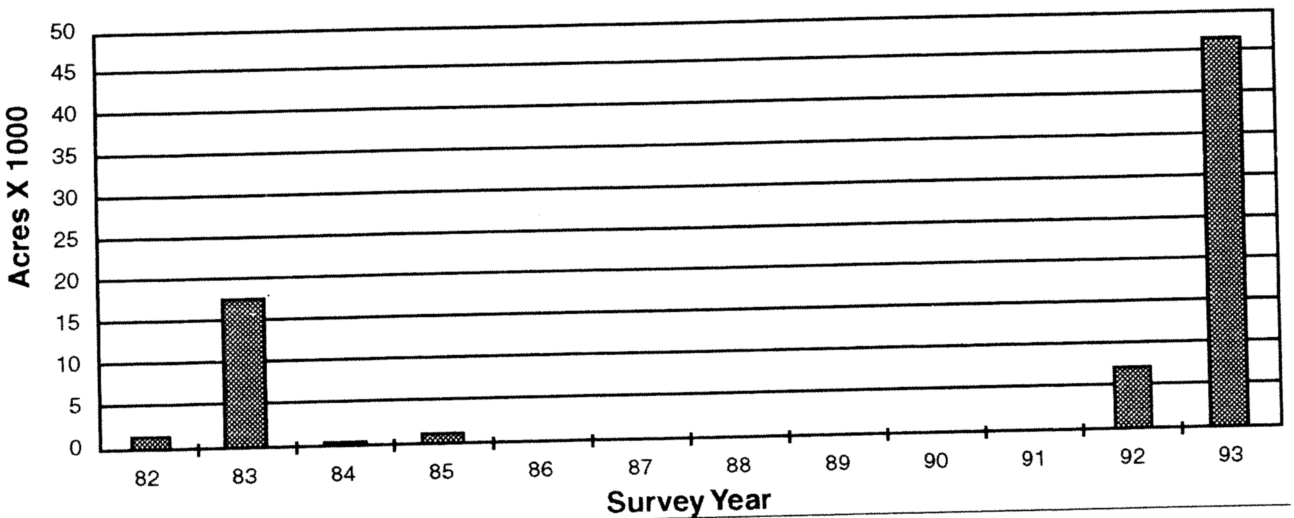


Figure 3 – Acres of Douglas-fir tussock moth-caused defoliation detected during aerial surveys in the Pacific Northwest Region, 1982 through 1993

trap catches; negligible amounts of defoliation are expected for 1994.

In 1993, male Douglas-fir tussock moths were sampled using pheromone baited traps at 398 locations. Trap catches at all locations were low to extremely low, with many locations recording zero catches. The regional trend in pheromone trap catches has been decreasing since 1991. Trap catches in 1994 are expected to remain low.

Pandora moth, *Coloradia pandora*

The pandora moth is a defoliator of pines. Growth loss and possible mortality follow successive years of outbreak level defoliation. Trees weakened by successive years of defoliation may also be more susceptible to bark beetle attack. The current pandora moth infestation in central Oregon is entering its tenth year or fifth generation (this insect has a two year life cycle). Defoliation, the majority of which occurs in even-numbered years, has increased with every generation since the infestation began in 1988. Most recently, over 77,000 acres were defoliated in 1992. Record numbers of moths were reported in 1993 in the communities of Bend, Sunriver, and LaPine. Egg hatch and larval survival have been high, which may mean another year of heavy and widespread defoliation in 1994. A special pandora moth aerial survey was conducted on June 15, 1994.

Western hemlock looper, *Lambdina fiscellaria lugubrosa*

The primary host for hemlock looper is western hemlock, although it will feed on other conifer species and understory shrubs found is association with western hemlock. Outbreaks typically will last three years and are kept in check by natural biological controls.

Western hemlock looper caused defoliation was detected on 1,412 acres of North Cascades National Park and on 47,806 acres of Mt. Baker-Snoqualmie National Forest. Large polygons of tributaries to the Stillaguamish River were mapped south of Rockport and also in the Bacon Creek drainage north of Marblemount. Several of the drainages emptying into Baker Lake and flowing from Mt. Baker recorded moderate to heavy levels of defoliation.

Larch budmoth, *Zeiraphera improbana* (Walker)

Approximately 15,600 acres of larch budmoth activity was reported within the Colville National Forest reporting area. Large areas of activity were noted south of Sullivan lake in the Harvey creek area and again west of Sullivan lake.

Western hemlock sawfly, *Neodiprion tsugae*

Western hemlock sawfly is found throughout the range of western hemlock in the Pacific Northwest. The larvae feed primarily on older hemlock foliage. Heavy defoliation of hemlock by sawflies is known to cause reduced radial growth and top-kill. As forest defoliators, hemlock sawflies may ultimately influence both stand composition and structure in some areas where they occur. The sawflies themselves are a food source for numerous birds, other insects, and small mammals, as are many forest insects. Western hemlock sawfly-caused defoliation was reported within the Bull Run watershed along the Bull Run river just to the west and northwest of Big Bend Mountain. Over 1,700 acres were mapped. Ground surveys indicated that hemlock looper may also be present in the area.

Gypsy moth (European form), *Lymantria dispar*

The gypsy moth is primarily a defoliator of hardwoods, but will also feed on the foliage of conifers when found in association with hardwoods.

While no defoliation has been observed in either state, pheromone traps continued to catch moths. These catches represent new introductions or populations not completely eradicated by the eradicative treatments. Based on trap catches, proposals are being developed to apply eradicative treatments from the ground to four areas in Washington and two in Oregon. One additional eradicative treatment area in Oregon will be treated from the air. It is expected that new introductions will continue as long as populations in the east persist and people move from the generally infested area to the Pacific Northwest. Two moths in Oregon and one in Washington have been identified as hybrids of the Asian strain and the European strain. One of the hybrid catch sites in Oregon may be included in the aerial eradicative treatment.

Bark Beetles

Mountain pine beetle, *Dendroctonus ponderosae*

Total area affected by mountain pine beetle increased from 428,600 acres (an average of 1.39 trees/acre) in 1992 to 546,100 acres (an average of 1.44 trees/acre) in 1993.

Mountain pine beetle in ponderosa pine

Although total acres of beetle activity increased from 214,700 in 1992 to 286,500 in 1993, the number of trees killed decreased significantly (355,200 trees in 1992 compared to 119,600 in 1993). Field checks in northeastern Washington revealed that in many areas the mortality which had been reported as mountain pine beetle in the past was actually western pine beetle. Reporting in 1993 reflected this new information and resulted in an increase of mortality caused by western pine beetle and a decrease in that caused by mountain pine beetle. Scattered mortality occurred throughout much of the pine type within the Region. Notable mortality occurred on private lands within the Fremont (10,300 trees killed) and Winema (6,100 trees killed) reporting areas, and on the Malheur National Forest (17,600 trees killed).

Mountain pine beetle in sugar pine

The bulk of the 680 reported trees killed in 1993 were located within the Rogue River and Siskiyou reporting areas. This represents a substantial reduction from 1992 levels.

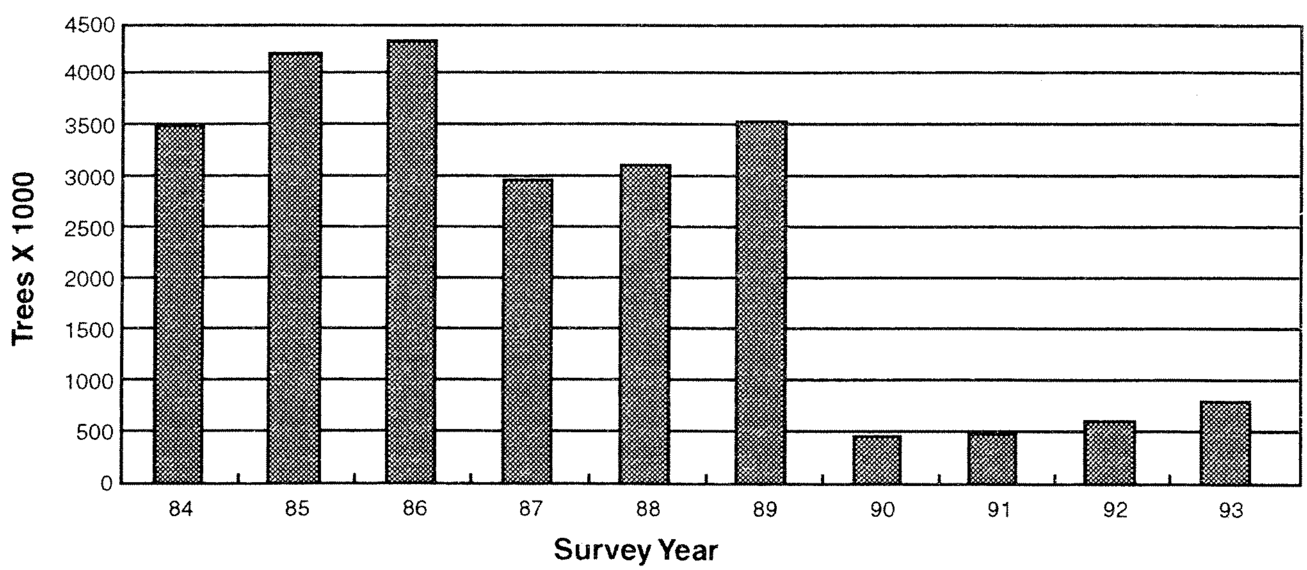


Figure 4 – Tree mortality associated with mountain pine beetle in the Pacific Northwest Region, 1984 through 1993

Mountain pine beetle in western white pine

Regionally, the number of trees killed increased from 21,098 reported in 1992 to over 26,000 in 1993. Ground checks indicate that some of the mortality was actually caused by western white pine blister rust or a combination of blister rust and mountain pine beetle. High levels of mortality occurred on the Cle Elum, Naches, and Lake Wenatchee Ranger Districts of the Wenatchee National Forest (total of 12,600 trees killed).

Mountain pine beetle in lodgepole pine

A substantial increase in the acres affected and the number of trees killed was reported in 1993. Reported number of trees killed in 1992 was 211,300 compared to 639,700 in 1993. Over 250,000 trees were reported killed on the Tonasket and Winthrop Ranger Districts of the Okanogan National Forest. Also reported were an additional 179,600 trees killed on state lands within the Loomis block, a critical lynx habitat area.

Mountain pine beetle in whitebark pine

Tree mortality more than tripled in 1993 from 1992 levels. 860 trees on the Bend Ranger District of the Deschutes National Forest and an additional 340 trees on the Naches Ranger District of the Wenatchee National Forest in Washington were reported killed by mountain pine beetle in 1993. Some of the mortality can probably be attributed to blister rust. Ground surveys are planned for summer of 1994.

Western pine beetle, *Dendroctonus brevicomis*

The western pine beetle is periodically destructive to ponderosa pine in the Pacific Northwest. Normally this beetle breeds in overmature trees, in windfalls, in trees infected by root disease, or in trees weakened by drought, overstocking, or fires. Under epidemic conditions it will attack and kill trees of all ages having bark sufficiently thick to protect the insect in its development. Two generations per year of this beetle are typical in the Pacific Northwest.

Reported western pine beetle activity increased in acreage in Oregon from 121,100 acres in 1992 (an average of 0.77 tree/acre) to 162,800 acres in 1993 (an average of 0.21 tree/acre). An additional 27,900 acres (0.34 tree/acre) were reported in pole-sized trees. Washington experienced a substantial gain in reported acreage with the bulk occurring in second growth, pole-sized stands of ponderosa pine (12,600 acres in 1992;

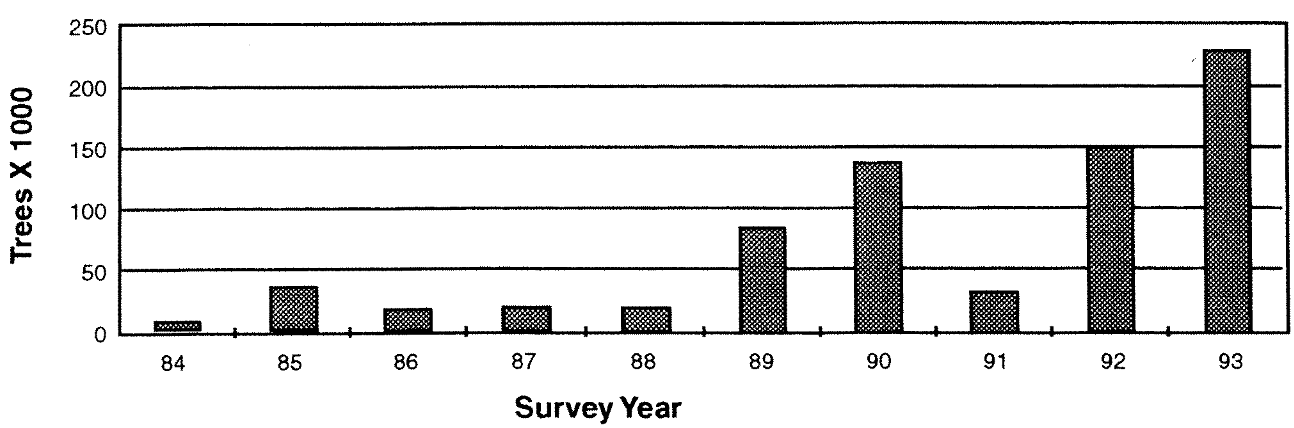


Figure 5 – Tree mortality Associated with Western pine beetle in the Pacific Northwest Region, 1984 through 1993

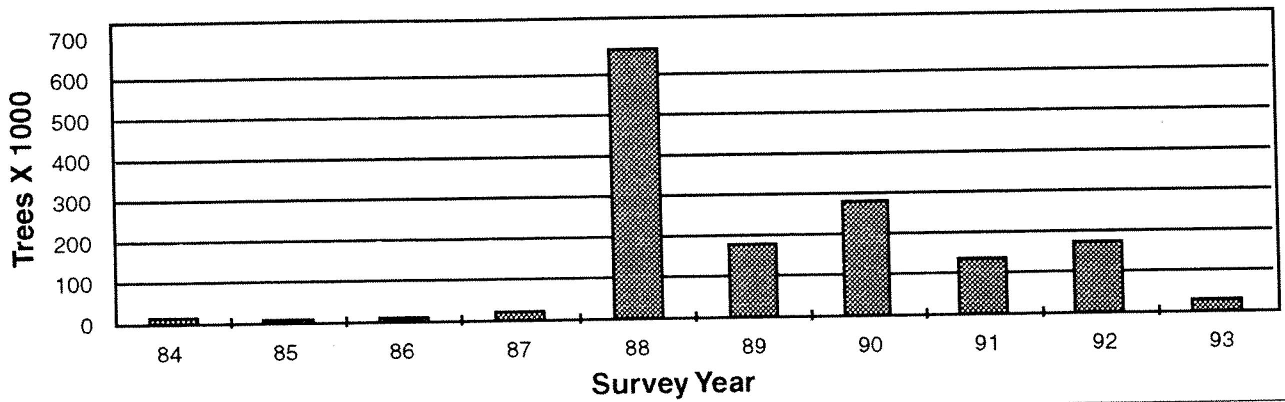


Figure 6 – Tree mortality associated with Douglas-fir beetle in the Pacific Northwest Region, 1984 through 1993

161,500 acres in 1993). Some of the most significant activity occurred on private lands within northeast Washington, Colville Indian Reservation and Glenwood reporting areas (a combined total of over 116,000 trees reported killed). In large ponderosa pine, Malheur and Ochoco National Forests had the highest levels of mortality. Observed activity on Mt. Hood and Fremont National Forests decreased.

Douglas-fir beetle, *Dendroctonus pseudotsugae*

Douglas-fir beetle occurs throughout the range of Douglas-fir, and is considered the most important bark beetle which causes mortality in Douglas-fir. Normally it breeds in felled, injured, or diseased trees. The resulting mortality is widely scattered when at low levels. At times, the insect reaches epidemic levels and kills apparently healthy trees over extensive areas.

Detected Douglas-fir beetle activity decreased significantly throughout the Region, down from 171,900 acres (an average of 1 tree/acre) in 1992 to 50,600 acres (an average of 0.6 tree/acre) in 1993. Mt. Baker-Snoqualmie National Forest experienced a twofold increase in reported acres, due, in part, to the continuing effect of a 1990 windthrow event. The Gifford Pinchot and

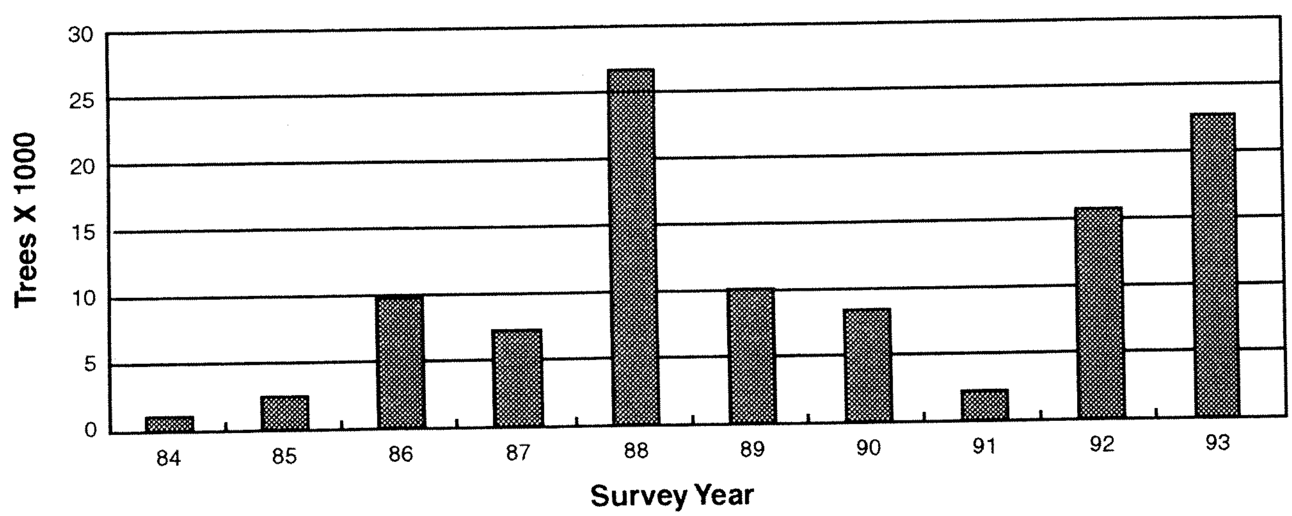


Figure 7 – Tree mortality associated with Oregon pine IPS in the Pacific Northwest Region, 1984 through 1993

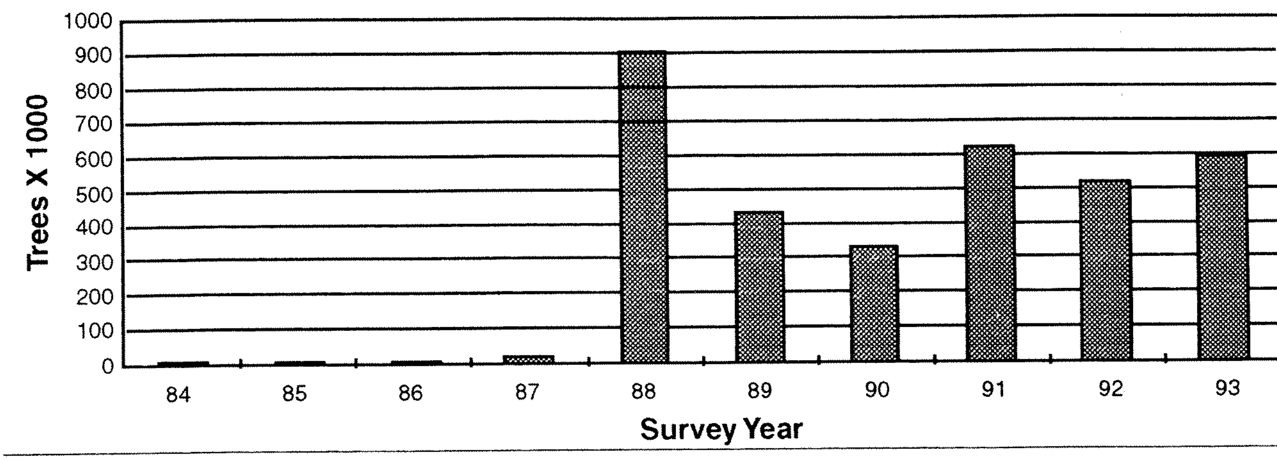


Figure 8 – Tree mortality associated with fir engraver in the Pacific Northwest Region, 1984 through 1993

Wallowa-Whitman National Forests, although down from 1992 levels, had significant levels of mortality associated with this insect. Drought and root diseases contributed to host susceptibility.

Pine engraver beetles, *Ips* spp.

Aerially detected pine engraver activity increased for the third straight year from 2,700 acres in 1991 to a three year high of 23,200 acres in 1993. Forty-six hundred acres were reported on Wallowa-Whitman National Forest with an additional 3,400 acres on private land within the reporting area. Central Oregon reported over 4,800 acres on private land, the largest reported acreage in over five years for this area.

Fir engraver, *Scolytus ventralis*

Fir engraver infests true firs in western forests. It attacks pole-sized and mature trees causing significant mortality during epidemics. Outbreaks often occur during and following periods of drought. Trees infected with annosus root disease are especially subject to attack. Trees defoliated by Douglas-fir tussock moth or western spruce budworm also are likely to be attacked. It commonly breeds in slash and windthrown trees.

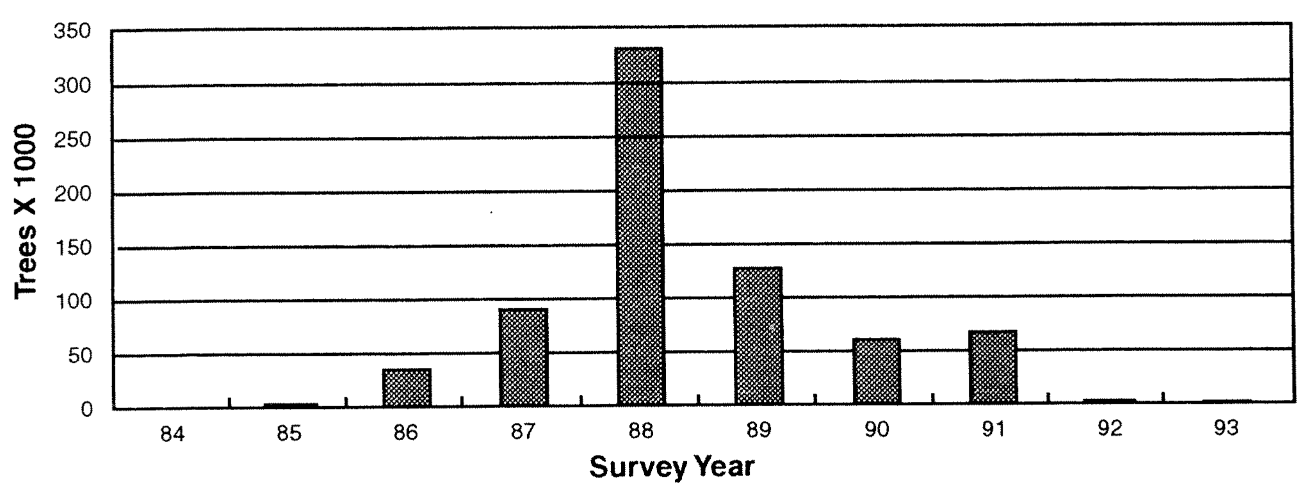


Figure 9 – Tree mortality associated with Engelmann spruce beetle in the Pacific Northwest Region, 1984 through 1993

Fir engraver activity increased from 324,900 acres (an average of 1.62 trees/acre) in 1992 to 473,300 (an average of 1.25 trees/acre) in 1993. The Fremont National Forest had 360,000 trees reported killed with an additional 113,800 trees killed on private lands within the reporting area. The Winema National Forest reporting area detected over 36,000 trees killed by the fir engraver.

Spruce beetle, *Dendroctonus rufipennis*

No significant activity was reported in 1993.

Silver fir beetle, *Pseudohylesinus sericeus*

Hosts of the silver fir beetle include true firs, Douglas-fir, and western hemlock. Mature silver fir is one of the most common hosts in the Pacific Northwest. Usually the silver fir beetle attacks windthrown, felled, injured, and severely suppressed trees.

The Gifford Pinchot National Forest reported the largest incidence of silver fir beetle with over 2,600 trees affected. Other scattered reports throughout the range of pacific silver fir were recorded.

Much of the reported mortality could also be attributed to tephra and water damage.

Western balsam bark beetle, *Dryocoetes confusus*

Western balsam bark beetle in combination with woodstaining, pathogenic fungi have contributed to the further decline of subalpine fir in the west.

Reported activity of this insect was usually light and scattered. The only areas reporting mortality of 400 or more trees were the Okanogan, Wenatchee, and Colville reporting areas. The Winthrop Ranger District of the Okanogan National Forest suffered some of the highest levels of mortality as a result of this insect. Other insects causing significant impacts in subalpine fir include fir engraver and balsam woolly adelgid.

Other Insects

Balsam woolly adelgid, *Adelges piceae*

The balsam woolly adelgid, a native of Europe, can slowly kill trees by infesting the twigs and branches, or quickly by infesting the bole. It also causes gouting in the tree crown and sometimes on the bole. This is an introduced insect which has become established in the Pacific Northwest.

The Gifford Pinchot, Mt. Baker-Snoqualmie, and Olympic reporting areas showed the highest levels of mortality associated with balsam woolly adelgid. The Olympic National Park had over 3,600 trees reported killed.

Satin moth, *Leucoma salicis*

Satin moth-caused defoliation of aspens was detected primarily within the Okanogan and Colville reporting areas. The Satin moth is a native of Europe.

Private lands were most severely affected; 3,700 acres in the Okanogan area and approximately 1,000 acres in the Colville area.

Root Diseases

Laminated root rot , *Phellinus weirii*

Laminated root rot was the most serious forest tree disease west of the Cascade Mountains crest in Washington and Oregon. Overall, an estimated eight percent of the area with susceptible species is affected in this portion of the Region. In some locations survey data indicates that as much as 15 to 20 percent of the area is affected. East of the Cascade crest, reports of laminated root rot increased as awareness increased. Effects of the disease include significant changes in species composition, size and structure. Regeneration of susceptible species in root disease centers may not grow beyond sapling and pole-size. Hardwood trees and shrubs, which are immune to the fungus, often increase their site occupancy. Where stand activities have occurred, managers have favored retention or planting of immune or resistant species to keep tree mortality and disease spread within acceptable levels.

Laminated root rot is located in a few known areas on the Wallowa-Whitman National Forest. Mt. Emily, including the Five Points drainage, has a substantial amount of this root disease. Several small areas of infestation are known in the Ladd Canyon area and on the east face of the Elkhorn Mountains. The Kuhn Ridge area is one of the few areas on the east side of the Forest where this disease is known.

On the Umatilla National Forest severe laminated root disease occurs on the Walla Walla Ranger District and one small portion of the Heppner Ranger District.

Laminated root disease was recently found on the east side of the Malheur National Forest in the Fox Creek drainage on the Long Creek Ranger District.

Armillaria root disease, *Armillaria ostoyae*

The most serious losses from this disease occurred east of the Cascade crest mixed conifer stands. In some stands in eastern Oregon where soils are compacted or displaced, mortality was high and is expected to continue. True firs and Douglas-fir sustain the most mortality, however in localized areas ponderosa pine may be killed. Losses west of the Cascade crest were usually confined to younger, stressed trees. Assessing species resistance on a site by site basis and discriminating for the more resistant species during stand management activities is considered the most effective means of controlling spread and mortality.

There are several areas on the Wallowa-Whitman National Forest where high levels of tree mortality and poor regeneration are occurring in large continuous areas due to development of virulent Armillaria root disease infestation. Large Armillaria centers occur in the upper South Fork Burnt River drainage on the Unity District, the Summit Spring Ridge on the LaGrande District, Kuhn Ridge on the Wallowa Valley District and others. A great many more areas, including mixed conifer communities on all Districts, have active Armillaria, causing individual tree, small center mortality and discontinuous gap formation over the landscape. In these and many other Armillaria-affected stands, extensive conifer mortality and reduced species diversity are considered impacts to management objectives. Armillaria has increased in incidence and severity as a result of recent human influences and activities. Partial cutting, entries and fire exclusion have allowed proliferation of shade tolerant species which are more susceptible to Armillaria infection. Soil damage, the result of caterpillar yarding during seasons when soil moisture is high and soils are compactible, has lead to increased virulent Armillaria activity in many instances. Recent vegetative management activities have strived to reduce these impacts by favoring less-susceptible hosts (restoring seral dominance) and placing high treatment priority on those stands being most impacted. Subsoiling compacted soils that are associated with virulent Armillaria may have a beneficial affect. Research is planned to answer this question.

Armillaria root disease on the Malheur is the most important root disease on the Forest, primarily damaging sites with compacted soils, but also believed to be increasing due to stand conditions developing from suppression of ground fires.

Black stain root disease, *Ophiostoma wageneri*

In southwestern Oregon, black stain root disease was the most commonly encountered disease in Douglas-fir plantations. High risk areas are considered to be those where disturbances such as road building or soil compaction has occurred or where road maintenance equipment injured roadside Douglas-firs. Black stain root disease was observed with increasing frequency on ponderosa pine east of the Cascade crest. It is an important management concern where stocking level control is planned for poor quality overstocked stands.

Black stain root disease was discovered on the Heppner RD in 1993; incidence and severity are light and low.

Black stain root disease on the south Malheur is a significant management concern due to its rapid spread, overstocked conditions of many stands, and planned stocking level control.

Annosus root disease, *Heterobasidion annosum*

Annosus root disease was responsible for losses in many partially cut white and grand fir stands in southern and eastern Oregon and eastern Washington. Mortality was high where annosus root disease and fir engraver beetles operate as a complex. In eastern portions of the Region where many stands were cut 10-20 years ago, trees surrounding cut stumps are dying. Disease severity is expected to increase with time. Using stump treatments to protect recently cut white fir stumps from colonization by the fungus is policy on the Wallowa-Whitman National Forest. Annosus root disease was observed with increasing frequency in predominantly ponderosa pine stands on drier sites in eastern Washington and Oregon. The potential impacts of annosus root disease on mountain hemlock and Pacific silver fir in high elevation stands in the Cascade Range continue to concern resource managers. Annosus root disease in low elevation western hemlock stands primarily causes butt rot; impacts are considered low unless stands are managed at rotations greater than 120 years.

On the Wallowa-Whitman National Forest areas of most substantial annosus activity are those that had the earliest and heaviest fir removals; where fir regeneration or residuals predominate. This fungus readily spreads to new sites by airborne spores. Freshly-cut stumps are infected and the fungus may successfully out-compete other organisms and colonize the stump and root system over the following decade or two.

Twenty years or so later, fir mortality may begin to occur around old fir stumps. This root disease in fir has not fully manifested itself since early removals on the Forest seldom included susceptible true fir. These last twenty-five years has included the bulk of the fir removal and there will be considerable appearance of annosus as a result. Three years ago the Forest implemented a policy of treatment to reduce potential for further spread of this disease. Where true fir will be managed in the future, freshly-cut stumps will be treated with borax to prevent colonization by the airborne spores of the fungus.

Port-Orford-cedar root disease, *Phytophthora lateralis*

Port-Orford-cedar root disease causes mortality of Port-Orford-cedar in southwestern Oregon. Approximately 4,200 acres containing diseased trees were mapped during the annual aerial detection survey. The disease causes extensive mortality on sites favorable for spread of its waterborne spores, especially along creeks, in lowlying areas, and below roads where water is channelled. Port-Orford-cedar on well drained sites usually escapes infection. Preliminary research results suggest that some resistance to the disease exists in Port-Orford-cedar populations.

Brown cubical butt rot, *Phaeolus schweinitzii*

Brown cubical butt rot is one of the most common root and butt rots in mature Douglas-fir on the westside of the Cascades. Douglas-fir, western larch, ponderosa pine and lodgepole pine are frequently infected on the east side. This is a commonly occurring pathogen in many developed recreation sites. Identification and careful monitoring is important in recreation sites where this disease occurs.

Stem Decays

Indian paint fungus,

Indian paint fungus occurs primarily in grand fir. Many of the fir-dominated stands are predisposed to high levels of this stem decay. Extensive levels of decay can be expected in older trees in mature stands. Damage is highest in the wetter of the grand fir plant community series. Where fir has invaded pine-dominated stands, Indian paint fungus-caused decay is expected to be lower. Levels of decay are believed higher than those that occurred in natural conditions. The proportion of defective trees tends to be increased by: proliferation of fir stocking in stands once dominated by seral species, and kept in seral dominance by disturbances (fire); maintenance of fir stocking for wildlife cover concerns; retention of wounded trees on the site; and protection of old stands from replacement fire events. No disease simulation models are available which accurately predict this defect on a stand basis.

Red ring rot, *Phellinus pini*

Red ring rot is the most common heartrot of Pacific Northwest conifers. Most stands of old-growth Douglas-fir, pines, larch, hemlocks, and true firs exhibit some amount of this disease. Red ring rot is more severely damaging moving south in Oregon, in older stands, in pure stands of host trees, on steep slopes, on shallow soils and on sites predominated by secondary shrub, herb, forb vegetation.

Dwarf Mistletoes, *Arceuthobium* spp.

Dwarf mistletoes are present on approximately 9.5 million acres of forested lands in the Pacific Northwest Region. Their status changes little from year to year. However, long term impacts including reduced growth, mortality, deformity, and topkill, are significant, particularly in unmanaged stands. All conifer species are affected to some degree. Douglas-fir dwarf mistletoe was the most damaging tree disease east of the Cascade crest. Western larch dwarf mistletoe causes significant effects in northeastern Oregon and central to eastern Washington.

Larch stands throughout the Wallowa Whitman National Forest have a high level of infestation. Most stands with a larch component are infected and in mature to overmature trees the level of infestation is at least 50 percent. There are a few large continuous areas of relatively healthy larch. These stands probably resulted from a large fire that burned hot enough to remove the existing larch component. Removal of residual larch will remove the source of infection. Trees will be killed after years of heavy infection when crown deterioration results from brooming and broom breakage. Most trees die when their functioning crown is less than ten percent of that of a healthy tree.

Douglas-fir mistletoe also results in high levels of mortality in severely infected trees. This mistletoe is also increasing in severity on the Wallowa-Whitman and Umatilla National Forests. Fire exclusion has greatly increased the proportion of fir on sites once kept in pine dominance. Use of unrecognized infected small trees as advanced regeneration in unevenaged management systems, has resulted in increased mortality and stand stagnation. Fire hazard on a landscape basis increases as brooms serve as fuel ladders. This last year saw considerable Douglas-fir beetle activity in severely mistletoe-infected trees.

Pine, Baker and Unity Districts of the Wallowa-Whitman National Forests all have ponderosa pine stands that are severely infected with western dwarf mistletoe. This mistletoe results in poor form, slower growth, and increased hazard to crown fire. It is recommended that infected pine stands be sanitized prior to embarking on unevenaged stand management, otherwise mistletoe infestation can quickly intensify. Spaced single story pine stands are only slightly impacted and easily manageable, even with moderate levels of mistletoe.

Insects and Diseases of Nurseries and Seed Orchards

Damping-off, *Fusarium* spp., *Pythium* spp.

At Wind River, J. Herbert Stone and Bend Pine Nurseries, seed lots sown at the usual time (April or May) suffered only average losses (approximately one percent) to damping-off. At one nursery, lots sown early (March) exhibited virtually no damping-off.

Fusarium root and hypocotyl rot, *Fusarium* spp.

At one nursery, two fields of ponderosa pine suffered only scattered losses, partly mitigated by the cool wet weather. The July fertilization seemed to stimulate an increase in Fusarium mortality. At another nursery, total losses were limited to a 30 percent loss of one seed lot of Douglas-fir to Fusarium root rot, associated with late sowing (June).

Phytophthora root rot, *Phytophthora* spp.

At one nursery, 1+1 larch seedlings had a high incidence of Phytophthora root disease. One third of two seedbeds was lost to root rot. Losses were associated with higher than normal rainfall, heavy/poorly drained soils, and root wrenching stress. At another nursery, the weather was cool, but dry; resulting in little detectable Phytophthora.

Gray Mold, *Botrytis cinerea*

At one nursery, up to ten percent cull is expected in 2-0 Douglas-fir, due to delay in treatment. Because Benomyl was temporarily unavailable, the nursery could only use chlorothalonil, and Botrytis builds resistance quickly. Implementation of the use of Botran authorized in the signing of the Supplemental EIS was delayed until the end of August, because of the required waiting period. At another nursery, losses were kept to a minimum (less than one percent) by maintaining seedbed densities near 20 per square foot, removal of pruned material (after top pruning), and one application of Benlate and Botran in a tank mix.

Storage Problems, *Pythium* spp.

At one nursery, 25 percent of the root systems of two lots of 1+1 Douglas-fir were destroyed by Pythium while in cold storage.

Poplar and Willow Borer, *Cryptorhynchus rapathi*

Willow stool beds at the J. Herbert Stone Nursery are infested by this borer. Current infestation is sparse, but contingencies are ready if the infestation level increases in 1994.

Dioryctria contortella

Large, overwintering larvae of this bivoltine species were found feeding on the bark of one and two year old graft unions of Douglas-fir seedlings. Less than 10 percent of the grafts were infested. In some instances the grafts were completely girdled by the feeding.

Poplar Leaf Rust, *Melampsora larici-populina*

Melampsora larici-populina, native to Eurasia, was found in late autumn 1991 in hybrid poplar plantations along the lower Columbia River in Washington and Oregon. Surveys completed in 1992 and 1993 indicate that the fungus has spread to other poplar plantings, however incidence and related damage were low. No impacts to coniferous alternate hosts were observed.

Shothole disease, *Coccomyces* spp.

Shothole disease caused by *Coccomyces* sp. became evident late in the season on chokecherry at Bend Pine Nursery; losses were less than one percent. This disease has the potential to destroy an entire chokecherry crop if left untreated. Treatment consists of approximately four applications of dodine during the summer.

Gymnosporangium rust, *Gymnosporangium* spp.

At Wind River Nursery, aecial infection of a Gymnosporangium rust was intense enough to cause growth loss in first year serviceberry. Of the many possible alternate hosts, only incense cedar is growing near the nursery (in the arboretum). Prevention requires fungicidal spray every two to three weeks from budbreak until the telia on the alternate host are inactive. A search for telial spore horns on the incense cedar in July was unsuccessful. In spring 1994, more searching will hopefully indicate when the telia are active.

Abiotic Diseases

Excessive moisture on bitterbrush

At Bend Pine Nursery, a heavy thunderstorm resulted in flooding of the field of 1-0 bitterbrush for several hours in June. Resulting foliar dieback stressed seedlings, making them susceptible to root rot caused by Fusarium. Of 1.2 million seedlings, only 500,000 (42 percent) survived. At J. Herbert Stone Nursery, two weeks of overwatering resulted in foliar dieback and five percent mortality in three lots of 1-0 bitterbrush. At both nurseries, most bitterbrush seedlings reflushed, but this was difficult for such small seedlings.

Excessive heat on mountain mahogany

Early in the season at Bend Pine Nursery, first year mountain mahogany seedlings suffered heat damage to the hypocotyl area near groundline. Mulching with sawdust successfully altered the microclimate until seedling foliage grew sufficiently to shade the soil surface.

Economic Analysis of Pacific Northwest FID Programs for FY 1993

As part of a national FPM study, the benefits and costs of certain FID programs in the Pacific Northwest Region were analyzed for fiscal year 1993. This analysis only covered those activities funded by Forest Health Management (formerly Survey and Technical Assistance) funds; activities funded by suppression/prevention funds, technology development funds, or other sources were not addressed.

Work funded through Forest Health Management funds was classified according to both the general type of activity and the resulting benefits. Six activity categories were recognized: technical assistance, suppression/prevention project support, technology development support, information transfer, forest health monitoring/pest detection, and pesticide use coordination. Twelve benefit categories were used: maintain ecological processes, avoid pesticide-related costs, increase seedling production from nurseries, avoid tree planting costs, avoid tree removal or replacement costs, avoid pest or fire suppression costs, salvage dead or dying trees, shift harvests to capture green value, avoid personal injury and property damage, increase seed production from seed orchards, program share of suppression/prevention project benefits, and increase timber volume at harvest. The allocations of FY 1993 FID funds (Forest Health Management account only) are shown by activity in figure 10 and by resulting benefit in figure 11.

Separate analyses were performed for each activity/benefit category in which $25,000 or more was spent in FY 1993. The overall benefit/cost ratio for FID programs was 8.03 (range: 1.5 to 28.0). Excluding one outlier (activity: forest health monitoring, benefit: salvage) whose B/C ratio was 28.0, the overall B/C ratio was 5.62 (range: 1.5 to 13.7). The overall present net value for FID programs was $541,000 (range: $25,000 to $2,554,000). Excluding the forest health

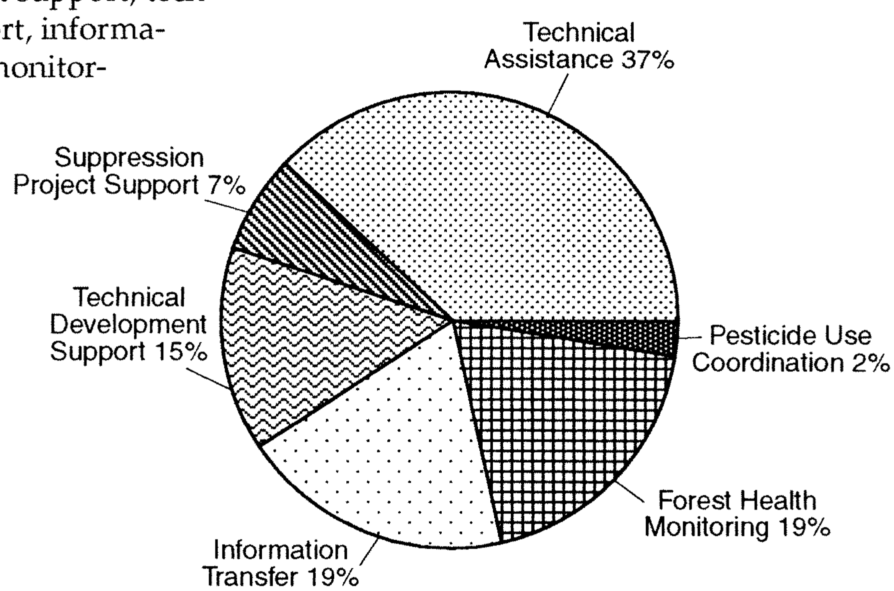


Figure 10 – FPM 1993 Activities

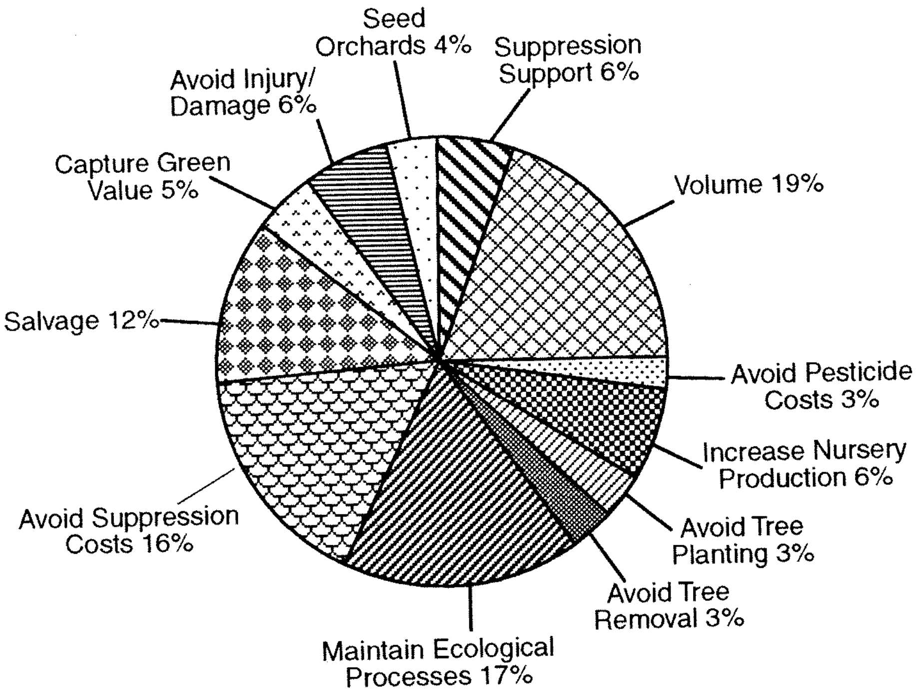


Figure 11 – FPM 1993 Benefits

monitoring/salvage outlier, the overall present net value was $416,000 (range: $25,000 to $1,301,000).

Forest Pest Management Reorganization

For the last several years, FPM has been represented in the Region by the FPM staff unit in the Regional Office (RO) and three zone offices. The RO staff consisted of a pathology group, an entomology group, a planning/integrated pest management group, and an operations group. Field offices were the Central Oregon Pest Management Zone located in Bend, OR; the Blue Mountains Pest Management Zone located in La Grande, OR; and the Eastern Washington Forest Health Office located in Wenatchee, WA.

Reviews of the three zone programs were conducted in 1992. Based on these reviews we decided to expand the decentralization of FPM to include the westside of the Cascades by establishing technical centers in southwestern Oregon (Medford), and northwestern Oregon and western Washington (Gresham). In addition, the Wenatchee office would be changed from a zone to a technical center and the area of responsibility would be expanded. We will begin staffing the Southwest Oregon and Westside Forest Insect and Disease Technical Centers in April 1994.

Once the technical centers have been established the areas of responsibility for each field location will be:

Blue Mountains Pest Management Zone, LaGrande, OR:

- Umatilla Indian Reservation
- Umatilla, Malheur, and Wallowa-Whitman National Forests
- other federally managed lands in northeastern Oregon

Central Oregon Pest Management Zone, Bend, OR:

- Ochoco, Deschutes, Winema and Fremont National Forests

- Warm Springs Indian Reservation
- other federally managed lands in central Oregon

Southwest Oregon Forest Insect and Disease Technical Center, Medford, OR:

- Siskyou, Umpqua, and Rogue River National Forests
- Coos Bay, Medford, and Roseburg Districts of the BLM
- other federally managed lands in southwestern Oregon

Westside Forest Insect and Disease Technical Center, Gresham, OR:

- Mt. Hood, Siuslaw, Willamette, Gifford Pinchot, and Olympic National Forests
- Columbia Gorge National Scenic Area
- Eugene and Salem Districts of the BLM
- Olympic National Park
- other federally managed lands in western Oregon and Washington

Eastern Washington Forest Health Office, Wenatchee, WA:

- Wenatchee, Okanogan, and Colville National Forests
- Yakima, Colville, and Spokane Indian Reservations
- other federally managed lands in eastern and north central Washington

Field offices were originally established to better serve Federal land managers at the field level. Prior to reorganization, insect and disease management assistance was provided from FPM out of the Regional Office. Because of the distance to the field sites, entomologists and pathologists spent too little time each year on some Forests except when attached to suppression projects. Now, with a Forest staff entomologist and pathologist, entomology and pathology information can be integrated more easily into every facet of District and Forest ecosystem management and planning.

Work planning is largely in response to requests and assigned priorities from Federal clients. Biological evaluations, largely for EA and EIS input, are a major portion of the workload. Training of field crews, silviculturalists and other resource specialists is also emphasized. Most field crews in the area offices are or will be exposed to at least one day of insect and disease identification and basic management training annually.

Technical Assistance Summary

Numerous technical assistance visits were made to the field in 1993. In addition to National Forests, these visits involved other agencies such as the Bureau of Indian Affairs and Bureau of Land Management. Most of the insect-related calls for technical assistance were associated with the prolonged drought which has affected areas of the Pacific Northwest Region over the past several years. Several administrative units dealt with large-scale fir mortality caused by the fir engraver. Technical assistance visits were needed to help develop salvage guidelines and schemes for risk-rating stands yet unaffected. Another drought-related area of concern was the loss of large overstory ponderosa pines in dense stands throughout many areas of the Region. These pines are being killed by the western pine beetle, and their death often causes dramatic changes in stand structure.

Several insect and disease training sessions were conducted in 1993. These sessions are being offered to a broader audience than in the past, with the intent of explaining the roles of insects and disease organisms in a broader context than simply as "pests".

Technical assistance was a high priority work area for the zone pathologists and entomologists, with assistance provided to assure that insect and disease influences are considered in District and Forest project planning.

Activities

Guidelines for Viable Ecosystems – Ochoco National Forest

Over the past 18 months, FPM has worked with the Ochoco National Forest to develop guidelines for managing viable ecosystems. The products of this effort will provide a framework for ecosystem management for the Forest. This framework is built on the distinct productivity levels associated with different plant association groups within forested environments. Each of these groups has its own disturbance regime, succession patterns, and potential habitats for other organisms. Within this context, insects and diseases are described as disturbance agents which influence plant succession and vegetative patterns on the landscape in each group of vegetative potentials. FPM participation in the development of these guidelines has been an avenue for broadening how insects and diseases are perceived and how their overall roles in the ecosystem are understood.

Hazard tree monitoring field aid

A draft field aid has been developed to assist in the documentation and monitoring of hazard trees in the field as an adjunct to the Region 6 publication; *"Long-Range Planning for Developed Sites in the Pacific Northwest: The Context of Hazard Tree Management."* After using the field aid this year, District recreation personnel will meet with Central Oregon FPM zone and discuss possible improvements or revisions to be incorporated into the final field aid which will be provided to each district next year.

Forest health coloring book

A coloring book was developed by pathologist Helen Maffei and the Deschutes National Forest for use by children in developed recreational sites. It explains how some of the more common human actions on these sites affects the health of the trees. The objective is to emphasize that every user has a responsibility to maintain and promote the health of our National Forests. A Spanish version of the book is currently being printed.

Santiam Pass Visualization Project

To better understand the impact of forest insect and disease management activities and catastrophic fire on the scenic beauty and, ultimately, the quality of the recreation experience, Central Oregon Pest Management Zone pathologist Helen Maffei, the Deschutes National Forest and FPM Statistician Tommy Gregg are working on a cooperative project with Brian Orland (Dept. of Landscape Architecture, University of Illinois), Terry Daniel (Department of Psychology, University of Arizona), and Ann Lynch (Rocky Mountain Forest and Range Experiment Station, USDA Forest Service).

This technology correlates data and projection models with Geographic Information Systems and High Definition Digital Image Processing. The technology will be used to assess the impacts of the western spruce budworm together with other factors influencing stand dynamics under various treatment scenarios, including no treatment, on mixed conifer stands throughout the Upper Santiam and McKenzie Pass areas.

Concurrent with the visual imaging and data collection this study deals with visitor perceptions pertaining to various visual quality conditions. When scrutinized by Forest Service specialists, the public, private industry and the courts, this process represents the best supportable technology available.

Watershed Summary

During FY 1994, the Blue Mountains Pest Management Zone will provide detailed input into the watershed analysis projects for the Wallowa-Whitman and the Umatilla National Forests. The Malheur is using past biological evaluations from the zone to identify issues on their analysis. Personnel are on the core team for the Wallowa-Whitman and consultant status on the Umatilla. Since insect and disease concerns are the driving factors in the current conditions and health of the east side forested ecosystems, especially in the Blue Mountains, they will be major issues in the watershed analysis.

Much of the work will involve using the aerial survey, vegetation, and activity databases, and use UTOOLS landscape and watershed analysis software to hazard rate communities in individual watersheds. Comparisons of historical and current conditions will be used to document the departure from natural range of variability. Potential projects will be identified for those communities that are at high risk to catastrophic impacts from biotic agents and fire.

Characterization of Canopy Gaps in the Blue Mountains

This study examines how diseases, insects, human activities and other agents of disturbance can change the structure and function of forest ecosystems in the Blue Mountains. It emphasizes a holistic approach to describing disturbance and the impact of disturbance. This approach was developed in response to the recent emphasis placed on sustained management of resilient ecosystems by the USDA Forest Service. The study involves an interdisciplinary effort among research (J.E. Lundquist RM, S. Martin PNW), State and Private Forestry, Forest Pest Management (J.S. Beatty FPM R-6 and MAG, WO), and National Forest Systems (Wallowa-Whitman National Forest).

Our initial efforts have focused on method development. During the summer of 1993, plots were established at three sites within the grand fir/Douglas-fir type on the La Grande Ranger District. Each plot was four-hectare in size with a 5 m X 5 m grid of optical densiometer readings. These data were used to generate two-dimensional graphic displays (patterned isopleths) of the variation of canopy closure over the plot using GIS software. Isopleths were subsequently used in the field to identify and relocate canopy gaps, which were then assessed for: 1) cause, predisposing conditions, and associated tree responses; 2) abundance and condition of snags and coarse woody debris; and 3) abundance of recolonizing vegetation. Spatial analysis and geostatistical techniques are currently being used to calculate indices useful in summarizing the disturbance status on an ecosystem scale. We hope managers will eventually be able to use these indices to describe desired future conditions and to help establish forest plan standards and guidelines.

Forest Health Monitoring

The goal of the Forest Health Monitoring (FHM) program is to detect changes and trends in forest conditions and to report and interpret these changes at a national, regional, and, when possible, a State level. Efforts are undertaken jointly between the USDA Forest Service, the US Environmental Protection Agency, the USDI Bureau of Land Management, the USDA Soil Conservation Service, other Federal agencies, and state forestry agencies plus university, conservation, and nonprofit groups. Ongoing FHM work complements other efforts within the EPA Environmental Monitoring and Assessment Program, started in 1990.

California and Colorado are two of 14 States in which FHM Detection Monitoring activities have taken place. The Western FHM program began in March 1991 when representatives from the California Department of Forestry and Fire Protection, and the Pacific Northwest Research Station identified potential partners, users, and cooperators. This led to an Information Needs and Assessment workshop held in Sacramento on May 22. Some 30 agencies and groups contributed suggestions at this meeting; another 30 groups were also identified as potential cooperators. Planning is also underway to begin operational FHM plot work in Oregon and Washington in summer 1995. Information Needs Assessment meetings were held in both States, respectively in November and December 1992. Grid points, aerial photos, and base maps are now being acquired and interpreted. Regionalization of FPM off-plot data with FHM on-plot data has begun. Operational field plot work in Alaska is not planned until summer 1997; Hawaii may enter the program a bit later.

Port-Orford-Cedar Management Program

A comprehensive interregional program to control Port-Orford-cedar root disease and insure the presence and productivity of Port-Orford-cedar was instituted in 1988 by Pacific Northwest and Pacific Southwest Regions of the USDA Forest Service. The program enlists, supports, and coordinates the work of concerned foresters, ecologists, resource managers, and research scientists to make sure that Port-Orford-cedar remains a viable component within the forested ecosystems of the Pacific Northwest. Participants in the program include the Forest Service, Bureau of Land Management, National Park Service, state universities, private companies, state and local governments, and interested foreign countries.

Approaches taken in the Port-Orford-cedar program to insure the viability of the species and control the spread of the disease are implemented under the Forest Service policy of ecosystem management. A multi-agency and multi-resource coordinating group ensures that appropriate resources are dedicated to studies of both the host tree and the root disease pathogen. Members of the coordinating group include managers, ecologists, pathologists, foresters, silviculturists, and geneticists from the Forest Service research, National Forest System and State & Private Forestry units, the Bureau of Land Management, and universities. Management direction for the program is contained in the Port-Orford-cedar action plan, in forest plans of the four national forests within the natural range of Port-Orford-cedar, in the Bureau of Land Management draft guide for management of Port-Orford-cedar, and in the National Forest Management Act (NFMA) and the National Environmental Policy Act (NEPA).

An action plan, developed for National Forest System and Bureau of Land Management lands, provides direction for maintaining Port-Orford-cedar as a viable component of the ecosystem. The action plan provides direction for inventory and monitoring, research, public involvement and education, and management policy. Direction for monitoring the presence and movement of the disease, and the development and evaluation of control strategies, are included in the plan.

Research and administrative studies in progress as a result of the action plan include a search for natural resistance to the root pathogen, analysis of genetic variation of Port-Orford-cedar throughout its native range, development of a soil assay test for detection of the root pathogen in soil, and determination of spore longevity in the absence of Port-Orford-cedar.

1993 Warm Springs Indian Reservation Western Spruce Budworm Suppression Project

A western spruce budworm suppression project was conducted on the Warm springs Indian Reservation in central Oregon in 1993. The project was a cooperative effort involving the Warm Springs Tribe, Bureau of Indian Affairs, and the USDA Forest Service. Slightly more than 64,000 acres were sprayed with a *Bacillus thuringiensis* insecticide to suppress the outbreak. All application was made by helicopters. The project was managed using the Incident Command System. The cost of the project was $862,000, an average of $13.43 per acre. Post spray population densities were less than one budworm per midcrown branch tip for the three treatment units in the project.

TM Biocontrol-1

The Forest Service operated facilities to produce Douglas-fir tussock moth nuclear polyhedrosis virus in Corvallis, Oregon from 1980 to 1992. The virus was produced by infecting large numbers of tussock moth larvae with virus and recovering it from the dead insects. The virus is the active ingredient in the insecticide TM Biocontrol-1. This insecticide, produced and registered by the Forest Service is available to suppress outbreaks of Douglas-fir tussock moth.

The Forest Service produced an estimated 501,598 acre doses of virus from 1980 to 1992. Several processing firms recovered a total of 403,680 acre doses of TM Biocontrol-1 from the virus. There are 375,237 acre doses of TM Biocontrol-1 in storage at the Forestry Sciences Laboratory in Corvallis. Cost of production of 403,680 acre doses was $3,190,000 or $7.90 per acre dose. Production ended in 1992.

FPM Geographic Information System (GIS) data currently available

The annual regional aerial detection survey data has been digitized for the years 1986-1993. Each year's survey is separated into the following five digital layers: Western spruce budworm; pine beetles; Douglas-fir and true fir beetles; Douglas-fir tussock moth; and other damage. The Western spruce budworm suppression project areas for 1980-1992 are also complete. The Port-Orford-cedar range and *Phytopthora lateralis* occurrence in Region 5 and Region 6 is available, but needs to have a field review before it will be considered final.

GIS software/hardware accomplishment

We have moved from AMS (and WAMS) to LTPlus for data capture. LTPlus allows us to edit scanned data (raster format) which speeds up our data capture ability. All our digital data was converted from MOSS to ARC/INFO last year, so now all analysis occurs in ARC/INFO. We are using an IBM x-terminal that is connected to an IBM workstation via a local area network. With the conversion to ARC/INFO and the workstation environment, we also gained the ability to plot our final display products on an electrostatic plotter.

Recent projects/analysis that were aided/accomplished using FPM's GIS

Several FPM projects have used GIS capabilities. One project is the annual reporting process of the regional aerial detection survey. The GIS allows us to determine acreage, number of trees killed, tree volume in board feet or cubic feet and spatial locations (state, county, and specific land-ownership) of the damage mapped. It is also being used quite extensively for spatial analysis and display to determine the effectiveness of western spruce budworm suppression projects over the past ten years. In addition, we used the GIS for spatial analysis and display of the location and acreage of Port-Orford cedar and the root disease, *Phytophora lateralis* in various administrative and reserved (Option 9) areas. We have generated cartographic display products for several federal and state government customers.

Analysis of the Effects of Suppression Projects on Subsequent Defoliation and Bark Beetle Activity

Many insecticide treatments have been applied to suppress western spruce budworm populations since the current Blue Mountains outbreak began in 1980. Several questions regarding the effectiveness of these treatments have arisen: What is the effect of treatment on defoliation in subsequent years? Is mortality caused by bark beetles higher in untreated areas than in treated areas? Is there any evidence of budworms from untreated areas invading adjacent treated areas? An analysis was initiated in 1993 that uses a GIS to answer those questions.

Several maps are being overlaid using the ARC/INFO GIS system. Boundaries of all suppression projects aimed at western spruce budworm and/or Douglas-fir tussock moth populations from 1980 to the present have been digitized. Aerial survey observations of defoliation and bark beetle activity are also being digitized for this time period. Insect activity will be evaluated within suppression project boundaries, in adjacent areas, and region-wide. For each project, insect activity will be analyzed for three years prior to the project year, during the project year, and for four years following the project. Defoliation intensity levels will also be examined. This analysis will be completed by September 1994.

Insect and Disease Models

Douglas-fir tussock moth (DFTM) model -- The DFTM model was one of the first insect or disease models developed (late 1970s). Like nearly all of the insect and disease models that have been linked to Forest Vegetation Simulator (FVS, formerly the Stand Prognosis Model), the DFTM model has not been tested using independent data. A team of cooperators including research (Pacific Northwest and Intermountain stations) and pest management (Region 4, Region 5 Region 6 and the Methods Application Group) was funded through a technology development project to evaluate the current DFTM model and test it using Boyd Wickman's data from an outbreak in the mid-1970s in the Blue Mountains.

The initial evaluation showed that a key component of the DFTM model -- the relation between midcrown branch defoliation and whole tree defoliation -- was very critical and inherently weak. The team tested the DFTM outbreak model and several options using the Budworm Damage Model against the observations recorded by Wickman in the 1970s outbreak. Preliminary results indicate that the budworm Damage Model performed better than the DFTM model, but none of the model options performed especially well. There was so much variation in the observed relation between defoliation and effects that other factors will need to be included when predicting the effects of defoliation by DFTM on stands.

Western spruce budworm (WSB) population model -- The WSB population model, which was designed as a research tool, is so huge and complex that it is rarely used. A technology development proposal has been funded to streamline the population model so that it can be used as a management tool. A team of managers and scientists will be assembled to determine the key factors and interactions to be included in the model as well as the outputs desired. One area of emphasis will be to design output that addresses non-timber concerns, such as wildlife habitat, stream quality, and visual impacts. This project will be completed in September 1995.

Western pine bark beetle model -- A new model that simulates the effects of several bark beetle species (mountain pine beetle, western pine beetle, and *Ips*) on a wide range of western pine species is being developed. Dissatisfaction with the scope of the current mountain pine beetle model (which simulates mountain pine beetle on lodgepole pine for single stands only) triggered development of this new model, which is expected to be made available in 1995.

Annosus Root Disease/Bark Beetle Model
A new forest vegetation simulator extension that simulates the effects of Annosus root disease (including interactions with several bark beetles) is nearing completion. The model will be field tested in 1994, and a user's manual and other training material will be prepared. Susan Frankel (Region 5) has lead responsibility for this project.

PNW Region Publishes Results of Vegetation Management Literature Search

In March of this year, Region 6 FPM distributed the results of its first computerized search of scientific literature and anecdotal accounts relating to managing competing and unwanted vegetation. The database contains 1559 citations, many with abstracts on the environmental and human health effects of manual, mechanical, biological, chemical, and thermal treatments. The search covered all items entered into commercial databases between September 1, 1990, and December 31, 1991.

The database is intended to keep the Region and cooperators abreast of research on the effects of vegetation management, in accordance with our obligations under the Mediated Agreement. It is designed to be used in the vegetation analysis and planning process. (For those new to the agency, in 1989 the "Mediated Agreement" ended a long-standing Federal lawsuit against the use of herbicides in Region 6.) Herbicides included within the scope of the search were glyphosate, hexazinone, triclopyr, picloram, asulam, atrazine, bromacil, simazine, dicamba, 2,4-D, 2,4-DP, and tebuthiuron.

Region 6 has entered into an interregional agreement with INFO-South of Region 8 to produce annual updates of the database for the agency and the Bureau of Land Management. Each Regional Forester and the Director of the NE Area was sent, under file code 2150, a set of floppy disks which included a licensed retrieval system and directions for loading the system.

Updated Guide to Conduction of Vegetation Management Projects in the PNW Region

The PNW Region updated its guide in 1992 and 1993 to reflect changing legal interpretations and to give more detailed direction to field employees. We revised sections of the Guide as follows:

Chapter III Worker Health Protection and Reporting

Updated to implement Supplement to Vegetation Management Record Of Decision (ROD), 1992. Changes to require additional available information and optional extra protective equipment for employees working on certain herbicide applications. Gender-specific restrictions of the original ROD (1988) are eliminated.

Chapter IVWorking with Cooperators

With Regional Lands and Minerals staff leading the rewrite effort, Chapter Four was rewritten to provide detailed guidance on requirements for planning and implementing vegetation management projects undertaken by individuals, agencies, or companies who hold a special use authorization for use of National Forest system land.

Chapter VI Information Profiles

Regional Integrated Pest Management (IPM) staff produced Information Profiles for three herbicides available for use under the Regional Vegetation Management FEIS: picloram, hexazinone, and triclopyr. They are for use by planners, decision-makers, workers, and the public. Herbicide Profiles present what is known about the use and potential effects of each herbicide and its formulations in forestry, range and noncrop uses. The profiles are not NEPA decision documents and do not require public comment on their contents when used in site-specific environmental assessments. Regional IPM will update profiles as we find important new information in our review of the annual literature search; new information may be submitted for evaluation in the review process.

Non-target Lepidoptera studies

"Investigations and Literature Survey of Region 6 Sensitive Plant Species and Potential Lepidopteran Pollinators," by Susan Kephart, Willamette University, Salem, Oregon.

The objective of this study was to assess the potential importance of insect pollinators, particularly lepidopterans, to selected Region 6 sensitive plants and develop a pollination monitoring protocol. A pilot literature survey on Region 6 plants and pollinator relationships was also completed.

Pollinator exclusion experiments demonstrated insects as important pollinators of four out of five species. Lepidopterans were found to be important pollinators of one of the five plants studied; Gorman's aster on the Willamette National Forest. The aster site on Ousterman Mountain near Detroit appeared to be along a major flyway for migrating butterflies.

Two new rare plant species, tall agoseris and the Nevus onion, were found at Prairie Farm and the range of the onion was extended by this new county record.

"Establishment of Baseline Data on Populations of Immature Lepidoptera for Reference to Future Spruce Budworm Control Projects and Components of Bat Diets" and *"Assessing the Impact of* Bacillus thuringiensis *on Field Populations of Nontarget Immature Lepidoptera, Warm Springs, Oregon"* by Jeffrey Miller, Oregon State University, Corvallis, Oregon.

The primary objectives of these studies were to develop baseline information on immature lepidopteran abundance, seasonal population trends, and host plant associations and assess effects of Bacillus thuringiensis (B.t.). sprays on species richness, abundance and live mass of caterpillars.

A total of 1445 caterpillars were collected from 52 plant species. Because there are few keys to identify larval lepidopteran species, caterpillars were reared on their host plants in the laboratory to the pupal stage. Many pupae are still dormant. Of those which have emerged as adults, most identified species (68%) belong to 3 families of lepidoptera (*Geometridae, Tortricidae,* and *Noctuidae*). The greatest number of larvae were found on four upland shrub species: snowbrush, greenleaf manzanita, bitterbrush, and ocean spray. Riparian shrubs did not harbor an abundance of caterpillars relative to the four upland shrub species. One species never before found in Oregon was found at Prairie Farm.

Comparisons of sprayed and unsprayed areas of the Warm Springs Indian Reservation demonstrated significant declines in certain non-target lepidoptera. In sprayed areas species richness was reduced 33-67%, number of caterpillars was reduced by 72-86%, and live caterpillar mass was reduced 84-97%.

"Impacts of Bacillus thuringiensis *on Nontarget Lepidoptera and Population Surveys of Lepidoptera in Potential Spray Areas"* by David Grimble, Pacific Northwest Experiment Station, Corvallis, Oregon.

The primary objective of this study was to determine baseline information on nocturnal lepidopteran species diversity, relative abundance, and periodicity of flight. Lepidoptera were collected in black light traps placed along Santiam Pass/Highway 126 from the Fish Lake Area to Suttle Lake and in sprayed and unsprayed areas of the Warm Springs Indian Reservation western spruce budworm suppression project. Plant lists were completed for trap vicinities to assess vegetative diversity of the immediate area. Some diurnal Lepidoptera were collected.

Over 400 species of lepidoptera were identified. The lava fields near Fish Lake yielded two species never before found in Oregon. Many new county and state records were established and several species ranges were substantially extended. Several rare moths were found in a wet meadow site on the Warm Springs Indian Reservation including a very rare noctuid moth. An unexpected finding was the abundance of large-bodied moths including pandora, sphinx, and silk moths.

Western Spruce Budworm Permanent Plots

In 1986 permanent plots were established in 33 stands on two national forests in the Blue Mountains of northeastern Oregon. Approximately 30 plots were established in each of these stands. Defoliation, topkill, and mortality data have been collected annually on all plot trees. In addition, root disease, stem decay, and dwarf mistletoe information has been collected on all plots. In 1995 or 1996, radial and height growth data will be collected for a subsample of plot trees.

The primary use of these data will be to develop topkill equations for the Western Spruce Budworm Damage Model, a computer simulation model which links to a tree growth model called the Forest Vegetation Simulator (FVS). In addition, this information will be analyzed to determine relations of stand structure and composition to the level of budworm-caused effects, and the differences between insecticide-treated and untreated stands. These data also should be very useful in updating and streamlining of the Western Spruce Budworm Population Dynamics Model. This model which will be valuable in forest planning efforts and in estimating the effects of budworm-caused defoliation on resources such as visual quality, wildlife habitat, fisheries habitat, recreation, and old growth habitat.

1993 Douglas-fir Tussock Moth (DFTM) Pheromone Trapping

Douglas-fir tussock moths are trapped in Oregon and Washington each year as part of the Douglas-fir Tussock Moth Early Warning System, a cooperative monitoring effort involving the following state and federal agencies: Oregon Department of Forestry, Washington Department of Natural Resources, USDA Forest Service, and USDI Bureau of Land Management. This trapping has been done in Region 6 since 1979. Data gathered annually on the Early Warning System plots are used to monitor trends in DFTM population levels, and to detect incipient DFTM outbreaks so that treatment alternatives may be evaluated and implemented in a timely manner.

California Gulch Bark Beetle/ Thinning Study

This study was installed in 1967 by Charles Sartwell, retired PNW research entomologist, and Bob Dolph, retired Region 6 Forest Pest Management entomologist, to ascertain whether thinning second-growth ponderosa pine stands would prevent or reduce tree mortality caused by mountain pine beetle attacks. The study site is located near Baker City in northeast Oregon, on the Wallowa-Whitman National Forest. Five thinning treatments were applied: unthinned, 12x12 ft. spacing, 15x15 ft. spacing, 18x18 ft. spacing, and 21x21 ft. spacing. Data on tree mortality were collected in 1972, 1977, 1982, and 1992. Stocking, insect, disease, and tree growth data also were collected in 1992. Analysis of these data is planned for 1994. Results of this study should provide useful information for management of second-growth ponderosa pine forests, and aid pine beetle model development and verification.

Region 6 Insect and Disease Guide

Region 6 Forest Pest Management staff are currently working to produce a forest insect and disease guide specific to Oregon and Washington. The guide will be designed to help inventory, cruising, and stand exam crews correctly identify insects and disease pathogens (or their diagnostic indicators), and rate severity of effects. Pathogens and insects to be included in the guide have been identified, and the accompanying descriptive writeups are nearly complete. The next step is compilation of appropriate photos and illustrations. We hope to have the guide available by spring 1995.

Current Vegetation Survey: What's New in Regional Vegetation Inventory

For several years, Forest Pest Management staff have been working with the Regional Plans and Inventory group to develop more accurate and consistent methods for acquiring information on the incidence, severity, and damage caused by the major forest insects and diseases at a scale useful to the forest planning process. During 1992, Tom Gregg and Ellen Michaels Goheen worked with a field crew on the Okanogan National Forest to test several vegetation inventory methods. Their goal was to determine how accurately and efficiently basic insect and disease information, including that required for model input, could be collected within the context of a Regional vegetation survey. The methods were evaluated over the field season by a team consisting of Tom, Ellen, inventory specialists, an ecologist, a silviculturist, wildlife biologists, and a fuels specialist. Data elements necessary for adequately characterizing the structure, composition, and stocking level of forests and including information on major forest insects and pathogens were agreed to by seasons end. These elements were incorporated into new Regional inventory procedures, the Current Vegetation Survey (CVS), in 1993.

The CVS is a permanent plot grid system, with the grid scale currently at 3.4 and 1.7 miles, that samples the range of vegetative conditions across all proclaimed National Forest lands in the Pacific Northwest. Sample units consist of one-hectare circular plots with subsampling units designed to describe current vegetation.

Disease and insect information gathered on plots include damage and severity coding for all trees (live and dead) greater than 1.0 inches dbh. Higher priority is given to damage caused by bark beetles, root diseases, dwarf mistletoes, and defoliating insects. Up to three damage codes can be recorded for an individual tree. Severity codes are designed to provide information required by current disease and insect model extensions to the Forest Vegetation Simulator (Prognosis). Stumps with root disease are lump tallied by diameter class. In addition, a root disease severity rating is estimated on five 1/20th acre subsampling units within the hectare plot to supply additional information for the Western Root Disease and Annosus Root Disease Models.

Forest Pest Management worked with the Regional Inventory Coordinators during the summer and fall of 1993, providing training in insect and disease identification to Forest crews and contract inspectors. Insect and disease identification demonstrations were also held on installed plots for several contractors. FPM visited several installed plots over the season to check for accuracy and to answer questions by crew members. Similar activities are scheduled for 1994.

In addition, FPM developed a report that can be generated from sample unit data. The report provides the user with a stand table by tree species, detailed information on insects and diseases recorded on the plot, standing dead tree information including condition and wildlife use, a down woody material report, and an FVS-ready treelist that includes keywords describing current root disease conditions.

All indications are that information gathered during installation of CVS plots will accurately describe the incidence, damage, and severity of the major insect and disease groups and will be useful at Forest and Regional levels.

Westwide Pest-Trend Impact Plot Project

The Westwide Pest Trend Impact Plot Project was created in 1990 to establish a series of permanent plots throughout the western states. Its purpose is to provide data for validating, calibrating, and developing forest disease and insect model extensions to the Forest Vegetation Simulator (formerly called Prognosis). Agents modelled currently include root diseases, bark beetles, dwarf mistletoes, western spruce budworm, Douglas-fir tussock moth, and white pine blister rust.

Forest Pest Management in Region 6 has established and monitored several plot systems in recent years as a part of this project. Several activities occurred in 1993. In cooperation with the Clackamas Resource Area, Salem District, Bureau of Land Management, we established a series of plots in second-growth Douglas-fir stands on the westslope of the Cascade Range where laminated root rot occurs. Plots were established to gather information on both "S" and "P" types of annosus root disease with the help of District personnel on the Bly Ranger District, Fremont National Forest and in cooperation with Region 5 FPM. We began a project on the Warm Springs Indian Reservation using previously established Continuous Forest Inventory plots in high elevation mountain hemlock stands where laminated root rot is a major disturbance agent.

Previously established plots that were remeasured in 1993 include approximately 30 western spruce budworm impact plots in each of 33 stands located on the Wallowa-Whitman and Malheur National Forests and 117 root disease monitoring plots located on the LaGrande Ranger District, Wallowa-Whitman National Forest. Ponderosa pine dwarf mistletoe growth impact plots were remeasured. These plots are a subset of a large group of plots established over the range of ponderosa pine in the Region and their data completes the ten-year post-thinning dataset for 140 plots.

Technology Development Projects

Alternative Technologies for Management of Soil Borne Disease in Bareroot Forest Nurseries in the United States

AKA "Methyl Bromide Alternatives"

by R. L. James, D. M. Hildebrand, S. J. Frankel, M. M. Cram and J.G. O'Brien

For the past few decades, most forest nurseries producing bareroot seedlings in the United States have relied on soil fumigation with methyl bromide and other chemicals to control soil-borne diseases. The production and use of methyl bromide in the United States will be phased out by the year 2001. Reliance on any chemical is a considerable risk, considering the continuing losses in registration and availability of many widely used chemical pesticides. Therefore, growers need alternative methods to continue producing high quality seedlings without chemical fumigation.

In 1993, Forest Pest Management pathologists from the Northeast Area and Regions 1, 5, 6, and 8, together with state, university, and private cooperators, began this multi-year (1993 through 1997) project. The objective is to enhance implementation of integrated pest management (IPM) at forest nurseries by 1) developing and evaluating alternative cropping procedures and determining effects on soilborne diseases; 2) Evaluating beneficial microorganisms as tools for managing soilborne diseases in forest nurseries; and 3) Developing accurate monitoring techniques for soilborne pathogens.

The alternative cropping procedures include the use of different organic amendments, fallow periods, cultivation, and cover crops. In 1993, field tests were begun at the following nurseries: Coeur d'Alene (Idaho), Lucky Peak (Idaho), Wind River (Washington), Bend Pine (Oregon), J. Herbert Stone (Oregon), Humboldt (California), Placerville (California), Toumey (Michigan), Andrews State Nursery (Florida), Magalia State Nursery (California), and Griffith State Nursery (Wisconsin).

Monitoring fungal population levels by assay of soil samples has been unreliable for prediction of disease. Techniques for differentiating pathogenic and non-pathogenic strains of soilborne pathogens are needed to accurately monitor pathogen levels and predict disease impact. Genetic analysis of *Fusarium* will lead to techniques of differentiating pathogenic and non-pathogenic populations of this common disease agent in nursery soil.

Evaluation of Burning to Reduce Overwintering Populations of Gall Midge Pupae and Seed Chalcid Larvae in Douglas-fir Seed Orchards

by R. Sandquist, C. Niwa, T. Schowalter, B. Randall, P. Owston, and seed orchard managers from Region 6, Weyerhauser, and other cooperators.

Project objective: Determine whether field burners are an effective pest management tactic to reduce populations of cone gall midge or seed chalcid. This tactic is expected to substitute for clean-picking or insecticides or as an adjunct to reduce losses to cone and seed insects.

The annotated bibliography was completed. Consultations were made with scientists experienced with field burning to further delineate the research parameters. Cooperation was obtained with USDA-ARS scientists for use of constant, high temperature ovens for bioassay. Bioassays with varying moisture regimes and temperatures were conducted on midge larvae.

Results to date: Heat treatments were selected to simulate various burning intensities and durations suggested by temperature profiles measured in grass field burning studies. For propane flamers propelled at 1.6-2 kph, temperatures reached 340-490 degrees C, with temperatures of at least 200 degrees sustained for at least 15 seconds, and temperatures of at least 100 degrees sustained for 20-30 seconds. Larvae were tested both at constant temperature for varying durations and at declining temperature. Larvae still active were counted 15 minutes, two hour and one day after treatment and percent mortality recorded. Midge mortality increased as temperature and duration of heat exposure increased and was maximized under dry conditions. For example, 100 percent mortality occurred under dry conditions at 100 degrees for 15 seconds, and 87% mortality under moist conditions at 200 degrees for 20 seconds and 80 degrees for 15 seconds. Control larvae returned to the refrigerator showed no mortality for up to five days, but suffered mortality reaching 100 percent by the eighth day when the filter paper had dried out. Thus desiccation appeared to be as effective as heat in reducing survival, and might complement flaming as heat both immediately kills larvae and desiccates the substrate. Research conducted in agronomy found that soil is an extremely poor conductor of heat. Heat of a duration of only a few seconds is conducted just a few millimeters into the soil. It is now thought that it is unlikely that a probable prescription of heat and its duration would be damaging to Douglas-fir roots. However this must be validated with tests conducted with the types of material typically found on soil in seed orchards.

Preliminary trials in January 1994 indicated that it is unlikely that the duration and intensity of temperatures found in grass fields during the summer can feasibly be duplicated in seed orchards during winter. Temperatures up to 50 degrees were recorded. Further trials in early April will determine if these temperatures are sufficient to disrupt life processes and habitat enough to significantly reduce emerging populations.

Monitoring of *Megastigmus spermotrophus* in Douglas-fir seed orchards using colored sticky panels

by C. Niwa, R. Sandquist, K. Sprengel and seed orchard managers (Forest Service, state, and private).

Gold Rebell™ panels were used in 44 seed orchard blocks over a four year period. The correlation between chalcids caught and subsequent seed damage was low. However, a cumulative average of one female per panel (until 10 days after cone pendency) accurately predicted seed infestation levels exceeding 20 percent. This monitoring system is useful in deciding whether insecticide application is beneficial in suppressing *Megastigmus spermotrophus (Hymenoptera: Torymidae)* in Douglas-fir seed orchards. Use of this monitoring system should be as part of a decision making process including other factors as cone crop size, tree phenology, seed value, and likelihood of a secondary insect outbreak.

A manuscript has been submitted for publication in a refereed journal and a "how to" publication is being prepared for use by seed orchard managers.

International Cooperation

Region 6 FPM entertained visitors from New Zealand who were interested in learning how the Animal and Plant Health Inspection Service (APHIS), FPM, and the States were monitoring and managing the potential introduction of Asian gypsy moth.

Three Russian scientists involved with an information exchange program with the Washington Office FPM visited the Region in June. Included in their itinerary were visits with PNW Station, discussion on managing Asian Gypsy Moth, the Regions use of GIS, and a visit to the Warm Springs Indian Reservation to observe the western spruce budworm suppression project.

Jerry Gabay was on a six week detail to Lesothu in Africa where he was involved with a program to train teachers and Peace Corps workers in methods to integrate environmental education into their classes, and to develop techniques to involve the community in activities that would reduce impacts on the environment. Farming, overgrazing and heavy uses of the land have caused significant erosion problems in Lesothu.

Risk Assessment for Importation of Unprocessed Larch Logs from Siberia and the Russian Far East

For the past three years, a number of American timber companies have shown considerable interest in the possibility of importing raw logs (especially larch) from Siberia and the Russian Far East to the United States. The USDA Forest Service and the scientific community expressed considerable concern about the potential for introducing destructive forest insects and pathogens on such imported logs and, in response, APHIS imposed a temporary ban on log imports from the region. APHIS and the USDA Forest Service conducted a risk assessment to determine what final regulations should be instituted.

The assessment was based on an extensive search of existing literature, consultation with American and Russian experts, and a visit by the assessment team to the Russian Far East and Siberia where on-site evaluations were made of forest stands, timber harvesting operations, log storage areas, and railroad, river, and seaport transportation facilities.

The assessment team found that though available information was far from complete, at least 175 phytophagous insects and pathogens that have larch as hosts are known to occur in the Russian Far East and Siberia. They evaluated six representative organisms in detail and concluded that all six had a high potential for colonizing Russian larch logs, surviving on or in logs during transit, becoming established in North American forests, and spreading rapidly once established. It seemed likely that many other organisms, including a substantial number of presently unknown insects and pathogens, would have similar potentials. The team further indicated that it was very likely that introduction of some of these pests could have very significant economic, ecological, and social impacts, similar in magnitude to those caused by introduced forest insects and diseases of the past, such as European gypsy moth, white pine blister rust, Dutch elm disease, and chestnut blight. They recommended that, to be safe, logs for importation from eastern Russia to the United States should receive mitigation treatments that would eliminate insects and pathogens on the surface, in the bark, and to the center of the wood. APHIS is currently developing regulations that would require such treatments.

Pest Risk Assessment for Importation of Monterey Pine and Native Hardwood Logs from Chile

In 1992, APHIS requested help from the Forest Service in conducting a pest risk assessment for Monterey pine and native hardwood logs to be imported into the United States from Chile. This was the third such risk assessment to be done in the past three years, and the second one involving a specialist from Region 6 FPM. The assessment involved a series of steps, including consultation with APHIS on the protocol for the assessment, contact with Chilean specialists in insects and diseases, a site visit to Chile and preparation of the assessment report.

The site visit to Chile (November 1992) was coordinated through the agency which is the Chilean counterpart of APHIS in their Ministry of Agriculture, and involved an intensive examination of forestry operations, wood processing facilities, and regulatory functions in the country. The assessment team was briefed on the regulations in Chile for inspection of wood materials prior to export. The team visited Monterey pine plantations to view all aspects of pest inspection, harvesting, transport, and storage of logs prior to shipping. In addition, the team conferred with specialists from Chilean universities and discussed the pest potentials of local organisms associated with Monterey pine and native hardwood logs.

Mexico Dwarf Mistletoe Workshop

In August 1993, Central Oregon Pest Zone plant pathologist, Helen Maffei presented a paper on the "Management of Dwarf Mistletoe in the United States" at a national workshop on the management of dwarf and true mistletoes. The workshop was held in Toluca, Mexico and was attended by about 65 people associated with forest management throughout Mexico. The attendees included silviculturists, wildlife biologists and plant ecologists from Mexico's national parks and the Ministry of Forestry as well as students and faculty from several Mexican universities.

International Union of Forestry Research Organizations Working Party: S2.07-01 - Cone and Seed Insects 4th Working Party Conference (Beijing and Harbin, China)

The first session was held in Beijing, Peoples Republic of China as a symposium of the 19th International Congress of Entomology, June 27 to July 4, 1992. Eighteen papers were presented by scientists from ten countries. Roger Sandquist co-authored and presented *"Systemic Insecticides for Control of Douglas-fir Cone and Seed Insects in Seed Orchards and Natural Areas"* In the poster session, a display *"Mortality of Ponderosa Pine Female Strobili in California, Oregon and Washington"* by J. D. Stein and R. E. Sandquist was presented.

The second session was held July 6-7 at Harbin, Northeastern Forestry University. It was attended by 25 Chinese scientists and 12 foreign scientists. A broad overview of research on cone and seed insects in Northeast China was given. Papers were presented for scientists who were unable to attend. Roger Sandquist presented "Stem injection of dimethoate for control of European larch (*Larix decidua*) cone and seed insects" for Dr. Olenici from Romania.

Post conference excursions allowed a view of conifer forests and seed orchards in Northeastern China, as well as the way of life of the people. At Hailar (Inner Mongolia) Mongolian scots pine natural forests were visited and at Honghuaerji seed orchards were visited. At Dai-ling (Heilongiiang, about 500 km northeast of Harbin) nurseries and stands of Korean pine and larch were visited.

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Appendices

Insect Activity Occurrence Maps

Insect Activity by Reporting Area

Submitting Insects and Diseases for Identification

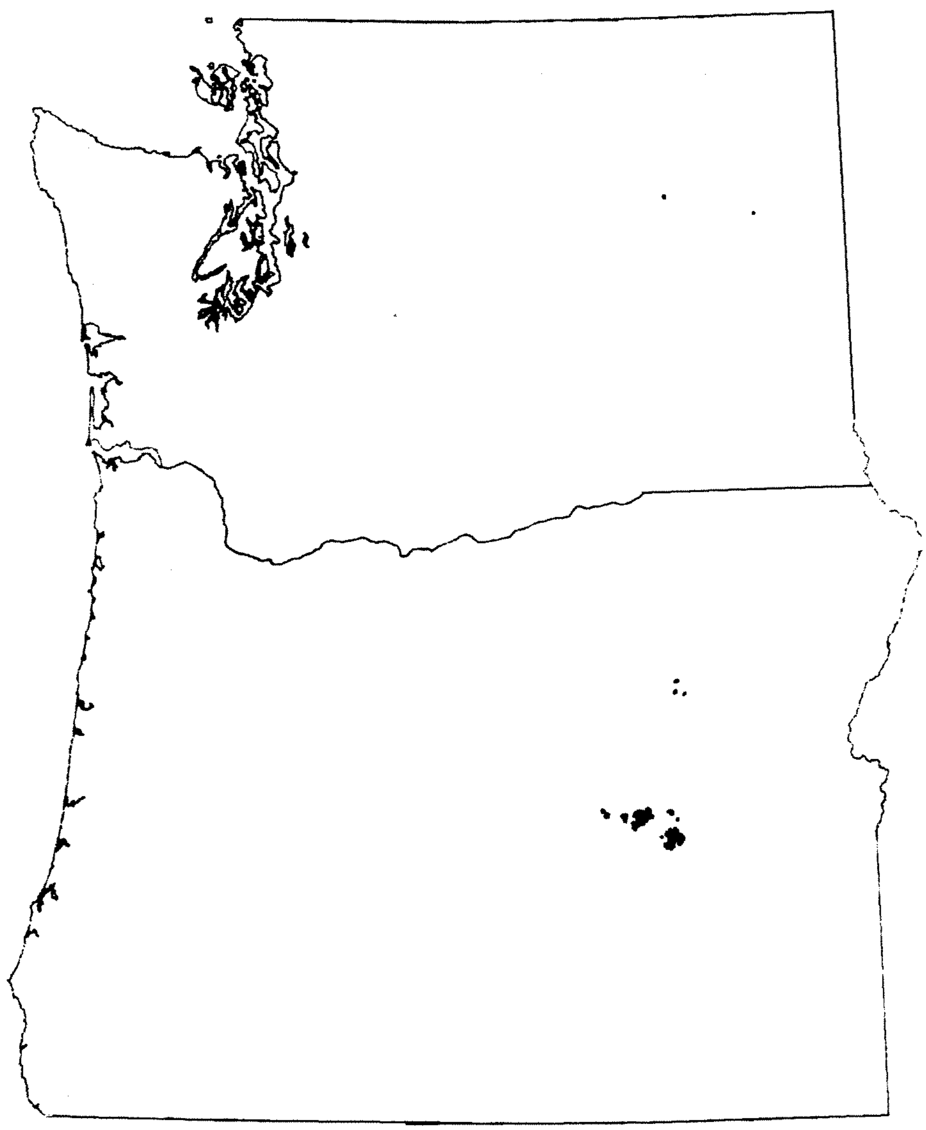

Figure 12 – Occurrence of defoliation associated with Douglas-fir tussock moth in the Pacific Northwest Region in 1993

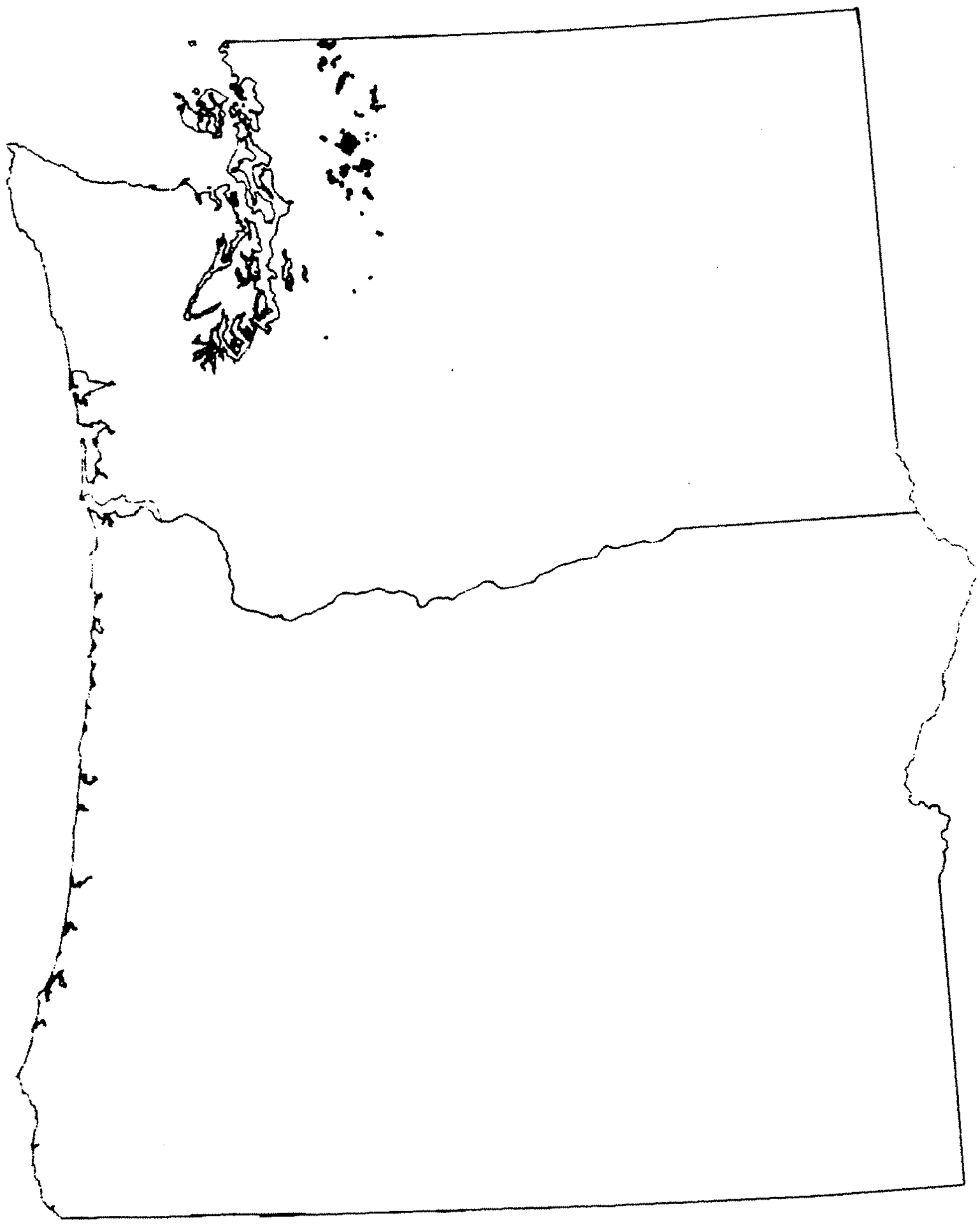

Figure 13 – Occurrence of defoliation associated with Hemlock looper in the Pacific Northwest Region in 1993

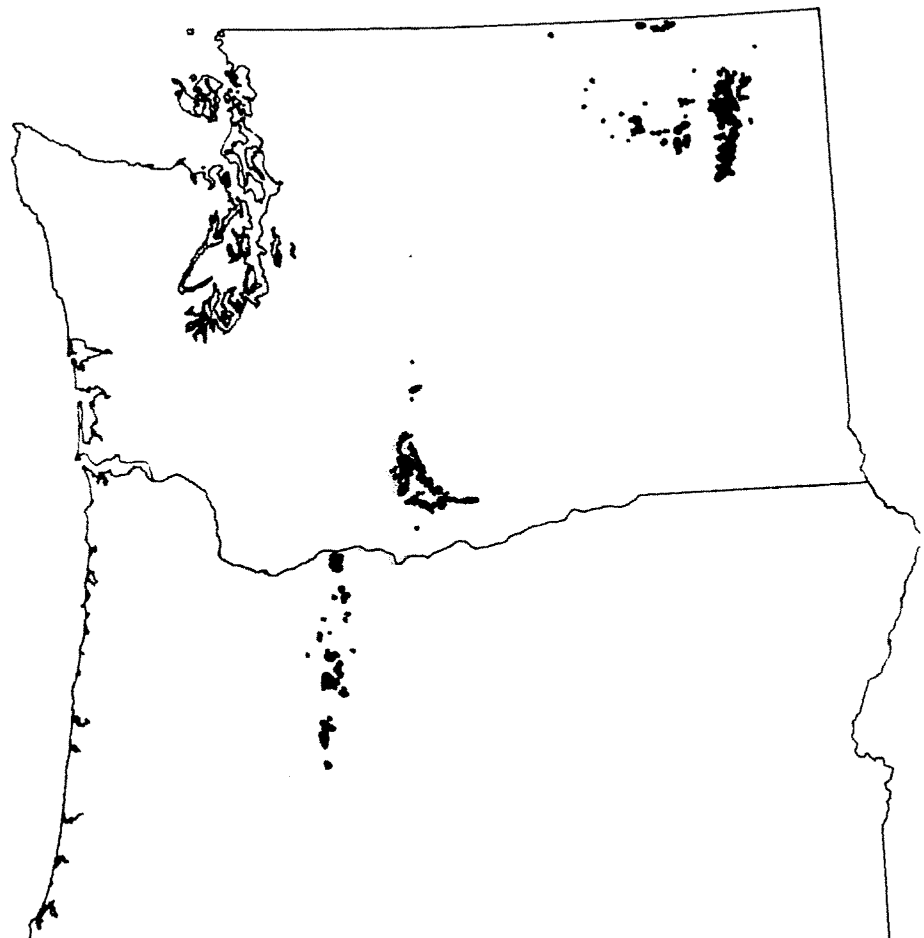

Figure 14 – Occurrence of defoliation associated with Western spruce budworm in the Pacific Northwest Region in 1993

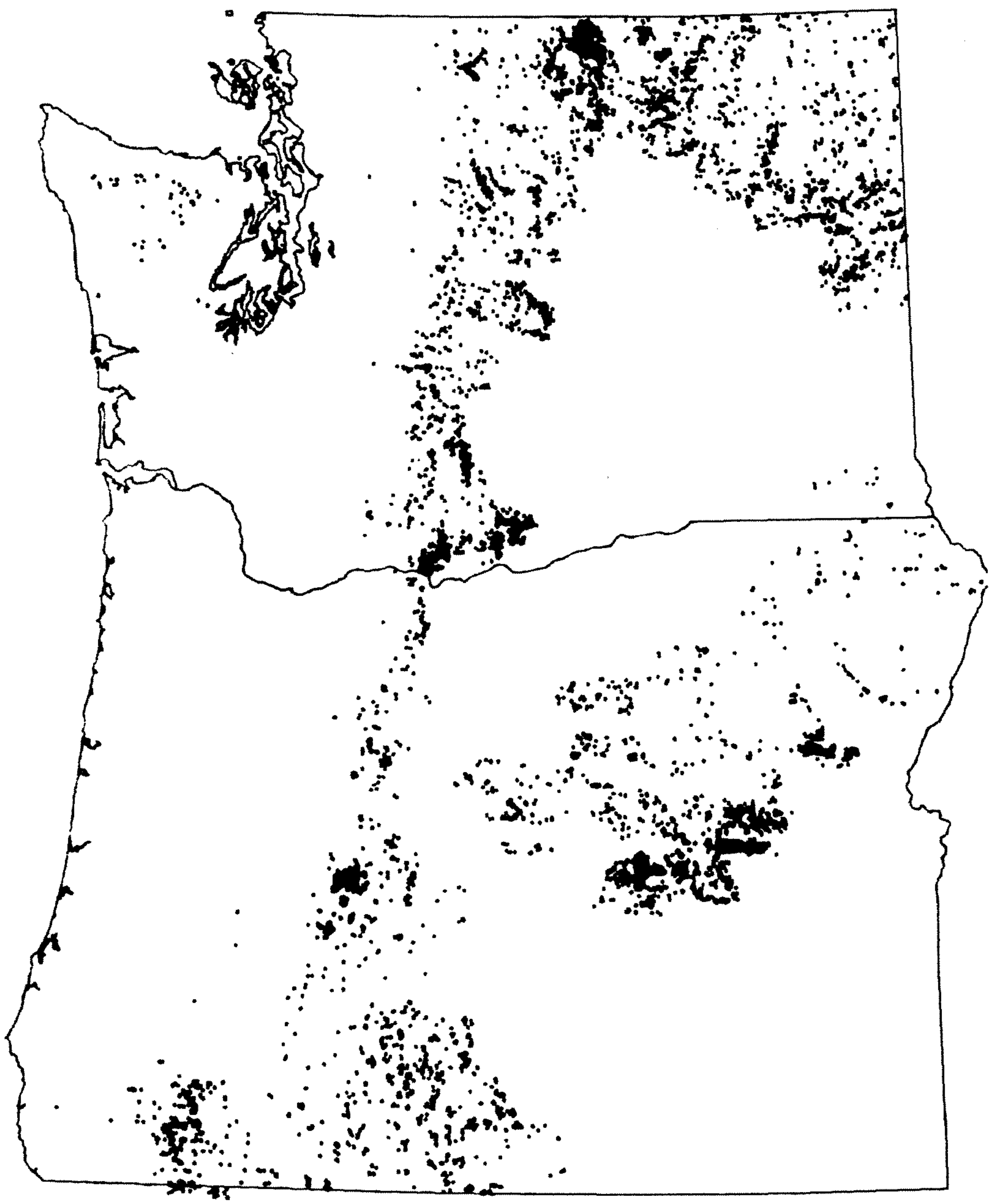

Figure 15 – Occurrence of tree mortality associated with Western pine beetle and Mountain pine beetle in the Pacific Northwest Region in 1993

Table 2 – Insect Activity by Reporting Area

mpb/pp = mountain pine beetle in ponderosa pine
mpb/lp = mountain pine beetle in lodgepole pine
wpb/pt = Western pine beetle in pole-sized ponderosa pine
wpb/lt = Western pine beetle in large ponderosa pine

dfb = Douglas-fir beetle
wsb = Western spruce budworm
dftm = Douglas-fir tussock moth

	mpb/pp		mpb/lp		wpb/pt		wpb/lt		fir engraver		dfb		wsb	dftm
Reporting Area	acres	trees	acres	trees	acres	trees	acres	trees	acres	trees	acres	trees	acres	acres
Central Oregon	8622	2671			390	401	385	223	297	355				
Colville I.R.	5979	3930	7191	5974	19842	60947	4594	2111	350	175	1303	607	35949	35
Colville N.F.	615	641	10107	8353	6720	4780	529	235	1358	765	1175	545	121567	
Coos-Douglas	41	15					35	20	157	95	271	113		
Crater Lake N.P			212	55					255	70				
Deschutes N.F.	16413	8359	62771	94658			1428	584	4447	5846	9	5	7783	
Fremont N.F.	26013	20465	15641	29060			7425	2102	284191	485186				
Gifford Pinchot N.F.	441	80	34	20			24	15	703	222	10927	8957		
Glenwood	15989	3065	53	40	61086	62884	1786	274	39	25	2133	470	10575	
Malheur N.F.	94722	25618	14169	52806	810	390	86224	17269	2002	1016	1100	1106		45994
Mt. Baker-Snoqualmie									50	28	2647	2163		
Mt. Hood N.F.	4446	4538	221	123			411	165	7826	3622	3370	1710	51811	
Mt. Rainier N.P.									10	30	275	300		
North Cascades N.P.			1012	1428					270	210	108	65		
Northeast Washington	1704	1980	306	351	32322	23419	2649	1739	1345	1084	367	155	5895	242
Northwest Oregon											182	88		
Northwest Washington			38	15							2064	1573		
Ochoco N.F.	29600	7929	106	14	349	221	30916	6668	3588	2090	261	135		
Okanogan N.F.	6367	4418	91769	431731	8965	6029	1667	685	5834	4135	957	658	783	
Olympic N.F.			196	120					94	120	960	788		
Olympic N.P.									159	235	226	137		
Puget Sound											136	75		
Quinault I.R.			76	35										
Rogue River N.F.	5700	2002	197	80	23552	7253	6533	1489	53213	15637	44	25		
Siskiyou N.F.	489	132			3056	1217	905	240	1153	693	19	5		
Spokane I.R.	31	40	24	30	5788	3903	406	225	9	16	22	10	5757	
Umatilla I.R.	25	35					199	27	94	30	111	14		
Umatilla N.F.	5630	1736	125	90	99	70	3684	652	2205	646	4468	2221		201
Umpqua N.F.	224	55	416	200					655	301	525	223		
Wallowa-Whitman N.F.	28826	7691	502	182	9	50	20128	3659	1896	695	7310	3867		
Warm Springs I.R.	4343	3876	345	293			530	255	4778	5172	26	15	12968	
Wenatchee N.F.	15632	11486	3711	5675	7625	3396	4181	1524	13330	11160	2014	789	3153	
Willamette N.F.	23	15	572	205					4156	1934	5269	2773	15181	
Winema N.F.	12551	7550	7291	8119			4888	840	75415	48791				
Yakima I.R.	1920	1160	50	15	19104	16584	7077	174	3046	1930	1184	195	60107	

Submitting Insects and Diseases for Identification

The following procedures for the collection and shipment of specimens should be used for submitting samples to specialists:

I. Specimen collection:

1. Adequate material should be collected
2. Adequate information should be noted, including the following:
   a. Location of collection
   b. Date collected
   c. Collector
   d. Host description (species, age, condition, # or percentage of plants affected)
   e. Description of area (e.g., old or young forest, bog, urban);
   f. Unusual conditions (e.g., frost, poor soil drainage, misapplication of fertilizers or pesticides).
3. Personal opinion of the cause of the problem is very helpful.

II Shipment of specimens:

1. General: Pack specimens in such a manner to protect against breakage.
2. Insects: If sent through the mail, pack so that they withstand rough treatment.
   a. Larvae and other soft-bodied insects should be shipped in small screw-top metal containers with at least 70% isopropyl (rubbing) alcohol (you cannot mail more than 1 quart of alcohol per shipment). Make certain the bottles are sealed well. Include in each vial adequate information, or a code, relating the sample to the written description and information. Labels inserted in the vial should be written on with pencil or India ink. Do not use a ballpoint pen, as the ink is not permanent.
   b. Pupae and hard-bodied insects may be shipped either in alcohol or in small boxes. Specimens should be placed between layers of tissue paper in the shipping boxes. Pack carefully and make certain that there is very little movement of material within the box. Do not pack insects in cotton.
3. Needle or foliage diseases: Do not ship in plastic bags. Sprinkle lightly with water before wrapping in newspaper. Pack carefully and make sure that there is very little movement of material within the box. Include the above collection information. For spruce and other conifers, include a description of whether current year's-needles, last-year's needles, or old-needles are attacked.
4. Mushrooms and conks (bracket fungi): Do not ship in plastic bags. Either pack and ship immediately, or first air dry and then pack. To pack, wrap specimens in dry newspaper and pack into a shipping box with more newspaper. If on wood, include some of the decayed wood. Be sure to include all collection information.

III. Shipping:

1. Ship as quickly as possible, especially if specimens are fresh and not air-dried. If samples cannot be shipped rapidly, then store in a refrigerator.
2. Include address inside shipping box. Label the outside with the address of your FPM Zone Office.
3. Mark on outside: "Fragile: Insect-disease specimens enclosed. For scientific purposes only. No commercial value." Also, mark the outside of the box with: UN 1220.

Pacific Northwest Region
Forest Insects and Diseases
333 S.W. First Avenue
Portland, OR 97204

TO: