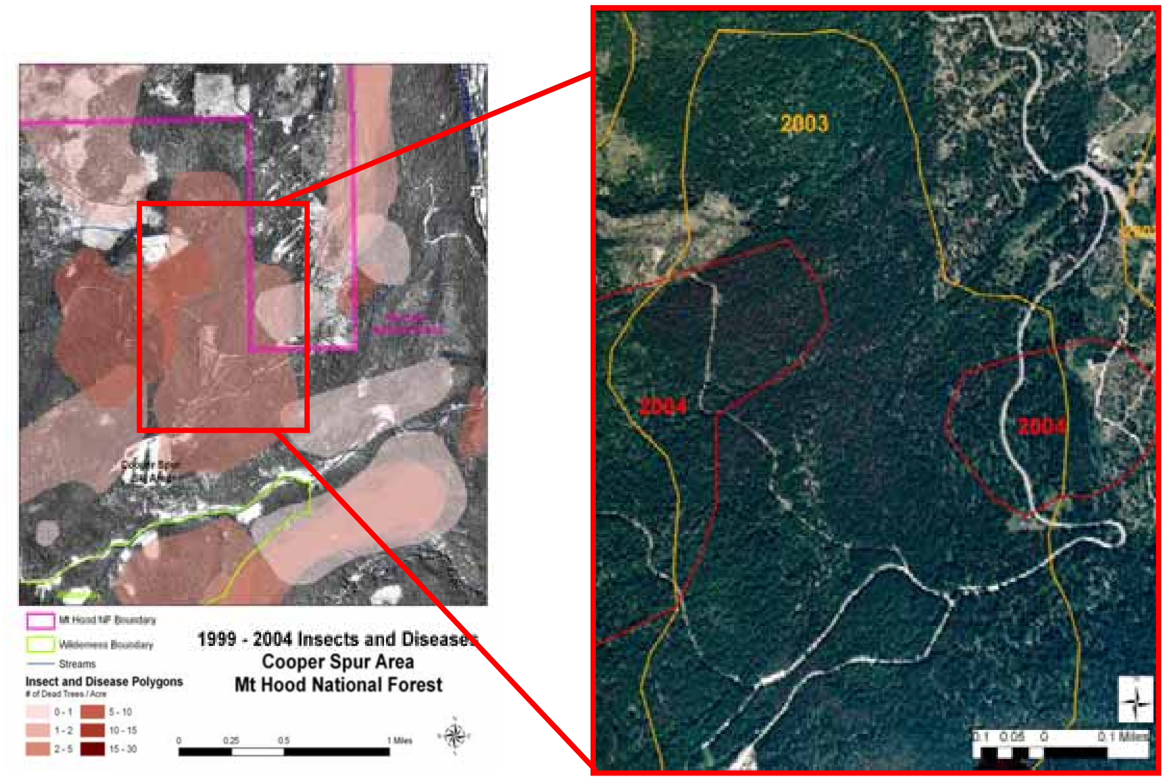
An Initial Review of Forest Insect Mortality and Related Wildfire Risk Issues on the Eastside of the Mt. Hood National Forest



Pacific Biodiversity Institute

An Initial Review of Forest Insect Mortality and Related Wildfire Risk Issues on the Eastside of the Mt. Hood National Forest

Peter H. Morrison
peter@pacificbio.org

and

Hans M. Smith IV
hans@pacificbio.org

Pacific Biodiversity Institute

October 5, 2005

Preferred citation: Morrison, P.H. and H.M. Smith IV. 2005. An initial review of forest insect mortality and related wildfire risk issues on the eastside of the Mt. Hood National Forest. Pacific Biodiversity Institute, Winthrop, WA. 43 p.

Table of Contents

Introduction

A wide variety of insects that feed on forest trees can be found on the Mt. Hood National Forest. These insects are a natural part of the biodiversity of the forest ecosystem. Forest dwelling insects can cause damage or mortality to the trees that they feed on. This mortality is of concern to some forest managers. Meanwhile, many ecologists recognize that insects are part of the native biodiversity of the forest and that the effects of insects are a natural process that furthers the normal successional development of forest stands.

There are various viewpoints on the issue of increase in fire-risk due to insect-related mortality. Some people fear that the insect-related mortality will greatly enhance the potential for devastating wildfire in this area. But there is evidence that any increased risk is short-lived and may not be of much concern at the present time. In this paper, we take an initial look into the issue of insect-related mortality in the eastern part of the Mt. Hood National Forest and the effect that this may have on wildfire occurrence and behavior.

Insect Damage and Tree Mortality - Overview

The primary insect damage to trees in the Mt. Hood National Forest in recent years has been caused by mountain pine beetle *(Dendroctonus ponderosae)*, fir engraver beetle *(Scolytus ventralis)* and balsam woolly adelgid, *(Adelges piceae)* (Tables 1-3). In the past, western spruce budworm *(Choristoneura occidentalis)* has caused significant damage in some areas. Most of the recent tree mortality has been caused by mountain pine beetle.

Table 1. Insect Species causing damage to trees on the eastside of the Mt. Hood National Forest in 2004 based on aerial survey data. Note: no aerial survey data is available yet for 2005.

Insect Species, Host Species	**Hectares**	**Acres**
Fir Engraver	5255	12986
Mountain Pine Beetle, Lodgepole Pine	3238	8002
Larch Casebearer/Hypodermella	660	1632
Balsam Woolly Adelgid	142	350
Silver Fir Beetle	107	264
Mountain Pine Beetle, Whitebark Pine	78	193
Western Balsam Bark Beetle, Sub-Alpine Fir	74	184
Douglas-fir Beetle	59	146
Western Pine Beetle	59	145
Mountain Pine Beetle, Ponderosa Pine	56	139
Western Pine Beetle, Pole-size Ponderosa Pine	51	127
Pine Engraver	41	101

Table 2. Insect Species causing damage to trees on the eastside of the Mt. Hood National Forest in 2003 based on aerial survey data.

Insect Species, Host Species	Hectares	Acres
Fir Engraver	5188	12820
Balsam Woolly Adelgid	3929	9710
Larch Casebearer/Hypodermella	886	2188
Mountain Pine Beetle, Ponderosa Pine	496	1227
Mountain Pine Beetle, Lodgepole Pine	343	847
Needle Miner, True Fir	74	183
Unknown defoliation	62	153
Mountain Pine Beetle, Whitebark Pine	11	26

Table 3. Insect Species causing damage to trees on the eastside of the Mt. Hood National Forest in 2002 based on aerial survey data.

Insect Species, Host Species	Hectares	Acres
Mountain Pine Beetle, Lodgepole Pine	3568	8816
Balsam Woolly Adelgid	1213	2998
Fir Engraver	212	523
Water Damage	207	513
Mountain Pine Beetle, Ponderosa Pine	166	410
Douglas-fir Beetle	101	250
Western Pine Beetle, Pole-size Ponderosa Pine	27	68
Western Pine Beetle	10	26
Larch Casebearer/Hypodermella	3	9

The Insect Species

Mountain Pine Beetle *(Dendroctonus ponderosae)*

From: Kim Smolt, Mt. Hood National Forest (PowerPoint presentation on September 13, 2005)

The mountain pine beetle, *Dendroctonus ponderosae* Hopkins, is a member of a group of beetles known as bark beetles. Mountain pine beetles attack various pine species by laying eggs under the bark. The beetle attacks and kills lodgepole pine *(Pinus contorta),* ponderosa pine *(Pinus ponderosa),* sugar pine *(Pinus lambertiana),* and western white pines *(Pinus monticola and Pinus albicaulis).* Lodgepole pine is the primary host species in the eastern part of the Mt. Hood National Forest.

Except when adults emerge and attack new trees, the mountain pine beetle completes its life cycle under the bark. When the eggs hatch, the larvae mine the phloem area beneath the bark and eventually cut off the tree's supply of nutrients. The beetles also carry a fungus that causes dehydration and inhibits a tree's natural defenses against beetle attacks. Mountain pine beetle outbreaks last from 5 to 10 years depending on the availability of the host species. Often mountain pine beetles attack lodgepole pines over 80 years old first (because lodgepole is a short lived species and the older trees are usually less vigorous). Over the course of an outbreak, the beetles work their way down from 10-inch diameter at breast height (DBH) trees to 5-inch DBH trees. (Amman et al 1990; Kim Smolt, Mt. Hood National Forest - PowerPoint presentation on September 13, 2005)

The role of mountain pine beetle in lodgepole pine stands

The mountain pine beetle, considered one of the main insect pests of western forests. While the beetle can cause significant mortality to lodgepole pine and, to a lesser extent other pine species, this insect does not affect most tree species on the Mt. Hood National Forest. The mountain pine beetle has been an integral part of forests containing lodgepole pine for millennia, with beetle epidemics playing an integral role in the structure and dynamics of these communities (Fuchs 1999, Black 2005). Mountain pine beetle epidemics are part of a natural boom-and-bust cycle (Amman 1977). The beetles selectively kill the most susceptible pine trees. This facilitates the development of a forest that is structurally, genetically, and compositionally more diverse and therefore less prone to beetle attack in the long run (Amman 1977, Black 2005). In the forest types found on the Mt. Hood National Forest, mountain pine beetles reduce the density of pine trees and cull the weakest individuals, which relieves the stress on the surviving trees and improves the overall condition of the forest (Schowalter 1994, Black 2005). In many cases the prime beneficiaries are true firs, larches, and Douglas-fir, which inhabit the forest stands (Schowalter and Withgott 2001, Black 2005).

In some parts of the western United States and Canada, lodgepole pines can form large, even-aged stands across vast landscapes. These stands provide habitat for beetles to develop large populations and significant stand-level mortality can occur (Fuchs 1999, Black 2005). But this is not the case on the Mt. Hood National Forest where lodgepole is only one of many species that compose the mixed-conifer stands of the area.

Fir Engraver Beetle (Scolytus ventralis)

Characteristic fir engraver egg gallery in cambium of a fir tree. From: Ferrell (1986).

The fir engraver beetle is a bark beetle. It is a wide-ranging, native beetle. The fir engraver attacks primarily white fir, grand fir, and red fir; its range coincides with the distribution of these three species.

MORE DESCRIPTION OF FIR ENGRAVER AND DETAILS ABOUT THE EFFECTS OF FIR ENGRAVER NEEDED HERE.

Balsam Woolly Adelgid *(Adelges piceae)*


Balsam woolly adelgid adults on fir needle. From: www.for.gov.bc.ca/hfp/forsite/pest_field_guide/BWA.htm

DESCRIPTION OF **Balsam Woolly Adelgid** AND DETAILS ABOUT THE EFFECTS OF **Balsam Woolly Adelgid** NEEDED HERE.

Insect-Caused Tree Mortality on the Mt. Hood National Forest from a Regional Perspective

To gain a perspective on the insect issues on the Mt. Hood National Forest it is useful to step back and look at insect problems at a regional level. To do this we looked at data the Forest Service has compiled since 1980 for tree mortality caused by mountain pine beetle in the Pacific Northwest.

Each year the United States Forest Service uses aerial surveys to keep track of forest stand mortality caused by native and exotic insects and diseases across all forested lands in Washington and Oregon. Data from the tracking efforts are stored into spatial data sets and maps known as USFS Region 6 Forest Insect and Disease Aerial Detection Surveys (insect and disease data) (REFERENCE). Methods for the creation of the insect and disease data are attached as an appendix to this report (Appendix A).

Insect and disease data is represented in polygon form, which outlines areas on the landscape where new tree mortality for each year is seen during the aerial surveys. Stand mortality estimates and the principle mortality agents are described in associated data tables related to each of the insect and disease polygons.

What is apparent from examining this data for mountain pine beetle across the entire region is that the east side of the Mt. Hood National Forest has been only slightly affected by this bark beetle over the last 25 years compared to many other areas in the region (Figure XX).

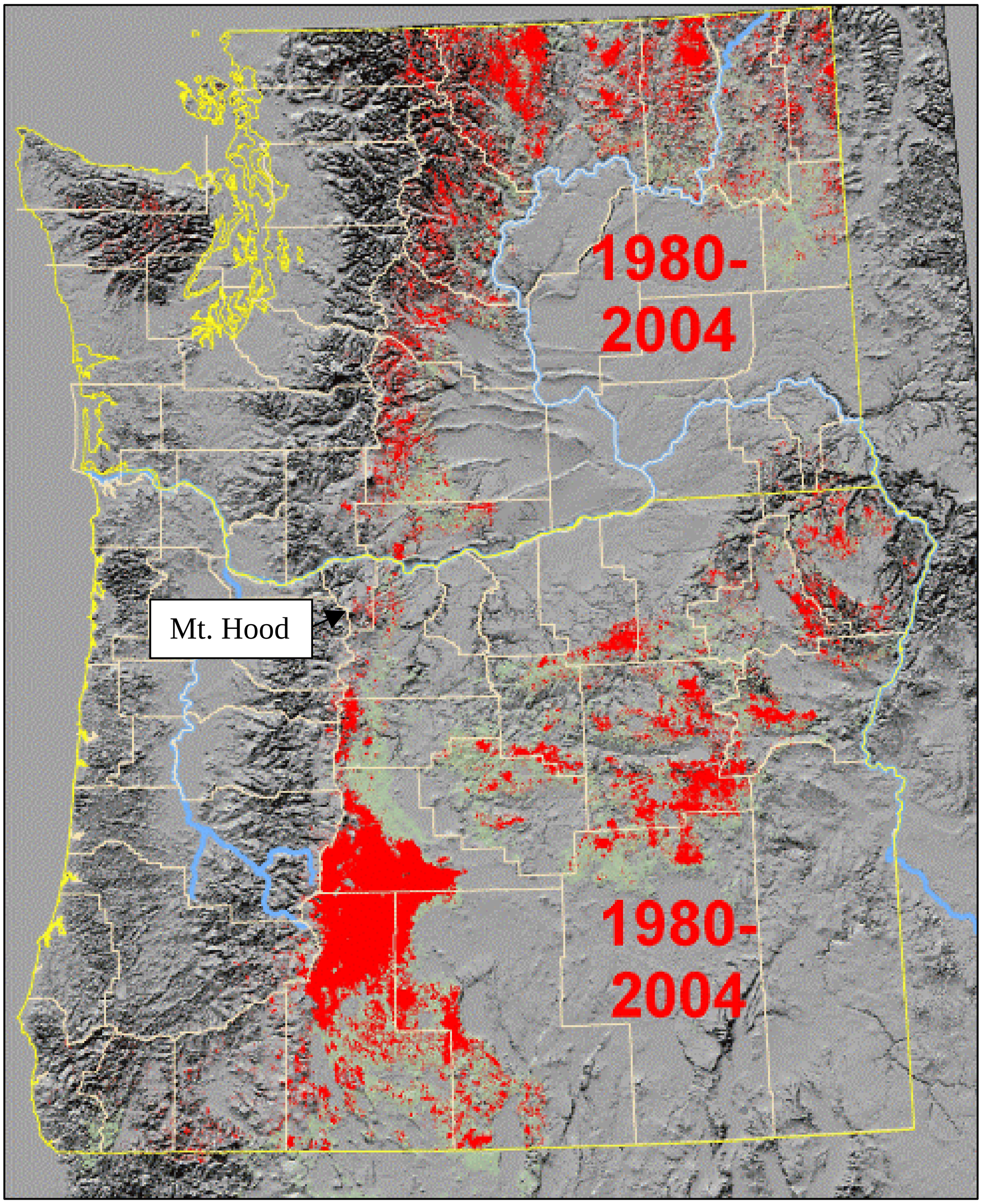


Figure XX. Tree Mortality caused by Mountain Pine Beetle 1980 – 2004. Source: US Forest Service Pacific Northwest Region, Natural Resources, Forest Health Protection

Red shaded areas show locations where trees were killed. Pink areas show stands contained Pinus sp. – the host species for mountain pine beetle. Intensity of damage is variable and not all trees in shaded areas are dead. Site-specific information is available at: www.fs.fed.us/r6/nr/fid/data.shtml

Sources: Annual aerial insect and disease surveys flown by USDA Forest Service, Oregon Department of Forestry, and Washington Department of Natural Resources; 250m forest type map developed by USDA Forest Service - Remote Sensing Application Center.

Forest Insects and Increased Fire Risk (NEEDS MORE WORK)

There is a general impression that bark beetle epidemics increase fire severity and occurrence. This may be true in some instances, but some studies do not support this premise (Bebi et al. 2003, Pollet and Omi 2002). In Yellowstone National Park, stands that experienced high mortality from beetles (more than 50 percent of susceptible trees) in the five to seventeen years preceding the 1998 fires typically burned more intensely than uninfested stands. However, the incidence of high-intensity crown fire in stands with low to moderate beetle mortality was lower than in uninfested stands (Turner et al. 1999). This suggests that, in some stands, beetle kill may actually decrease the hazard of high-crown fire by decreasing the continuity of woody fuels in the canopy. (Black 2005)

There is little doubt that beetle outbreaks that cause significant mortality at the stand scale increase the risk of crown fire immediately after tree mortality. However, this is often restricted to the two or three years after the foliage has died but before it falls to the floor. Once the trees have defoliated, the risk of crown fire is significantly lower than before the outbreak. Needle litter and fine twigs from trees killed by beetles quickly decompose in the mesic environments found in most areas of the Mt. Hood National Forest. Therefore, these fine fuels (and the associated elevated fire risk) do not persist in a stand for long after a beetle attack. (Black 2005)

Bebi et al. (2003) quantified spatial associations of fire and spruce beetle *(Dendroctonus rufipennis*) outbreaks over more than a century and developed a multivariate logistic model. Forests that had burned in 1879 were less affected by an outbreak in the 1940s than were older stands. On the other hand, areas affected by the 1940s outbreak showed no higher susceptibility to subsequent fires (Bebi et al. 2003). Beetle-killed lodgepole pine (self-thinned to lower density) experienced significantly lower fire severity compared to adjacent burned areas in the 3,400- hectare Robinson Fire that burned in Yellowstone National Park in 1994 (Pollet and Omi 2002). (Black 2005)

Insect Infestations and Insect Damage to Forest Stands in Cooper Planning Area

Aerial surveys conducted by the US Forest Service have identified areas where insect infestations are active or have caused damage to forest stands in the project area. The main forest insect that is active in the area is the mountain pine beetle, which has attacked lodgepole pine trees interspersed in the mixed conifer forests of the area. Fir engraver beetle is present in some areas, but has not caused significant mortality or damage.

Peter Morrison conducted field examinations of the forest stands in the area. These examinations indicate that mountain pine beetle was indeed present and that some lodgepole pines were killed (Figure 25). However, lodgepole pine is usually just a minor component of these forest stands and is an early successional species in this area. Most of the stands in the area do not show substantial insect damage. There are isolated pockets where mortality from mountain pine beetle is higher, but these are quite limited in extent in the context of the larger landscape (Figures 26a and 26b).

Figure 25. Dead lodgepole pine above a healthy understory of other conifer species. This photo was taken of a forest stand east of the Cooper Spur Ski area.

Figures 26a and 26b. Landscape view of forests in Cooper Planning Area north of Cooper Spur Ski Area.

In many forest stands within the planning area most of the trees are unaffected by insects and only scattered infestations and associated mortality exists among the lodgepole pine (Figures 27 and 28). The level of insect infestation and mortality is relatively low in the planning area compared to many areas in eastern Oregon and Washington. The forests of the planning area are generally not "unhealthy" and they represent various stages of natural succession and natural diversity.

Figure 27. Patches of mountain pine beetle mortality in lodgepole pine in older forest below road leading to ski area.

Figure 28. Forest canopy showing live trees and a few dead ones in area mapped by the Forest Service as having high insect damage and mortality. Photo stop 6.

It is expected and normal to see lodgepole pine drop out of the stand at about this time in forest development (Pfister and Cole, 1985). Also, the population levels and outbreak characteristics of the mountain pine beetle are subsiding and should no longer be an issue in the area. Mt. Hood National Forest personnel have stated that the recent outbreak affecting lodgepole pine is over and that the occurrence was a natural process with self-correcting mechanisms (Kim Smolt, Forest Service District Silviculturalist, September 9, 2005 Cooper Area Fuels Reduction Collaboration Group meeting). Forest treatments to suppress mountain pine beetle outbreaks in the area would not be appropriate at this time.

In a few areas, such as the stand immediately east of the Cooper Spur Ski Area (Figure 29), logging of dead lodgepole pine may be warranted to improve the aesthetics of the area for skiers. But only a very limited area needs to be treated to accomplish this objective.

Figure 29. Stand immediately east of Cooper Spur ski area with dead lodgepole pine.

The Role of Insects and Forest Stand Succession in the Production of Coarse Woody Debris

One of the natural consequences of insect-related mortality and normal successional processes in forest stands is the production of dead trees and down logs. As most forest stands age, they move through a "stem-exclusion stage" (Oliver and Larson 1996). During this stage, many of the weaker trees in the stand are more susceptible to insect attack. The trees that die first form standing dead trees (snags) and later fall to the forest floor as logs. These logs constitute coarse woody debris on the forest floor. As a stand emerges from the stem-exclusion stage of stand development a considerable number of logs may exist on the forest floor. This situation is a normal result of stand development, but can be accelerated by an insect outbreak.

Coarse woody debris (CWD) loading is high in some areas of the Mt. Hood National Forest as illustrated in the photo below. But coarse woody debris loading is often very patchy and many areas have low to moderate levels. The areas with the highest coarse woody debris loading are early mature stands (60-80 years old) that are just emerging from the stem-exclusion stage of successional development. High levels of coarse woody debris are common at this stage of stand development.

The climate in much of the Mt. Hood National Forest is relatively warm and moist. This will cause relatively rapid decomposition of coarse woody debris by natural decomposition processes. Therefore, the presence of coarse woody debris is not a long-term issue. In fact, the nutrients that are bound up in the wood are important for the maintenance of ecosystem productivity. Coarse woody debris on the forest floor also provides important habitat for a diverse set of vertebrate and invertebrate species. Many fungal species also rely on coarse woody debris for their primary habitat.

Figure 41. High levels of coarse woody debris exist in some areas (photo stop 6).

Figure 42a. Lower levels of coarse woody debris exist in other areas (photo stop 3).

Figure 42b. Typical levels of coarse woody debris in mature forests after lodgepole pine dies out of the stand (photo stop 3).

Coarse Woody Debris and Surface Fires

It is relevant to understand the relationship between coarse woody debris and surface fire spread when evaluating wildfire risk and probable behavior in the Mt. Hood National Forest. A recent report released by the Rocky Mountain Research Station presents an easy to understand summary of predicted behavior patterns for a comprehensive set of fuel models affecting the flaming front of a fire (Scott and Burgan 2005). Many of the surface fuel models fit the situations occurring in the Mt. Hood National Forest. In short, Scott and Burgan indicate that heavy loadings of naturally occurring large downed logs (CWD) do not contribute to a substantial increased risk in rates of surface fire spread or increased flame lengths along a flaming front. Also, a surface fuel situation with naturally occurring moderate fine and coarse fuels will maintain low rates of spread and flame length. The driving factor in terms of rates of spread and flame length along a flaming front seem to be fine fuel loadings, with activity slash (produced during logging operations) providing the most suitable conditions for rapid fire spread and high flame lengths.

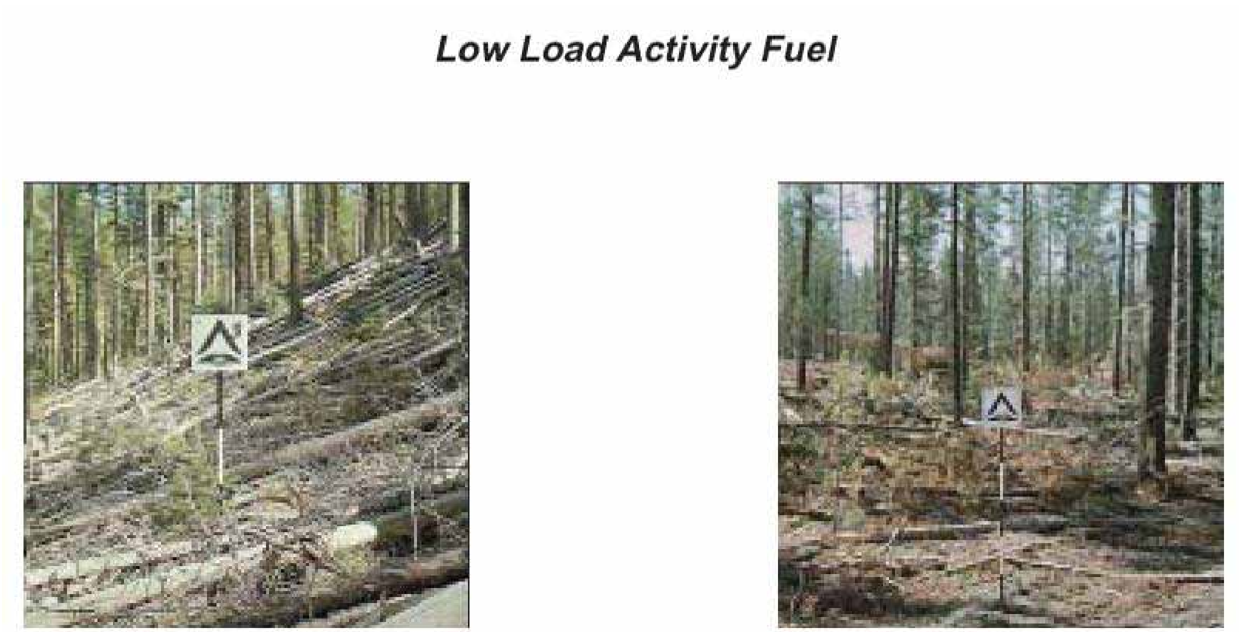


Figure 43. Low load activity fuels photos from Scott and Burgan (2005).

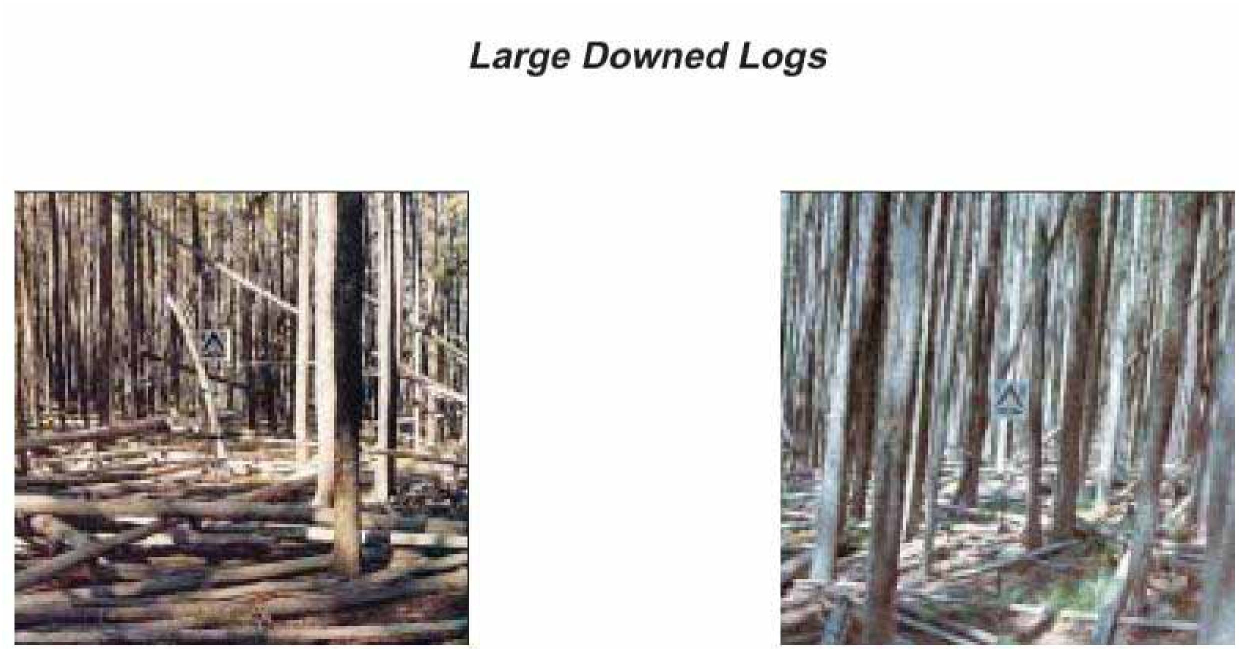


Figure 44. Large downed logs example fuel model photos from Scott and Burgan (2005).

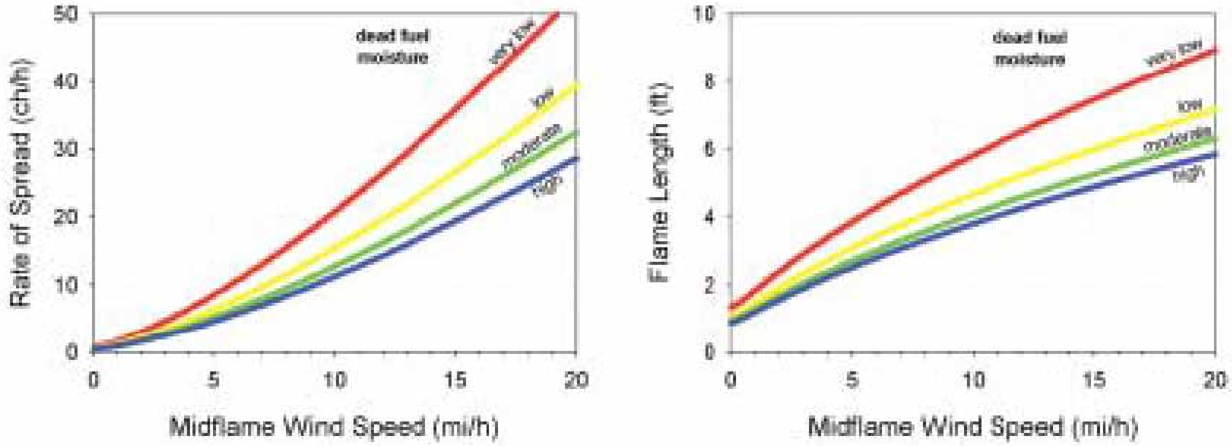


Figure 45. Low load activity fuel model rate of spread and flame length performance under different fuel moisture conditions and wind speeds from Scott and Burgan (2005).

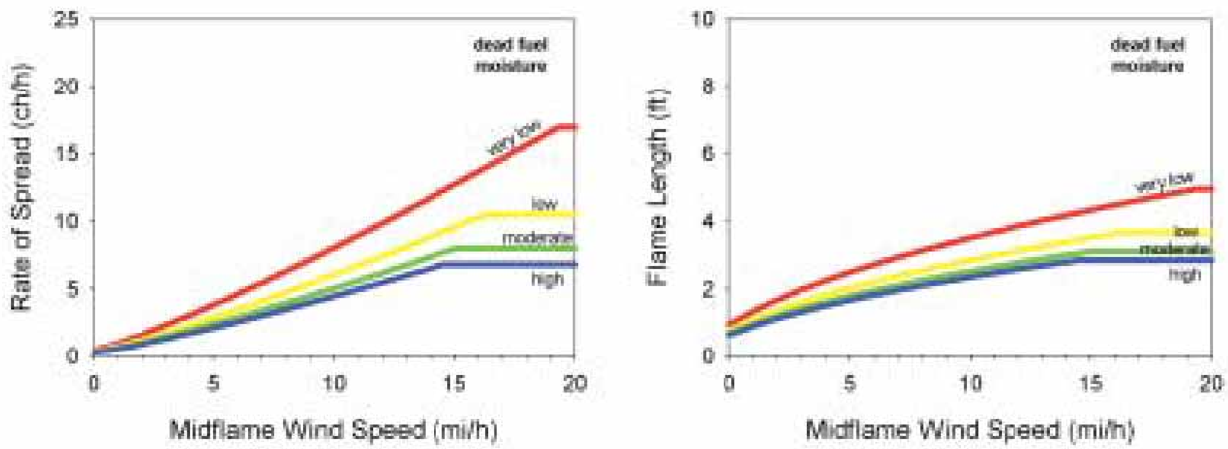


Figure 46. Large downed logs fuel model rate of spread and flame length performance under different fuel moisture conditions and wind speeds. Note: rate of spread Y-axis is ½ that of low load activity fuel model from Scott and Burgan (2005).

Rates of fire spread and flame lengths are dramatically reduced in the large downed logs fuel model compared to low load activity fuel model illustrated above. The large downed logs fuel model is a fitting model for many places within the Mt. Hood National Forest where naturally occurring surface fuel loadings may seem high because of the presence of coarse woody debris, but these areas are actually far safer in terms of wildfire spread rates and flame lengths than areas where treatment has occurred and light dead and down activity fuel remains on the forest floor.

Initial Review of the US Forest Service Region 6 Insect and Disease Aerial Detection Surveys

Example Area: Cooper Spur Area of Mt Hood National Forest

Pacific Biodiversity Institute has recently conducted a preliminary assessment of aerial survey insect and disease data for the Mt Hood National Forest collected for the years 1999 - 2004. We found that if displayed correctly, the data can be useful for calling attention to general insect and disease caused mortality at very broad spatial scales. However, actual patterns of insect mortality observed on the ground or in high resolution aerial photography often differs substantially from the Forest Service aerial survey polygon data. The Forest Service aerial survey insect and disease polygons often do not encompass an even distribution of stand mortality or damage that can be observed on the ground. In many cases a polygons over-exaggerate the amount of mortality.

The following maps and photos depicting the Cooper Spur area of the Mt Hood National Forest help illustrate this (Figures 1 – 12).

Without personal knowledge of an area, a viewer shown Figure 1 would be likely to assume that insects and diseases are killing large amounts of trees across the landscape. Such maps give the appearance that the forests are “unhealthy” or are undergoing an epidemic.

The following Figures (2 - 8) express the same data as Figure 1, but these maps differentiate between the levels of mortality each polygon represents. These maps give a wholly different impression of insects and diseases on the landscape than what is expressed in Figure 1.

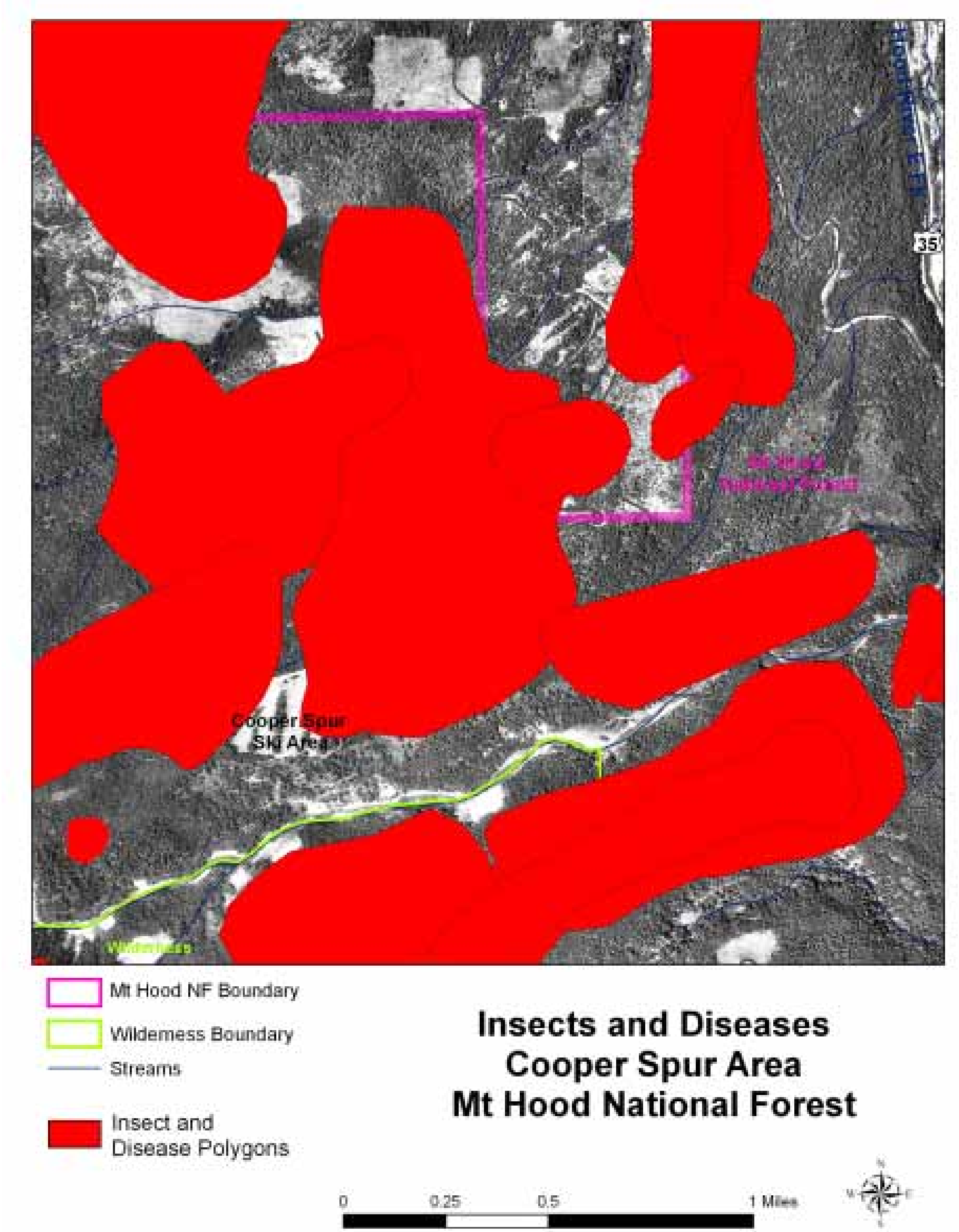


Figure 1. General layout of the insect and disease polygons from 1999-2004 in the Cooper Spur area. By displaying the polygons in this manner, without differentiating between different levels of stand mortality, it would seem that the area has experienced a devastating outbreak resulting in major tree die off across the landscape.

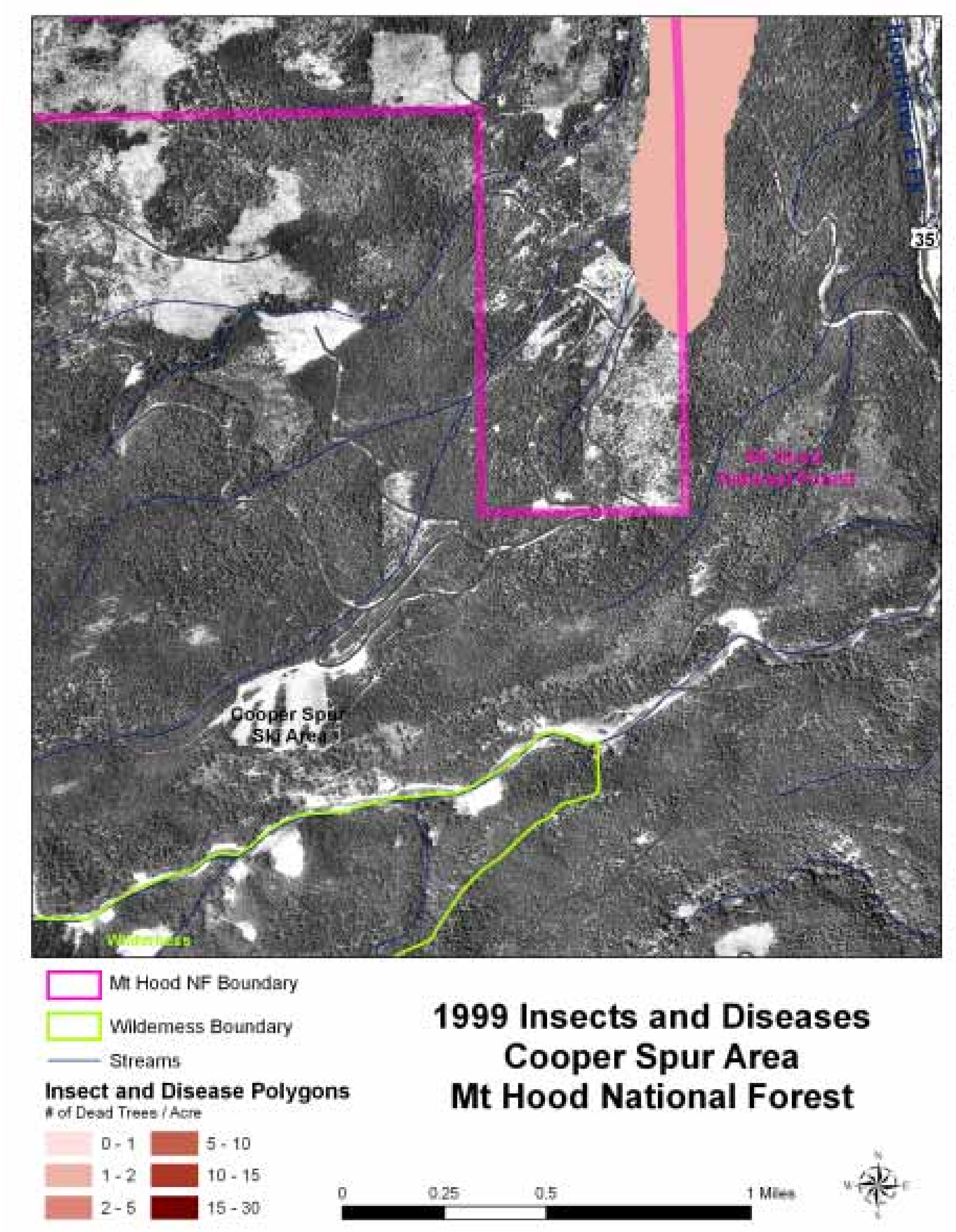


Figure 2. The polygon in the northern section of this map represents an area that has experienced a mortality rate of 1.034 trees / acre. Douglas-fir beetle is listed as the mortality agent.

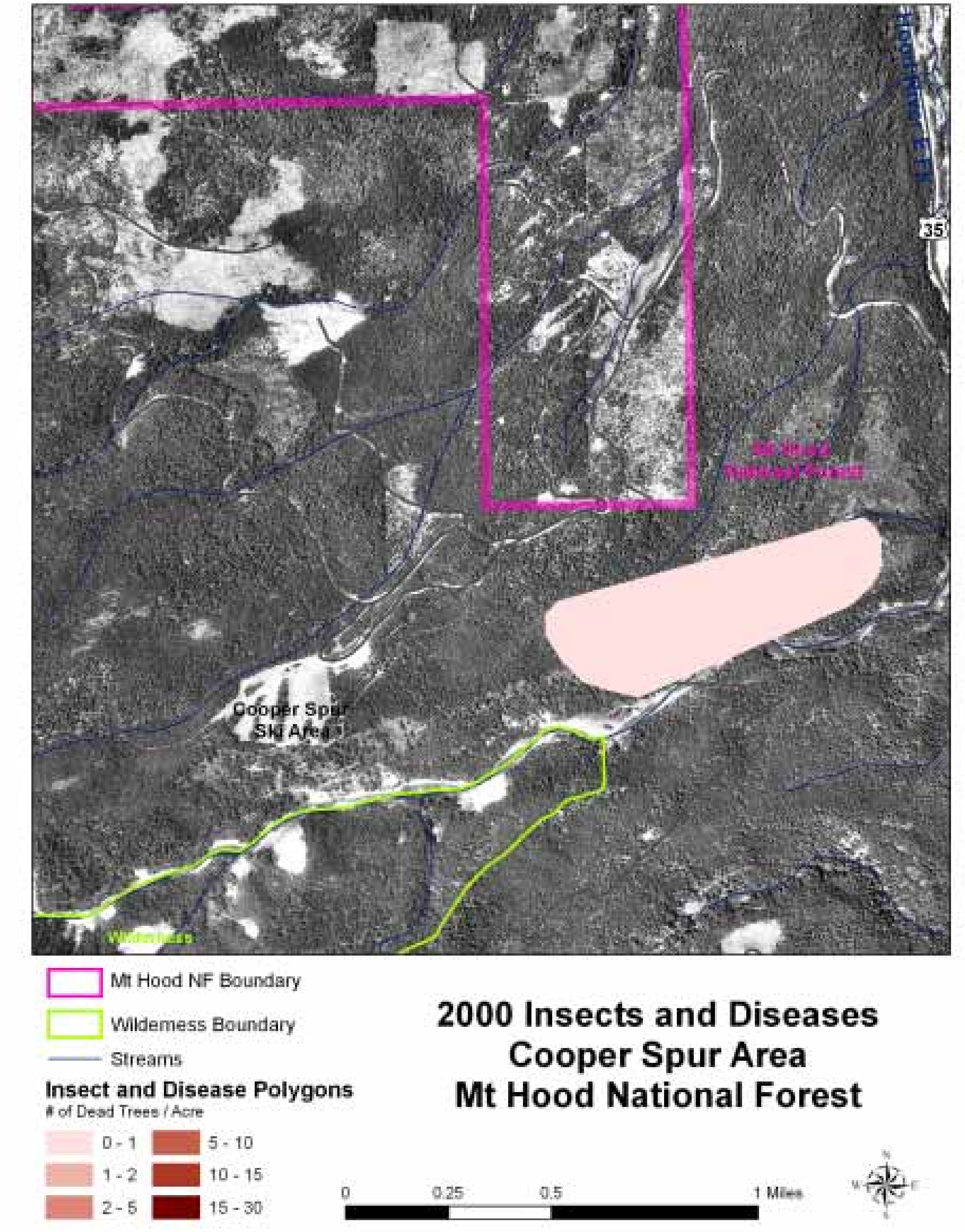


Figure 3. The single polygon on this map represents stand mortality of 0.4167 trees / acre. Douglas-fir beetle is the mortality agent.

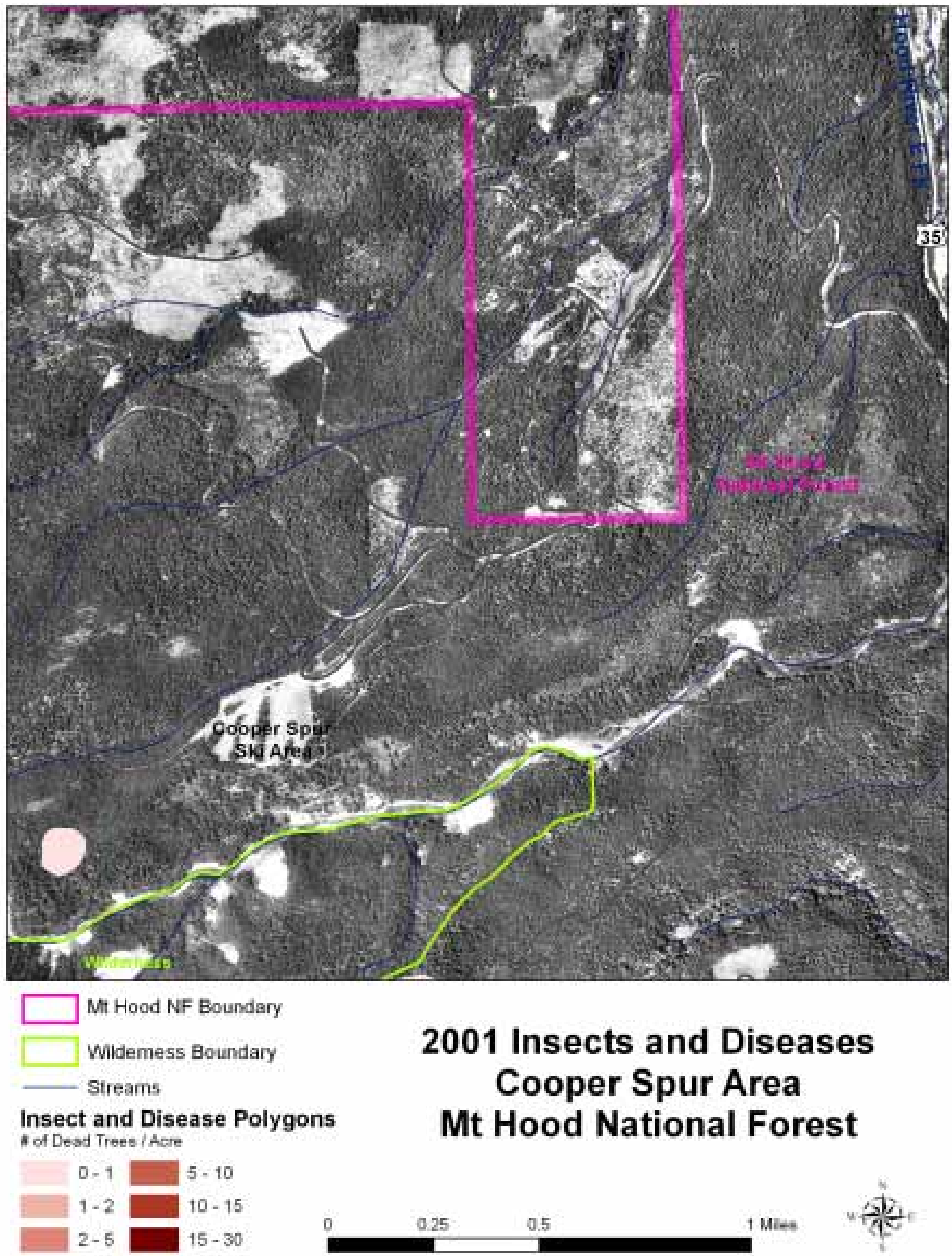


Figure 4. Fir-engraver is listed as the mortality agent for this small polygon in the southwest corner of the map. The polygon is representing a stand mortality of 0.8189 trees / acre.

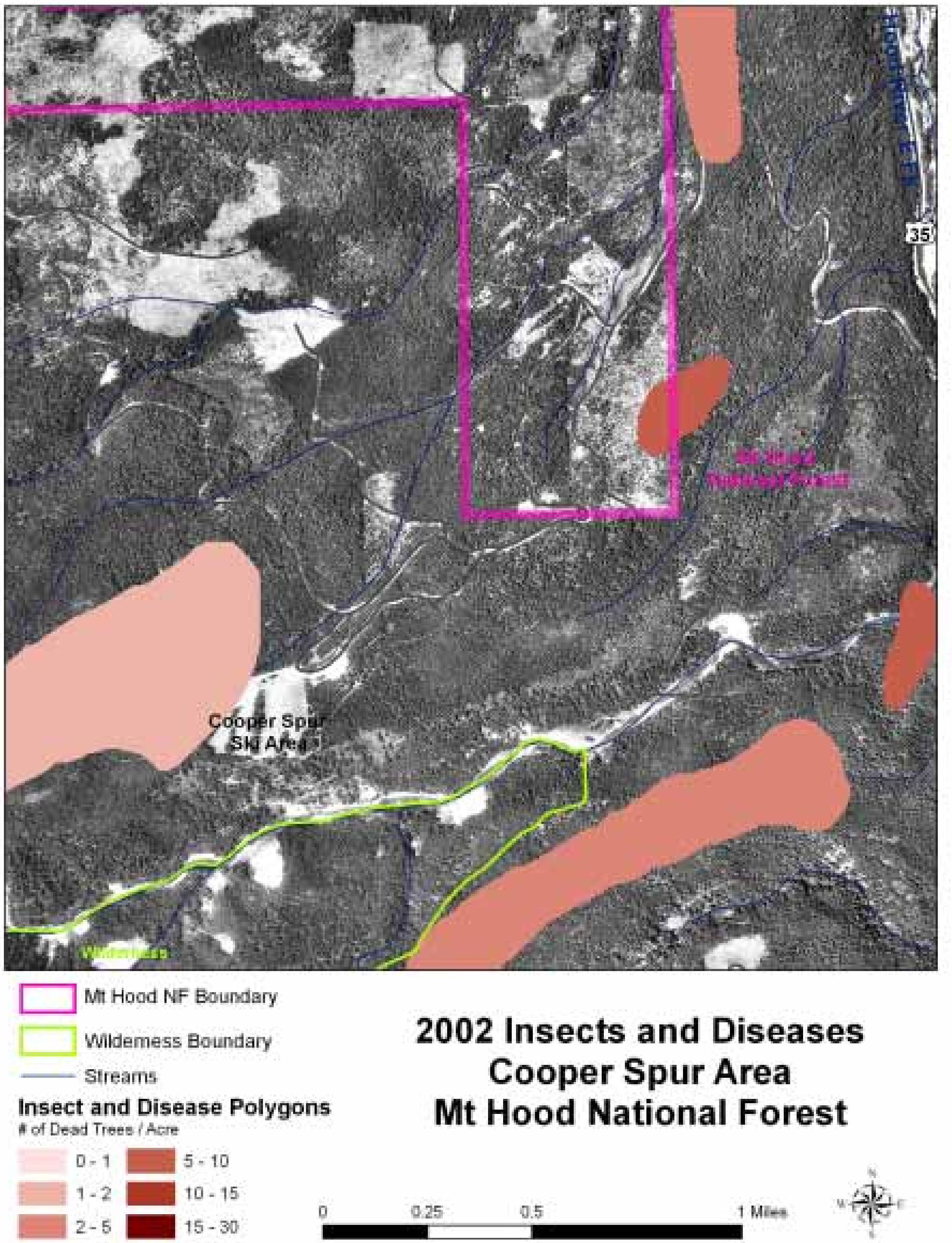


Figure 5. Mountain pine beetle is listed as the mortality agent of all of these insect and disease polygons. None of these polygons show stand mortality greater than 6 trees / acre.

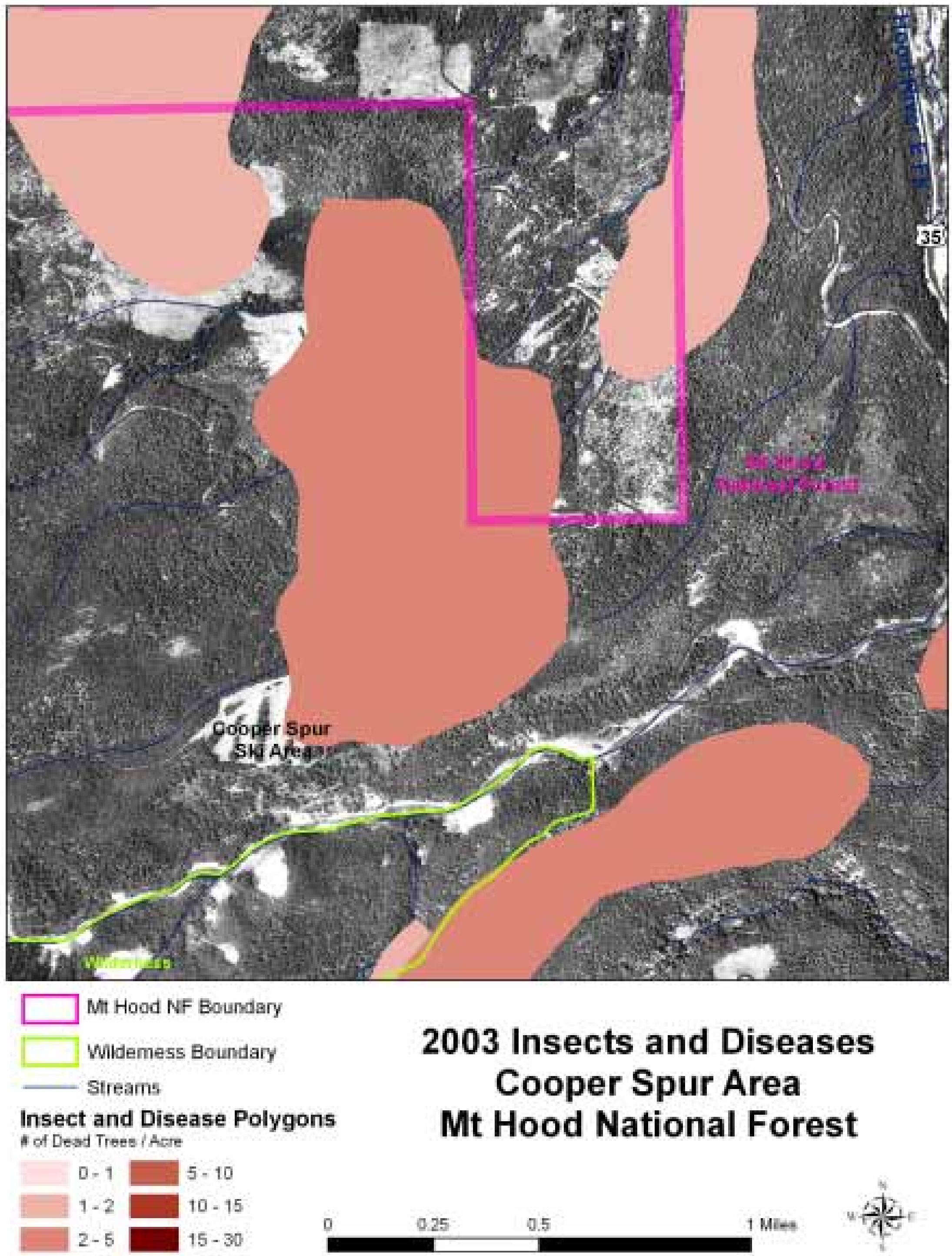


Figure 6. Fir Engraver and mountain pine beetle are the culprits behind these mortality polygons. None of these polygons shows stand mortality higher than 5 trees / acre.

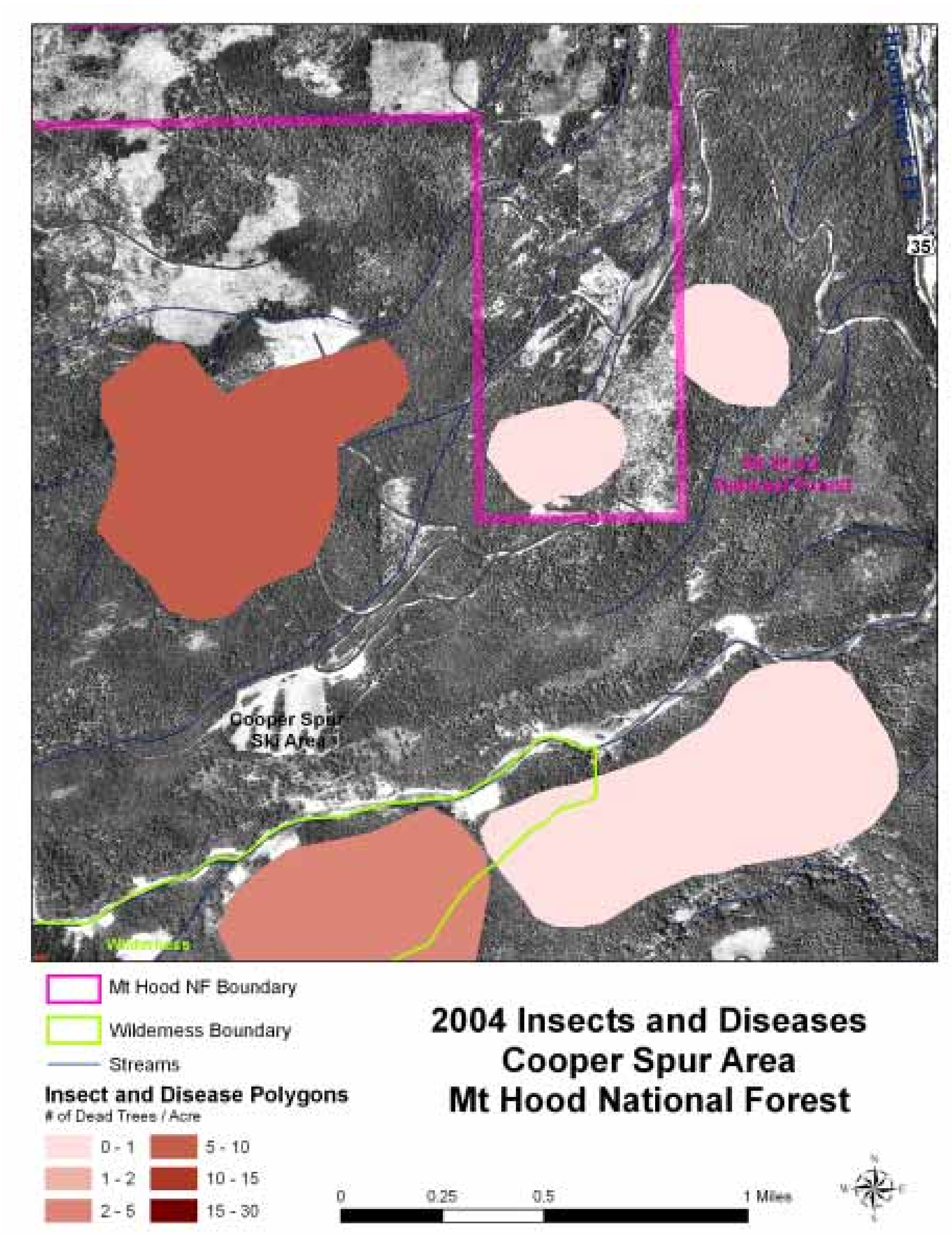


Figure 7. Mountain pine beetle is the main agent of mortality in these polygons, with western pine beetle affecting the two smallest polygons in the northeast portion of the map. The furthest west polygon in the map shows stand mortality at 8 trees / acre.

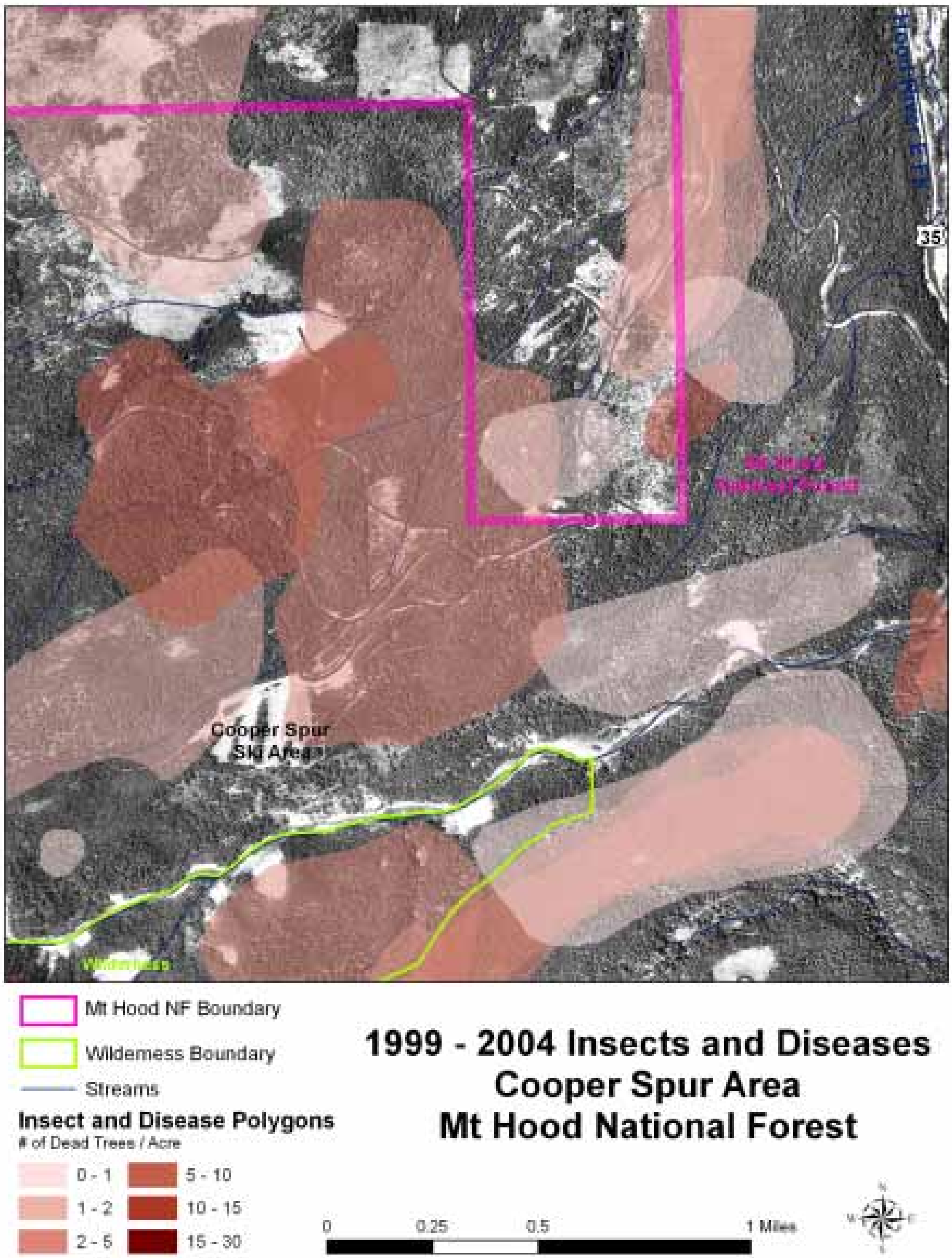


Figure 8. This map shows the same data as Figure 1, but this time the insect and disease polygons are differentiated based on levels of stand mortality. From this map, it is apparent that most of the polygons have experienced very low levels of mortality, typically less than 3 dead trees / acre. A few polygons show 5 dead trees / acre, while one polygon shows 8 dead trees / acre. These levels of mortality are normal and hardly indicate a devastating outbreak. By simply displaying the polygon data in more detail, the landscape no longer seems to be experiencing an epidemic. It is now apparent that the polygons are representing normal levels

of stand mortality, and the causal agents are mostly native insects that play important ecological roles in healthy forest ecosystems.

Further investigation into the insect and disease data reveals that accuracy issues exist in terms of delineating the boundaries of stand mortality, and in capturing consistent levels of mortality throughout a given polygon In many cases, the area of affected forest is far less than what a given polygon suggests. The following Figures (9 - 10) illustrate this issue.

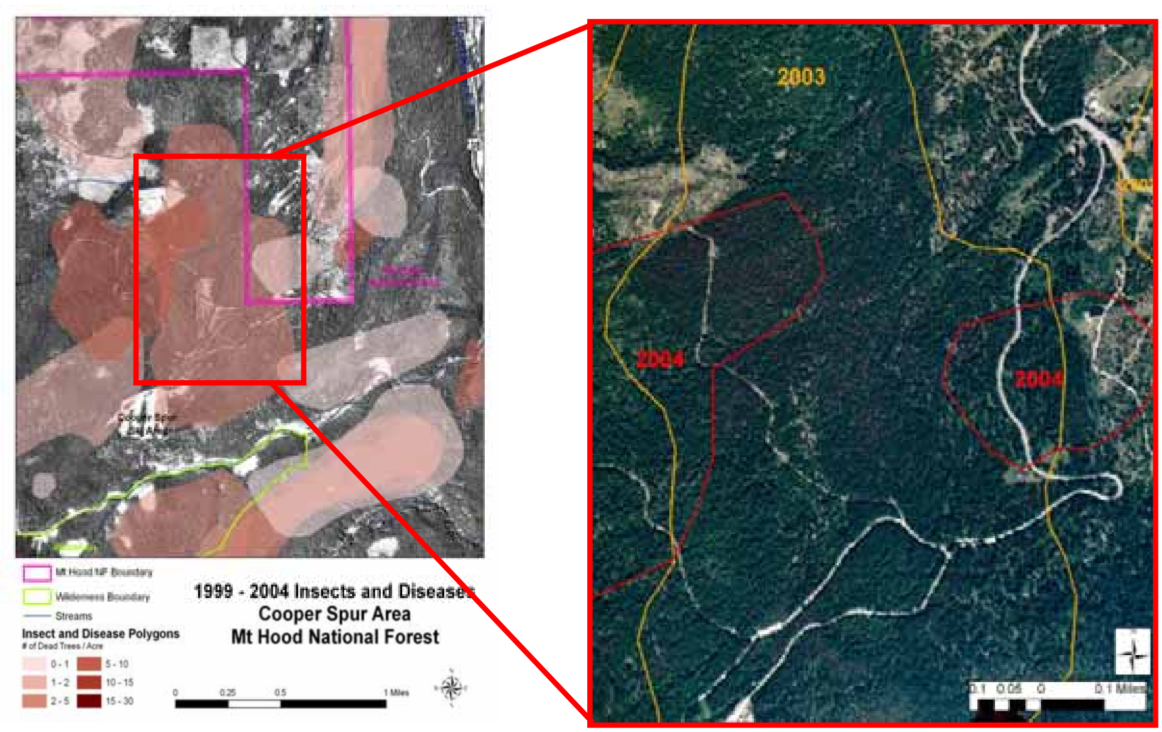


Figure 9. We will zoom further into the Cooper Spur area in order look at how accurate the insect and disease polygons are in representing consistent levels of mortality within each polygon and in delineating the extent of stand mortality.

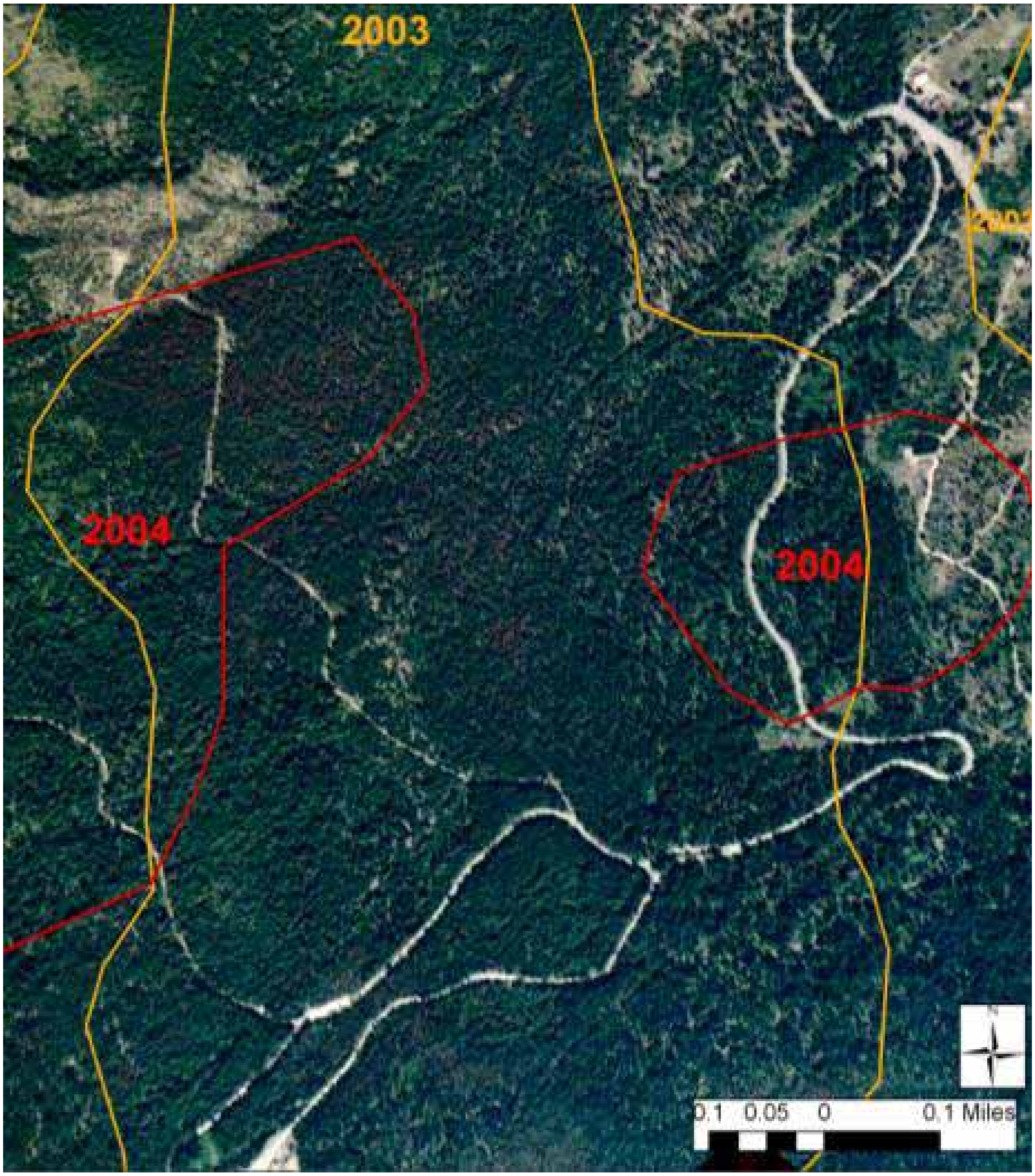


Figure 10. Here we can see that tree mortality (visible red clusters) is visible within different forest patches. Within the largest polygon displayed from 2003, there are some areas with dense clusters of dead trees, while in other areas no dead trees are apparent. This polygon is labeled as having 3 dead trees per acre. The red 2004 polygon on the right side of the photo encompasses uneven levels of mortality as well as multiple stand types: a regenerating clear cut on the right side, a more mature forest in the middle, and a less dense yet more mature forest on the left side. The polygon labeled 2004 on the left has moderate to high levels mortality in some areas, but other areas have low to no levels of mortality. This polygon is listed as having 8 dead trees / acre.

In 2004 and 2005, Pacific Biodiversity Institute visited the region where the highest amounts of mortality occurred in Figure 10. The forest in that area is in the moist grand fir to lower subalpine forest zone, where mixed conifer stands are in the stem exclusion successional phase following a large wildfire that occurred early in the twentieth century. We determined that most of the dead trees in the area are lodgepole pines (Pinus contorta), a pioneering tree species that is expected to drop out of this type of mixed conifer forest around this time in stand development (Pfister and Cole, 1985). The dead lodgepole pines had been attacked and killed by mountain pine beetle, a native insect and natural mortality agent for lodgepole pine. We did not see evidence that the insects had affected other species of tree in the area. Though tree mortality was high in some limited instances where many lodgepole pines were growing together with low numbers of other species present, throughout most of the broader area dispersed lodgepole pines were dead with many other healthy conifers dominating the forest canopy. The forest appeared to be in a healthy and natural condition and we have been told by Forest Service personnel that further pine beetle mortality seems unlikely in the area.

It is clear from this analysis that insect and disease polygons are not highly accurate at smaller spatial scales, and that they tend to over-estimate the area affected by mortality agents. Investigating the details associated with the insect and disease polygons reveals that most polygons are representing normal levels of stand mortality and do not in themselves illustrate large scale outbreaks or epidemics.

Initial Assessment of the Insect and Disease Aerial Detection Surveys across Mt Hood National Forest

The issues of polygon accuracy and display detail are consistent across the landscape of Mt Hood National Forest. The following Figures (11 - 12) provide a broader scale overview of insect and disease characteristics within the National Forest.

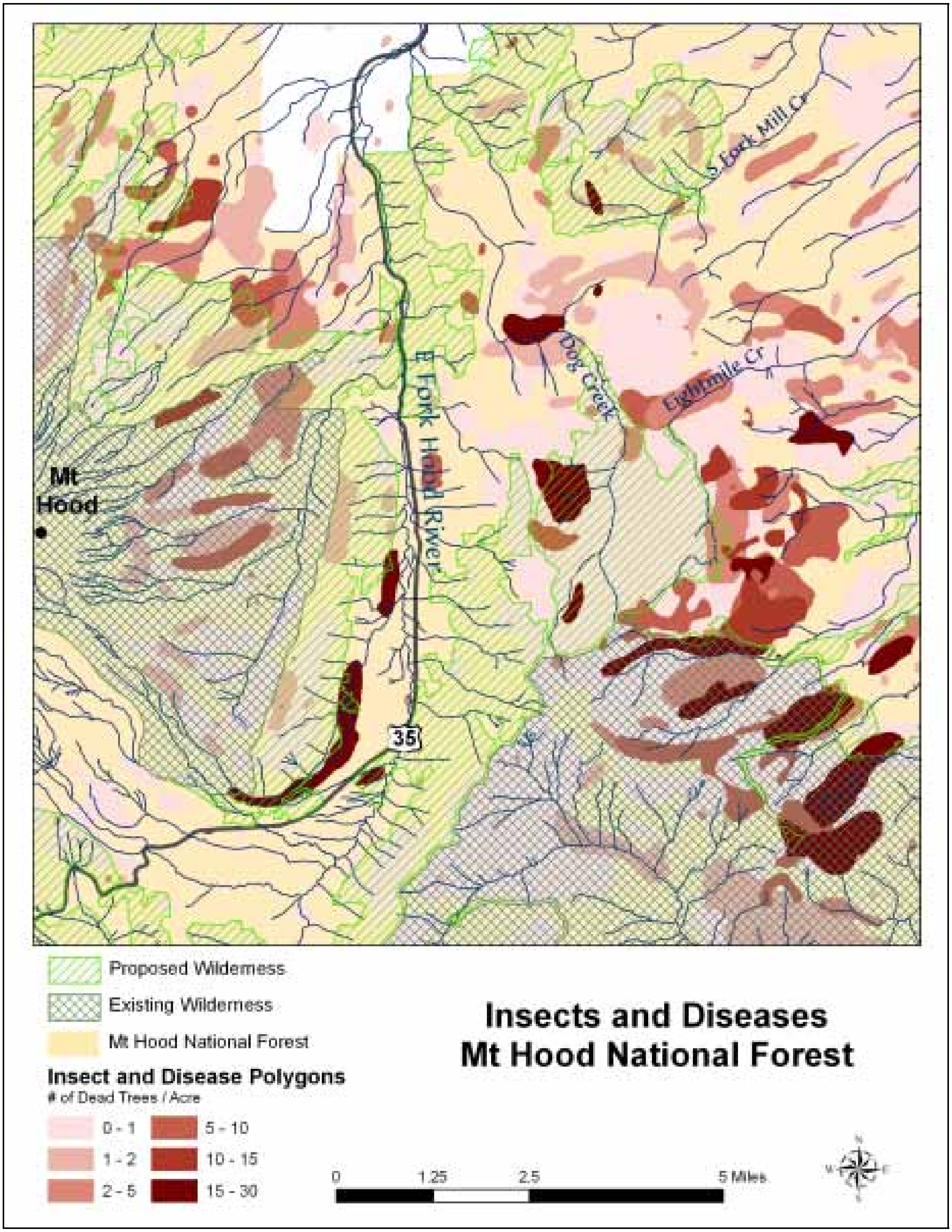


Figure 11. Insect and disease polygons cover a good portion of the eastern side of Mt Hood National Forest as seen in this map. However, most of these polygons are representing very low levels of stand mortality. The accuracy of the data is unknown.

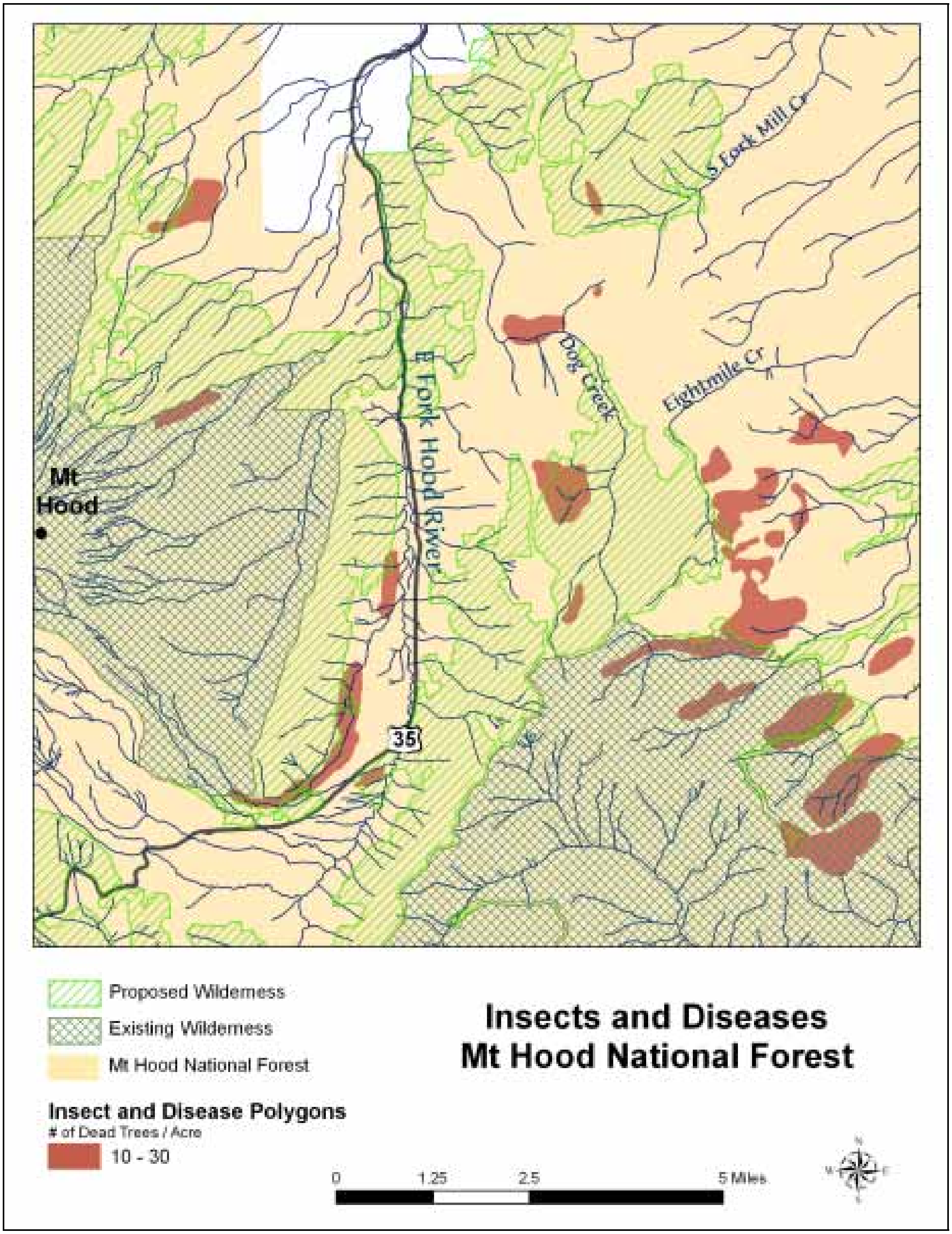


Figure 12. When we remove the lower level mortality polygons from Figure , it becomes apparent that regions of the National Forest experiencing higher levels of mortality are quite limited and that most of this mortality is occurring in a focused region on the eastern side of the National Forest. Higher levels of insect and disease mortality are occurring in both wilderness and non-wilderness areas. The accuracy of the data is unknown.

Conclusions (ADD MORE HERE)

Our site visits and analysis of the insect and disease data for the Cooper Spur area reveal that careful presentation of detail and careful scrutiny of the USFS Region 6 Forest Insect and Disease Aerial Detection Surveys needs to accompany any display of this data for the true forest health characterization of the data to be realized. Simply displaying the data without qualifying what it means can be misleading and result in misconceptions about the health of forests across a landscape. Such misconceptions are a disservice to the public and land management agencies as they can negatively impact policy and decision-making.

To its credit, the US Forest Service does provide a disclaimer along with the distribution of its insect and disease data. This disclaimer accurately depicts the appropriateness of this data for use in investigating broad level insect and disease trends across a landscape, and it also appropriately describes the need for further stand level surveys to be completed before the data can be of use at finer spatial scales. The disclaimer reads as follows,

> The insect and disease data should be used only as an indicator of insect and disease activity, and should be ground-truthed for actual causal agent and location. Polygons indicate areas of tree mortality and/or defoliation; intensity of damage is variable and not all trees indicated by polygons are dead or defoliated. The joint cooperators reserve the right to correct, modify, update or replace the data as necessary. Using this data for purposes other than those for which it was intended may yield inaccurate or misleading results. (2004 Insect and Disease Data Dictionary)

Recommendations (ADD MORE HERE)

Given the issues discussed above related to the accuracy and appropriateness of scale of the Forest Service aerial survey insect and disease data, it should be used with caution and only at a national forest or regional scale. Presentations and illustrations relying on this data should clearly state the limitations of the data. Simply displaying the polygons across a landscape without adequately illustrating the levels of mortality each polygon represents could be misleading and create the assumption that large scale insect outbreaks and/or tree mortality are plaguing that landscape.

We recommend to anyone using the Forest Service aerial survey insect and disease data read the accompanying disclaimer provided with the data dictionary. Also careful examination of forest characteristics in the field and from current high-resolution aerial imagery should be undertaken so as to avoid broad misconceptions of forest conditions across the landscape.

A thorough, state-of-the-art, accuracy assessment of the Forest Service aerial survey insect and disease data is need to determine whether this data is sufficiently accurate for forest management planning at various spatial scales.

References

Amman, G.D., M.D. McGregor, and R.E. Dolph, Jr. 1990. *Mountain Pine Beetle.* Forest Insect & Disease Leaflet 2. U.S. Department of Agriculture Forest Service. 8 p.

Amman, G.D. 1977. The role of the mountain pine beetle in lodgepole pine ecosystems: Impact of succession. In *The Role of Arthropods in Forest Ecosystems: Proceedings in the Life Science*s, ed. by W.J. Mattson, pp. 3–18. Springer–Verlag, New York, NY.

Bebi, P., D. Kulakowski, and T.T. Veblen. 2003. Interactions between fire and spruce beetles in a subalpine Rocky Mountain forest landscape. *Ecology* 84(2): 362–71.

Black, S.H. 2005. *Logging to Control Insects: The Science and Myths Behind Managing Forest Insect "Pests." A Synthesis of Independently Reviewed Researc*h. The Xerces Society for Invertebrate Conservation, Portland, OR.

Ferrell, George T. 1986. *Fir Engraver.* Forest Insect & Disease Leaflet 13. U.S. Department of Agriculture Forest Service. 8 p.

Fuchs, M. 1999. *The Ecological Role of the Mountain Pine Beetle* (Dendroctonus ponderosae*): A Description of Research from the Literatur*e. Prepared by Foxtree Ecological Consulting for British Columbia Parks Service, Victoria, BC.

Oliver, C.D. and B.C. Larson. 1996. Forest stand dynamics. New York, Wiley, 520 pp.

Pfister, R. D., D.M. Cole, 1985. The Host. p 7 - 28 in M.D. McGregor and D.M. Cole (eds.). Integrating management strategies for the mountain pine beetle with multiple-resource management of lodgepole pine. USDA, Forest Service General Technical Report INT-174

Pollet, J., and P.N. Omi. 2002. Effect of thinning and prescribed burning on crown fire severity in ponderosa pine forests. *International Journal of Wildland Fire* 11: 1–10.

Schowalter, T.D. 1994. An ecosystem-centered view of insect and disease effects on forest health. In *Sustainable Ecological Systems: Implementing an Ecological Approach to Land Managemen*t, ed. by W.W. Covington and L.F. DeBano, pp. 189–95. USDA Forest Service General Technical Report RM-247.

Turner, M.G., W.H. Romme, and R.H. Gardener. 1999. Prefire heterogeneity, fire severity, and early postfire plant reestablishment in subalpine forests of Yellowstone National Park, Wyoming. *International Journal of Wildland Fire* 9(1): 59–77.

Appendix A

USFS Region 6 Forest Insect and Disease
Aerial Detection Survey
Data Dictionary
Date: 11/2004

Region Six Insect and Disease Layers Available:

r6id1980.e00/.shp	r6id1987.e00/.shp	r6id1994.e00/.shp	r6id2001.e00/.shp
r6id1981.e00/.shp	r6id1988.e00/.shp	r6id1995.e00/.shp	r6id2002.e00/.shp
r6id1982.e00/.shp	r6id1989.e00/.shp	r6id1996.e00/.shp	r6id2003.e00/.shp
r6id1983.e00/.shp	r6id1990.e00/.shp	r6id1997.e00/.shp	r6id2004.e00/.shp
r6id1984.e00/.shp	r6id1991.e00/.shp	r6id1998.e00/.shp	
r6id1985.e00/.shp	r6id1992.e00/.shp	r6id1999.e00/.shp	
r6id1986.e00/.shp	r6id1993.e00/.shp	r6id2000.e00/.shp	

Data Description:

Theme keywords: insect, disease, tree mortality, tree defoliation, tree damage
Place keywords: Oregon and Washington
Temporal keywords: 1980-2004
Feature Class: polygon
Data source and date: various (see narrative below)
Data extent: all forested lands in Oregon and Washington (all ownerships)
Data Confidence: fair (see narrative)
Locational Confidence: fair (see narrative)
Scale: 1:100,000
Date data transferred to base: various/none (see narrative)
Projection: UTM 10
Horizontal Datum: NAD27
Units: Meters
Ellipsoid Name: Clarke 1866
Primary contact: Julie Johnson - jljohnson02@fs.fed.us/503.808.2998
Secondary contact: Sundi Sigrist – ssigrist@fs.fed.us/503.808.2995
Originator/publisher: USFS/R6/RO/Natural Resources/Forest Health Protection
Availability for download: http://www.fs.fed.us/r6/nr/fid/data.shtml
Download format: Arc/Info .e00 files; shapefiles

Column	Item	Definitio	Description

1-24			Standard coverage items
25-54	ALYYYY	30,30,C	Summary of the damaging agent(s) and the total number of current dead trees and/or severity level of the defoliation affecting that polygon; there are 1-3 damaging agents/polygon.
55-58	AGENT1	4,4,C	First damaging agent code
59-64	DAM1C	6,6,C	Number of dead trees/acre or severity level associated with the first damaging agent; character field
65-68	AGENT2	4,4,C	Second damaging agent code
69-74	DAM2C	6,6,C	Number of dead trees/acre or severity level associated with the second damaging agent; character field
75-78	AGENT3	4,4,C	Third damaging agent code
79-84	DAM3C	6,6,C	Number of dead trees/acre or severity level associated with the third damaging agent; character field
85-94	DAM1	10,10,N	Number of dead trees/acre (if present in dam1c); numeric field
95-104	DAM2	10,10,N	Number of dead trees/acre (if present in dam2c); numeric field
105-114	DAM3	10,10,N	Number of dead trees/acre (if present in dam3c); numeric field

Attribute Examples:

Example 1.) If AL2000 = ‘4-10!BS-L!1-.25A’ and the polygon is 20 acres, then:

AGENT1: 4
DAM1C: .5 (10 dead trees / 20 acre polygon = .5 dead trees/acre)
AGENT2: BS
DAM2C: L
AGENT3: 1
DAM3C: .25 (‘A’ indicates dead trees/acre; no conversion needed)
DAM1: .5
DAM2: .0
DAM3: .25

Example 2.) If AL1984 = ‘RD’ and the polygon is 10 acres, then:

AGENT1: RD
DAM1C: (no severity modifier is **required**, so this item may remain blank)
AGENT2: (there is no second damaging agent, so this item remains blank)

DAM2C: (there is no second agent severity, so this item remains blank)
AGENT3: (there is no third damaging agent, so this item remains blank)
DAM3C: (there is no third agent severity, so this item remains blank)
DAM1: .0
DAM2: .0
DAM3: .0

Process Record/Narrative:

Each year, all forested federal, state and private land in Oregon and Washington are aerially surveyed for insect and disease damage. This survey is flown cooperatively by the Region 6 US Forest Service, Forest Insects and Diseases group; the Oregon Department of Forestry, Insect and Disease Section; and the Washington Department of Natural Resources. This data is collected to determine regional insect and disease trends and to serve as an indicator to land owners/managers on insect and disease activity in their area.

Data is collected during annual surveys that are generally flown from early July through September. Historically, the surveys were flown in fixed wing aircrafts on various grid patterns. The accuracy of polygon placement and polygon attributes was limited by several factors, including: surveyor experience, weather, time of day, time of year and visibility. Areas of activity were sketched on 1:126,720 or 1:100,000 USGS quad, paper maps by two flight observers, each one sketching approximately a two mile swath out their side of the plane. After the flight, the two observer's maps were combined and overlapping polygons were resolved on a final map. The data was then manuscripted on a stable base and scanned; it was edited and attributed using Arc/Info software. All data was forced into a UTM Zone 10 projection.

In 2000, the Region 6 aerial surveyors began beta-testing a digitally assisted sketch mapping system. GeoLink software allows the surveyor to digitize and attribute the damage polygons in real time using gps and a geo-referenced, digital base map on a laptop. After the flight, the data is converted to Arcview shape files and processed. Since 2000, portions of the regional surveys have been flown using this software. Since 2003, 100% of the surveys have been flown using GeoLink. Details about the GeoLink system can be found at http://www.fs.fed.us/foresthealth/id/id_tech.html. Arc/info coverages showing when areas were flown, which data capture method was used, and who flew the areas are available on request.

Since 2003, the insect and disease data has also been posted as 100k quad .pdf maps on the web. They are best used when plotted at 36"x36", but users can also zoom in, on screen, and print a small area of interest. The 95 quad maps cover the forested areas in Oregon and Washington that are surveyed each year. The base map data is the TOPO! 100K quad series from National Geographic. Draft maps of the survey data are posted anywhere from one day to one week after the flight (between July and September) for use during the current year's field season. No draft spatial data is made available during this timeframe. Feedback from field personnel is used to help clean up the current-year data for final posting. Finalized survey maps and spatial survey data are generally posted on the website by November of the survey year. Links to these maps and data can be found at: http://www.fs.fed.us/r6/nr/fid/as/index.shtml

Disclaimer:

The insect and disease data should be used only as an indicator of insect and disease activity, and should be ground-truthed for actual causal agent and location. Polygons indicate areas of tree mortality and/or defoliation; intensity of damage is variable and not all trees indicated by polygons are dead or defoliated. The joint cooperators reserve the right to correct, modify, update or replace the data as necessary. Using this data for purposes other than those for which it was intended may yield inaccurate or misleading results.

Other Aerial Survey Insect and Disease Data:

Insect and disease detection survey digital coverages for 1955-1979 are available for the SW portion of Oregon (all ownerships) and the Blue Mountains area of Oregon; some data is available for the Olympic NF area in the 1950's. Please contact Julie Johnson at 503.808.2998 for more information.

Hard copy maps of the non-digital, insect and disease surveys from 1955-1979 are available for a copying fee. The insect and disease group will eventually have all this data available digitally and posted on the web. If you have an interest in obtaining hard copy maps of the non-digital, historic data, please contact Sundi Sigrist at 503.808.2995.

Attribute Code Lists:

BEETLES

Code	Description	Severity
1-	Douglas-fir Beetle	# of dead trees
2-	Douglas-fir Engraver	# of dead trees
3-	Engelmann Spruce Beetle	# of dead tress
4-	Fir Engraver	# of dead trees
5-	Western Balsam Bark Beetle, Sub-Alpine Fir	# of dead trees
F-	Flathead Borer	# of dead trees
6B-	Mountain Pine Beetle, Whitebark Pine	# of dead trees
6J-	Mountain Pine Beetle, Jeffrey Pine	# of dead trees
6K-	Mountain Pine Beetle, Knobcone Pine	# of dead trees
6L-	Mountain Pine Beetle, Lodgepole Pine	# of dead trees
6P-	Mountain Pine Beetle, Ponderosa Pine	# of dead trees
6S-	Mountain Pine Beetle, Sugar Pine	# of dead trees
6W-	Mountain Pine Beetle, Western White Pine	# of dead trees
7-	Pine Engraver (Historically, L/M/H was used as a modifier)	# of dead trees
8-	Western Pine Beetle	# of dead trees
88-	Western Pine Beetle, Pole-size Ponderosa Pine	# of dead trees
9-	Silver Fir Beetle	# of dead trees

OTHER INSECTS

Code	Description	Severity
AB-	Balsam Woolly Adelgid	# of dead trees - AND/OR - L/M/H*
AC-	Cooley Spruce Gall Aphid	L/M/H
AM	Maple discoloration	L/M/H
AS-	Spruce Aphid	L/M/H
BB-	Western Blackheaded Budworm	L/M/H
BM-	Modoc Budworm	L/M/H/V
BM-	Modoc Budworm	1/2/3/4**
BP-	Sugar Pine Tortrix	L/M/H
BS-	Western Spruce Budworm	L/M/H/V
BS-	Western Spruce Budworm	1/2/3/4**
CH-	Larch Casebearer/Hypodermella	L/M/H
GP-	Gouty Pitch Midge	L/M/H
HL-	Western Hemlock Looper	L/M/H
LG-	Green Striped Forest Looper	L/M/H
LL-	Larch Looper	L/M/H
LS-	Black Pine Leaf Scale	L/M/H
MD-	Douglas-fir Budmoth	L/M/H
ML-	Larch Budmoth	L/M/H
MN-	Douglas-fir Needle Midge	L/M/H
MS-	Spruce Budmoth	L/M/H
NM-	Needle Miner	L/M/H
ND-	Needle Miner, Douglas-fir	L/M/H
NJ-	Needle Miner, Jeffrey Pine	L/M/H

NK-	Needle Miner, Knobcone Pine	L/M/H
NL-	Needle Miner, Lodgepole Pine	L/M/H
NP-	Needle Miner, Ponderosa Pine	L/M/H
NS-	Needle Miner, Sugar Pine	L/M/H
NT-	Needle Miner, True Fir	L/M/H
NW-	Needle Miner, Western White Pine	L/M/H
OL-	Western Oak Looper	L/M/H
PB-	Pine Butterfly	L/M/H
PH-	Phantom Hemlock Looper	L/M/H
PM-	Pandora Moth	L/M/H
PN-	Pine Needlesheath Miner	L/M/H
PS-	Pine Needle Scale	L/M/H
S-	Spider Mite	L/M/H
SA-	Sawfly	L/M/H
SD-	Sawfly, Douglas-fir	L/M/H
SF-	Sawfly, True fir	L/M/H
SH-	Sawfly, Hemlock	L/M/H
SK-	Sawfly, Knobcone Pine	L/M/H
SL-	Sawfly, Lodgepole Pine	L/M/H
SM-	Satin Moth	L/M/H
SP-	Sawfly, Ponderosa Pine	L/M/H
SW-	Sawfly, Western Larch	L/M/H
TA-	Tent caterpillar, Alder	L/M/H
TC-	Tent caterpillar, Other	L/M/H
TM-	Douglas-fir Tussock Moth	L/M/H
TS-	Tent caterpillar, Aspen	L/M/H

*AB = Number of dead trees or L/M/H. Balsam woolley adelgid can have both mortality and severity reported because of differences in vector infestation.

1) Branch infestation causes flagging and is reported as L/M/H.
2) Bole infestation can cause tree mortality, which is reported by the number of current dead stems observed during the survey.

One polygon may have both types of damage recorded (example: AB-L!AB-15).

**The numbering system used in Oregon to reflect current budworm defoliation severities, while indicating relative cumulative damage, from 1984-1998:

1 = Current year's defoliation is visible from the air.
2 = Current year's defoliation with some bare tops visible (very little gray and still a lot of green foliage).
3 = Current year's defoliation visible with a lot of bare tops (both some gray foliage and some green foliage visible in host trees).
4 = Current year's defoliation with bare crowns (very gray in color, no visible green foliage in tree).

OTHER DAMAGING AGENTS

Code	Description	Severity
BEAR-	Bear Damage	# of dead trees (1993->present; Prior to 1993, L/M/H were used.)
BR-	Blister Rust	# of dead trees - OR – L/M/H
BY-	Bynum's Blight/Lophodermella Mordida, P.Pine	L/M/H
CC-	Cytospora Canker	L/M/H
DH-	Dying Hemlock	# of dead trees - OR - L/M/H
FIRE-	Fire Damage	# of dead trees -OR- No modifier
HAIL	Hail Damage	L/M/H
HD-	Hardwood decline	# of dead trees - OR - L/M/H
LC-	Needle cast, Lodgepole Pine	L/M/H
LW	Black Stain Root Disease (If another agent is present, no modifier is used with the LW code.)	# of dead trees -OR- no modifier
NF	Areas not flown	
OUT	No Damage Detected (in the middle of a polygon with activity)	
PC	Needle cast in Ponderosa Pine	L/M/H
PL-	Port Orford Cedar Root Disease, Phytophthora lateralis	# of dead trees - OR - L/M/H
PMD-	Pacific Madrone Decline	L/M/H
PR-	Needle Rust in Poplars	L/M/H
RC-	Needle cast, Larch	L/M/H
RB-	Red Belt	L/M/H
RD-	Root Disease (If another agent is present, no modifier is used with the RD code.)	# of dead trees - OR – No modifier
SLID-	Slide	# of dead trees -OR- No modifier
SNC -	Swiss Needle Cast	L/M/H
UNKD-	Unknown defoliation	L/M/H
UNKM-	Unknown mortality	# of dead trees
WATR-	Water Damage	# of dead trees - OR – No modifier
WIND	Wind-throw	# of dead trees -OR- No modifier
WNTR	Winter Damage	# of dead trees - OR- no modifier

Kim Schmolt's description of forest:
Lodgepole pine in the area is a result of the last fire disturbance, sometime around 1910. As lodgepole goes out, in the absence of disturbance, stand will eventually advance into the potential "climax" vegetation of silver fir or Douglas-fir. The majority of area within WUI on national forest system land is in the mature stem exclusion phase, followed by late seral, stem exclusion, and stand initiation.